Pre-Programmed Descent with Modification: Functional Integrity, Intelligent Design, and Natural History

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In this paper, I present the bare bones of a hypothesis that may prove useful to evangelical scientists striving to develop a Christian view of natural history. It is not a form of special creationism, for it allows for the great antiquity of the earth and does not insist that God created all or even most extant species separately in the beginning. It is not a form of theistic evolution, though it affirms descent with modification. It is not a form of progressive creationism, for it does not posit many separate, direct creative acts over the course of geologic time to account for discontinuities in the fossil record. The hypothesis proposes a kind of functional integrity in the original biota, enough functional integrity to obviate the necessity of God's repeatedly creating new taxa throughout the several billion years of natural history. Methodological naturalists, however, are unlikely to accept the kind of functional integrity proposed here, for I view the information contained in DNA as the product of intelligent design. For convenience, the hypothesis I advance may be labeled pre-programmed descent with modification (PPDM).

The Role of the Logos in Creation

Any Christian view of natural history must take into account both Holy Scripture and the relevant natural phenomena. We could start with either as long as we deal fully with both before we are through. We begin with Holy Scripture.

In the prologue to his gospel, the apostle John calls Jesus the *Word* (John 1:1-18; see also Rev. 19:13). The Greek word John uses is *Logos*. Like the English *word*, the Greek *logos*

can mean a syllable or combination of syllables bearing a meaning or a message. But *Logos* had a broader, deeper meaning in Hellenistic Greek, a meaning John must have had in mind when he wrote his gospel. "The word Logos can mean nearly any expression of thought: it means book, word, ratio, theory, or argument."[1] When John calls Jesus the *Logos* who created all things (John 1:1-4), he means that Jesus is the rational and spiritual First Principle of creation, the source of its being, form, and order.

Augustine and Calvin both understood the Johannine concept of Jesus as the *Logos* and used it in their interpretations of the words "and God said" in Genesis 1. They took those words anthropomorphically, as God's way of stating that it was by means of his Son that he created the heavens and the earth and all their parts. Augustine wrote (emphasis added):

> It must therefore be that you spoke and they were made. In your word alone you created them. But how did you speak? ... It is this way, then, that you mean us to understand your Word*, who is God with you, God with God*, your Word uttered eternally ... and it is by this Word that all things are made which you say are to be made. You create them by your Word alone and in no other way.[2]

Calvin adopts the same view (emphasis added):

> The Word was truly God. And this is clearly enough shown by Moses in his account of the creation, *where he places the Word as intermediate*. For why does he distinctly narrate that God, in creating each of his works, *said*, Let there be this--let there be that, unless that the unsearchable glory of God might shine forth in his image? I know prattlers would easily evade this, by saying that Word is used for order or command; but the apostles are better expositors, when they tell us that *the worlds were created by the Son*.[3]

This paper builds on the centrality of the *Logos* in creation, as stated by the Apostle John and emphasized by Augustine and Calvin. Jesus Christ, the *Logos*, is the source of all the form and order in the world, including that exhibited by living organisms past and present.

Functional Integrity and Information

No doubt all Christians in the sciences would subscribe to the central role of the *Logos* in creation as a general principle, but how the *Logos* accomplished the work of creation is subject to debate. Apart from young-earth creationists, whose views will not be dealt with here, there are two schools of thought forming in the Christian scientific community, the Functional Integrity (FI) school and the Intelligent Design (ID) school.

Increasing numbers of Christians in science are adopting a philosophical position denominated *non-reductive physicalism*, *substance monism*, or *theistic monism*.[4] They hypothesize that the matter and energy created "in the beginning" (Gen. 1:1-2) exhibited such a robust "functional integrity" that the first living organisms arose out of nonliving matter without subsequent direct divine intervention.[5]

The FI hypothesis is not really new. As early as 1837, Charles Babbage, inventor of the first calculating machine, proposed its equivalent in the Ninth Bridgewater Treatise:

To call into existence all the variety of vegetable forms, as they become fitted to exist, by the successive adaptations of their parent earth, is undoubtedly a high exertion of creative power ... To change, from time to time, after lengthened periods, the races which exist, as altered physical circumstances may render their abode more or less congenial to their habits, by allowing the natural extinction of some races, and by supplying by a new creation others more fitted to occupy the place previously abandoned, is still but the exercise of the same benevolent power ... But, to have *foreseen*, at the creation of matter and mind ... all these changes, and to have provided, by one comprehensive law, for all that should ever occur ... manifests a degree of power and of knowledge of a far higher order.[6]

Babbage's philosophical preference for an initial creation able to undergo a natural history free from multiple, successive divine interventions is attractive to the contemporary FI proponents. Yet the assumption that the laws of chemistry and physics (including, for Babbage, some yet-to-be-discovered "one comprehensive law") can account for natural history remains an article of faith rather than a hypothesis validated by scientific evidence. Nearly fifty years after Miller's famous experiment, "origin-of-lifers" have failed to provide a plausible scenario for the abiogenic origin of life.[7] Indeed, the implausibility of chemical evolution has become so apparent that Dean Kenyon, a noted proponent of "biochemical predestination" thirty years ago, now concludes that only ID can account for the existence of organisms.[8]

ID proponents have good reasons for maintaining that nonliving matter and energy alone cannot produce life. Living organisms carry *information* in their genes. Norbert Wiener, the noted information theorist and a materialist himself, stated well the dilemma faced by materialists of all kinds:

The mechanical brain does not secrete thought "as the liver does bile," as earlier materialists claimed, nor does it put it out in the form of energy, as the muscle puts out its activity. Information is information, not matter or energy. No materialism which does not admit this can survive at the present day.[9]

John von Neumann, another giant in information theory and a contemporary of Wiener, saw clearly the application of this truth to biology. In a 1955 letter to the physicist George Gamow, he wrote: "I shudder at the thought that highly efficient purposive organizational elements, like the protein, should originate in a random process."[10]

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Wiener and von Neumann have been dead for more than a third of a century now. Despite many advances in information theory, no one has yet proposed a convincing materialistic scenario accounting for the existence of the information that produces the kind of specified complexity exhibited by living organisms. Hubert Yockey, a contemporary information theorist, concludes that the information contained in the genes

of even the simplest organisms could not have arisen through the operation of the laws of physics and chemistry in a world consisting only of matter and energy. He notes:

Regarding the protobiont as a von Neumann machine ... it must have between 10^5 and 10^6 bits on its genome in order to metabolize and replicate ... this means that the protobiont must be able to specify between 267 and 2670 proteins. I have shown ... that none of the origin of life scenarios suggested at present comes even close to these figures.

The reason that there are principles of biology that cannot be deduced from the laws of physics and chemistry lies not in some esoteric philosophy but simply in the mathematical fact that the genetic information content of the genome for constructing even the simplest organisms is much larger than the information content of these laws.[11]

ID theorists view the continued pursuit of such a scenario as quixotic; they agree with Yockey that information cannot arise by random natural processes as hypothesized in any system based on reductive physicalism.[12] The burden of proof is clearly on the FI school to demonstrate the contrary.

Shortcomings of Current Popular Approaches to Origins and Natural History

Valid as the ID arguments are, they are incomplete. ID theory has not yet proposed a view of natural history, only the argument that the appearance of design and the presence of information in genes cannot be satisfactorily accounted for save by an Intelligent Designer. What kind of scenario can we hypothesize regarding the work of the *Logos*, not in writing the genomes of his creatures (an instantaneous act without a natural history), but in superintending the unfolding history of life on earth? Young-earth special creation, theistic evolution, and old-earth progressive creation are the views most widespread in Christian circles. But none of them is very satisfactory.

Special creation is not a viable option. The evidence of geology overwhelmingly points to an earth several billion years old, and the fossil record reveals that new taxa continued to appear on earth throughout the course of natural history.[13]

Theistic evolution, too, is unsatisfactory. Traditional theistic evolution grants the Creator an immediate role in creating the first simple life forms, then relegates him to the providential ordering of random mutation and natural selection as secondary causes. An apparently insuperable difficulty for this view is that the later appearance of higher organisms would require the generation of more and more complex information by random natural processes. Truly random action, however, destroys information. Random mutation followed by natural selection cannot generate more information than that which God wrote in the genomes of the simple organisms he created in the beginning.

Theistic evolution, moreover, is faced with discontinuities in the fossil record that simply ought not to exist if random mutation followed by natural selection is the mechanism responsible for descent with modification. It is no longer possible to plead the imperfection of the fossil record as Darwin did.[14] Though incomplete, the fossil record of life on earth, at least since the Cambrian explosion, is very full.[15] The geologically

sudden appearance of new taxa without close intermediate forms linking them to older taxa requires an explanation.

Contemporary paleontologists are willing to acknowledge the relative fullness of the fossil record. No one has said it better than Stephen Jay Gould:

> [The] extraordinary abundance of some fossils illustrates something important about the history of life. Evolution is a theory about change through time-- "descent with modification," in Darwin's words. Yet, when fossils are most abundant during substantial stretches of time, well-represented species are usually stable throughout their temporal range, or alter so little and in such superficial ways (usually in size alone), that an extrapolation of observed change into longer periods of geological time could not possibly yield the extensive modifications that mark general pathways of evolution in larger groups. Most of the time, when the evidence is best, nothing much happens to most species ... we note the paradox: nothing much happens for most of the time when evidence abounds: everything [by way of evolutionary change] happens in largely unrecorded geological moments.[16]

The rarity of transitional fossil forms does not shake Gould's confidence in evolution, for he and other biologists have developed the well-known theory of *punctuated equilibria* to account for supposed gaps in the stratigraphic record.The theory (though not the label) of punctuated equilibria goes back at least as far 1936, when Schindewolf proposed (as summarized by R. Goldschmidt) that "macroevolution on a higher level takes place in an explosive way within a short geological time, followed by a slower series of orthogenetic perfections." [17] Nevertheless, punctuated equilibria cannot provide positive proof for any mechanism of change, as acknowledged by Niles Eldridge: "by the very rules of the game paleontologists *cannot* say anything about the rules of genetic transmission or genetic change" (emphasis in the original).[18] The punctuationists have forced biologists to come to grips with the reality that natural history was mostly stasis, and that episodes of change were extremely brief (in geological terms), but they have not proved-- admittedly cannot prove--that those episodes proceeded by evolutionary mechanisms. We will see that the paleontological evidence supporting punctuated equilibria can be interpreted nicely in terms of PPDM.

Finally, the principle of "irreducible complexity," proposed and argued vigorously and persuasively in recent years by ID biochemist Michael Behe, requires that multiple genetic changes occur *simultaneously*, in one generation, to produce functioning limbs, organs, and systems.[19] In the punctuated equilibria model, episodes of change occupy only brief intervals of time, but those intervals still involve many generations. Evolutionary change cannot be compressed into a single generation, yet multiple, simultaneous genetic changes within a single generation are exactly what had to take place.

If, on the other hand, we accept the fossil record as a valid sample of life on earth through time, we must seek another explanation. One such explanation proposed by biologists of an earlier generation was the theory of *saltations*, i.e., the theory that certain mutations result in offspring with a large number of simultaneous morphological changes. Richard Goldschmidt, of "hopeful monster" fame, believed that chromosomal pattern mutations might do just that. He states:

> The discoveries just discussed ... have led me to believe that a pattern change in the chromosomes, completely independent of gene mutations, nay, even of the concept of the gene, will furnish this new method of macromutation ... a new phenotype emerges, the new species, separated from the old one by a

bridgeless gap and an incompatible chromosomal pattern. "Emergent evolution" but without the mysticism![20]

A better understanding of genetics has rendered Goldschmidt's hypothesis untenable. We now know it takes many mutations to bring about multiple morphological changes. Even a mutation in a homeotic gene cannot bring about multiple morphological changes without the preexistence of multiple inactive genes subject to its control.

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Is progressive creation the only alternative left to us? Let us hope not. The progressive creation hypothesis views God's direct role in creation as consisting of separate creative acts spread out over several billion years of time. Ramm admits only to "several acts of fiat creation in the history of the earth," and makes a distinction between *fiat creation* and *process, or derivative creation.*[21] He sees most of God's creative work as *process creation* carried out by the "Divine Entelechy of Nature," i.e., the Spirit of God working in creation. But Ramm's view reduces to "punctuated theistic evolution," i.e., long intervals of evolution interrupted by a few acts of direct divine intervention.[22] Such a view is liable to the criticisms of full-blown theistic evolution voiced above.

An alternative view still within the progressive creation framework would be to propose numerous divine interventions throughout the course of natural history, each followed by microevolutionary diversification. The abrupt appearance of an important new *Bauplan* in the fossil record would indicate that God acted at that time to bring that taxon into being. This alternative progressive creation view would necessitate thousands of fiat creative acts over several billion years.

I submit that [Gen. 1] is most naturally read as indicating that the Logos acted directly but a few times, and then allowed secondary causes to work.

A serious problem with the alternative view is that Genesis 1 does not lend itself to being read as an account of creative activity spread out over the entire span of life on earth. We have seen that the creation account in Genesis 1 uses anthropomorphic language to

express creation by Jesus Christ, the Word of God. Creation over six days should likewise be considered an anthropomorphism. Collins states:

> The simplest explanation for these six days is that they are anthropomorphisms: that is, they are "God's days." This view, far from being an imposition on the text, arises naturally from several considerations in the narrative itself. First, the story of Gen. 1-2 pictures God as a craftsman, industriously making and shaping his creation. Indeed, 2:7 portrays God as a potter when it says he "formed" man; and of course when God "breathed" into the man that is a recognisable anthropomorphism.[23]

Anthropomorphic language, though not "literal" in the commonly understood sense of that word, still conveys objective meaning. We do not have liberty to read Genesis 1 any way we please, but must seek to understand the text as the divine Author intended it to be understood. I submit that the text is most naturally read as indicating that the *Logos* acted directly but a few times, and then allowed secondary causes to work. God commanded, "Let the earth put forth vegetation," and "the earth brought forth vegetation" (Gen. 1:11-12). God said, "Let the waters bring forth swarms of living creatures" (Gen. 1:20), and the waters brought them forth. God said, "Let the earth bring forth living creatures," and it was so (Gen. 1:24). The biblical text presents God's work in each of these cases as a *word*, i.e., the direct action of the *Logos*, followed by the earth and waters putting forth, i.e., the action of secondary causes. Progressive creation according to this scheme requires too many direct acts of the Creator over too long a period of time to fit the text comfortably.

Pre-Programmed Descent with Modification

I have listed several unsatisfactory hypotheses regarding creation and natural history. Let me advance a new one, stating at the outset that what follows is only a bare-bones hypothesis that needs to be fleshed out and subjected to critical evaluation.

I propose that *all* the genomes (perhaps we should call them *logoi* in recognition of their source) of *all* the species that ever were to be, were written in the DNA of the first created organisms. The appearance of new taxa over the course of natural history was brought about by the action of master regulatory genes that switched off batteries of genes and switched on others. Those regulatory genes became active in response to biological clocks that measure time in millions of generations or cell divisions or years.

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Natural history viewed as PPDM unfolded somewhat as individual development unfolds.[24] Consider the way genes control the growth and development of an individual organism over the course of its lifetime--a human being, for example. We possess latent

genes that get switched on at predetermined times in our life; we also possess genes that get switched off at predetermined times. The changes that result from such gene action are most profound during early embryonic development, but the switching on and off of genes occurs throughout the course of life. Permanent teeth start to grow at about age seven. The changes associated with puberty come at about age twelve for girls, a little later for boys. As men age, they develop more body hair. Men may go bald; both sexes may grow gray. Women undergo menopause in mid-life.

Such changes are timed and initiated internally by biological clocks. Environmental factors may retard or advance the onset of some of these processes, but who doubts that their onset and nature are ultimately under genetic control?

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I propose that gene action in a taxonomic line over a long period of time was similar to what we know of gene action in the individual organism over the course of a lifetime. The species God first created possessed latent genes--"junk DNA" as far as those first organisms were concerned, but genes that would be needed by species pre-programmed to descend from them.[25] Included in a species' DNA were genetic clocks which were passed on, "ticking" all the while, from one generation to the next.[26]

More than fifty years ago, Goldschmidt hypothesized that the kind of discontinuous changes seen in the fossil record could be bridged by the birth of "hopeful monsters," that is, offspring differing in many morphological ways from their parents.[27] Adherents of the synthetic theory rejected Goldschmidt's hypothesis because they could not see how evolution could proceed except by cumulative, one-at-a-time, point mutations. They were right. That is the only way *evolution* could proceed. But Goldschmidt was right, too. There had to be many simultaneous morphological changes to yield the pattern of virtually instantaneous species appearance, which was the norm in natural history as revealed by the fossil record. The hypothesis of pre-programmed, latent *logoi* renders Goldschmidt's general idea credible.

The notion of pre-programmed genes that become operable after a given number of generations (or cell divisions or years) is strengthened by the existence of analogous computer programs. Software manufacturers do not want their customers to buy one copy of an application and install it on a hundred computers. To foil this practice, some applications are written such that they can be copied only a limited number of times; then they foul themselves up. If computer programs can count generations or copies and bring

new subroutines into play after a given number of generations, genes could carry the same kind of information.

Genetic pre-programming may also account for the sudden (in geological time) extinction of a species or higher taxon. What if God built into crinoids, ammonites, and dinosaurs master genes that, after so many million generations, switched off other genes necessary for life? Many theories have been advanced to account for mass extinctions, most centering on external causes, all raising as many questions as they purport to answer. The notion of pre-programmed extinction is at least as tenable as other extant theories, and it has the virtue of being a corollary of a more general theory of natural history.

Objections to the Hypothesis

One might object that we can already explain the existence of fossil DNA on an evolutionary basis. Evolutionary biologists also hypothesize that junk DNA contains fossil or vestigial DNA; they would certainly concur that such DNA is inactive.[28] But the PPDM hypothesis proposes that *multiple* genetic changes were triggered *simultaneously*. If so, junk DNA will be found to contain many genes of each predecessor species. The evolutionary paradigm suggests that fossil genes were preserved by chance. There is no evolutionary basis for explaining why an assemblage of, say, 50 to 100 genes from a single predecessor species would be preserved and none from intermediate species; yet that is what will be found if the PPDM hypothesis is correct. This objection, then, soon will be testable, as discussed below.

A more serious objection to PPDM questions the synchronization of genetic clocks after several million years. For species that breed only once, there is no difficulty. Consider the "17-year locust," or periodical cicada (*Magicicada septendecim)*. Every seventeen years hordes of cicadas emerge *en masse* from underground to mate once, lay eggs, and die. The internal clocks of the cicadas in a particular "brood" have remained synchronized for perhaps many millions of years.[29]

Species that produce offspring several times in a lifetime present a more complicated picture. The first offspring produced by the originally created population of such a species will mature sexually sooner than later offspring. Their first offspring will mature sexually sooner than their younger siblings, and even sooner than the last offspring of the last offspring of the founding generation. The appearance of the n^{th} generation, where the molecular clock goes off, might be spread out over such a long interval of time that there would never be enough of the new species to establish a breeding population.

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Data unearthed (literally) by Eldridge furnish an answer to this objection.[30] He discovered that the trilobite species, *Phacops milleri*, was succeeded by the similar species, *Phacops rana,* in a geologically short time period. The two species overlapped in the same thirty-five feet of strata, representing a time period of 1,000-10,000 years--an eyeblink in geological time. Eldridge interprets the fossil record as evidence for punctuated equilibria and attributes the change to evolutionary mechanisms; but it also can be interpreted as indicating a fairly short interval during which genetic clocks were going off in various members of the n^{th} generation of *Phacops milleri*. The first *Phacops rana* born from the pioneers of the n^{th} generation of *Phacops milleri* coexisted with the *Phacops milleri* stragglers whose *n*th generation was yet to be born, and whose genetic clocks had not yet struck midnight.

But what about species that breed *continuously*, like the collared lemming of the tundra? Females are ready to breed a month or so after birth and may breed monthly after that, year-round. A given male may impregnate its mother, daughter, granddaughter, etc., on the same day. It is difficult to imagine how collared lemming clocks could remain synchronized over several million years. The answer to the collared lemming problem is that an extant species has no need for synchronized genetic clocks. I hypothesize that most, if not all, extant species represent the end of a pre-ordained line of descent. Microevolution may continue, but pre-programmed descent with modification probably has ceased.[31]

Another objection to the PPDM hypothesis is that it seems to require the first-created species at the beginning of a line of descent to have the same number of genes as those at the end; the only difference would be which genes were switched on and which were switched off. Can we believe that very simple organisms contain as much genetic material as higher ones? In some cases, clearly, they do not; but in other cases they do--presenting more of a problem for evolutionary biologists than for me! Goldschmidt states:

> Now the hardly organized protozoan *Monocystis* has chromosomes of the same order of magnitude as those of the highest animals and plants ... If Roux's analysis is correct--and how can it be otherwise-- *Monocystis* must have approximately the same number of genes as some higher animals and plants.[32]

Studies in developmental biology suggest another possible objection to PPDM.[33] The developmental program of a fertilized egg appears to reside in its microtubule array and membrane patterns. DNA controls the manufacture of the protein units making up the microtubules and cell membranes, but it does not control the way they assemble together. Centrosomes control the formation of the microtubule array, and pre-existing membranes control the formation of new membranes. But centrosomes and membrane patterns are inherited independently of DNA. If we believe in descent with modification at all, we must believe that centrosomes and membrane patterns have descended with modification, too. But can PPDM, a genetic theory, account for inheritance independent of DNA?

In its present embryonic form, PPDM does not offer an explanation for inheritance independent of DNA. But failure to explain a fact does not infirm a hypothesis; it only shows that a hypothesis is not comprehensive. It is only when facts cry out for

explanation that failure to account for them becomes critical. While I anticipate that future elaboration of the PPDM hypothesis will yield a theory comprehensive enough to account for inheritance independent of DNA, I do not believe that this lacuna is a killing defect at the present time.

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Finally, someone may object that PPDM smacks of vitalism. I hope no one who has read this paper carefully will think so. The *Logos* is not an immanent life force manifesting itself in the self-development of the biosphere. It is information written in the genes by the *Logos*, who is external to his creation, not some resident *elan vital* that drives descent with modification forward. Once the *logoi* were written, the outworking of natural history was largely pre-programmed. Natural history was like the execution of a computer program, not the self-expression of an inner "impulse of life."[34]

A Testable Hypothesis

The PPDM hypothesis is, or presently will be, testable. The genomes of various species, including *Homo sapiens*, are being elucidated experimentally even as this paper is being written. It is already known that from seventy to ninety percent of a species' DNA is junk DNA. If the PPDM hypothesis is correct, some of that junk DNA consists of deactivated or repressed genes of predecessor species; if PPDM has not entirely ceased, some of that junk DNA consists of latent genes for species yet to emerge. Moreover, whole batteries of deactivated or repressed genes from a particular predecessor species are likely to be found in a successor species. In addition to deactivated or repressed genes of predecessor species, a species' junk DNA will prove to contain molecular clocks that kept time for millions of generations, cell divisions, or years.

It may eventually prove possible to trace the natural history of a species by identifying the species to which the deactivated or repressed genes belong. I cited the lack of a natural history as a deficiency of theories currently held by Christians in the sciences. While the PPDM hypothesis does not supply a natural history per se, it does provide a means of elucidating one.

Again: PPDM is a bare-bones hypothesis. God willing, it will stimulate debate along fresh lines and contribute to the development of a new view of natural history that explains known phenomena better than current theories, serves as a research program for future investigation, and honors the Word of God.

Notes

[1]G. H. Clark, *Thales to Dewey* (Jefferson, MD: The Trinity Foundation, 1989), 19.

[2]St. Augustine, *Confessions*, Book XI, 5-7 (Harmondsworth, Middlesex, England: Penguin Books Ltd., 1985), 258-9.

[3]J. Calvin, *Institutes of the Christian Religion*, Book I, Chap. XIII, 7 (Grand Rapids, MI: Eerdmans Publishing Company, 1957), 115.

[4]According to *The Newsletter of the ASA and CSCA* 40, no. 6 (Nov/Dec 1998), the 1998 annual meeting of the ASA featured a dozen papers advocating "substance monism" under one label or another; these papers generated a good deal of interest among Christian scientists in attendance. The same issue of the *Newsletter* also reported that, according to science historian Edward B. Davis, most scientists today, Christian or not, have a more active view of matter and its capabilities than intelligent design theorists.

[5]See H. J. Van Till in "God and Evolution: An Exchange," *First Things* 34 (June/July 1993): 32-41.

[6]C. Babbage, "The Ninth Bridgewater Treatise: A Fragment," 2d ed., in *The Works of Charles Babbage*, vol. 9, ed. M. Campbell-Kelly (Washington Square, NY: New York University Press, 1989), 10.

[7]S. Miller, "A production of amino acids under possible primitive earth conditions," *Science* 117 (1953): 528-9. For a thorough (and admittedly unsympathetic) evaluation of the experimental evidence often adduced in support of prebiotic chemical evolution, see S. C. Meyer, "The Explanatory Power of Design," in *Mere Creation: Science, Faith, & Intelligent Design,* ed. W. Dembski (Downers Grove, IL: Intervarsity Press, 1998).

[8]D. Kenyon and G. Steinman, *Biochemical Predestination* (New York: McGraw-Hill Book Company, 1969); and P. Davis and D. Kenyon, *Of Pandas and People* (Dallas: Haughton Publishing Company, 1989), 55-8. See also "A Scopes Trial for the '90s," *The Wall Street Journal* (Monday, Dec. 6, 1993) for an account of Professor Kenyon's trials at the hands of professional colleagues who object to his new views.

[9]N. Wiener, *Cybernetics*, 2d ed. (Cambridge, MA: The MIT Press, 1961), 132.

[10]S. J. Heims, John von Neumann and Norbert Wiener, *From Mathematics to the Technologies of Life and Death* (Cambridge, MA: The MIT Press, 1982), 154.

[11]H. P. Yockey, *Information Theory and Molecular Biology* (Cambridge: Cambridge University Press, 1992), 334, 336.

[12]See W. Dembski, *Mere Creation*.

[13]D. A. Young, *Christianity and the Age of the Earth* (Grand Rapids, MI: The Zondervan Corporation, 1982), Part Two.

[14]Darwin considered the lack of numerous intermediate forms "perhaps ... the most obvious and serious objection" to his theory, and devoted an entire chapter (X) to pleading "the extreme imperfection of the geological record" as the reason those forms did not exist. (The *Origin of Species* [Chicago: Encyclopedia Britannica, Great Books of the Western World, Vol. 49, 1952], 152 ff).

[15]See the debate, "Is the fossil record adequate?" in *Nature* 396 (Nov. 19 and Nov. 26, 1998). The major disagreement among the participants is with regard to whether the fossil record or molecular data should be relied on more to establish phylogenetic relationships.

[16]S. J. Gould, "This View of Life: Ten Thousand Acts of Kindness," *Natural History* (December 1988): 14.

[17]The theory (though not the label) of punctuated equilibria goes back at least as far 1936, when Schindewolf proposed (as summarized by R. Goldschmidt) that "macroevolution on a higher level takes place in an explosive way within a short geological time, followed by a slower series of orthogenetic perfections." R. Goldschmidt, *The Material Basis of Evolution* (New Haven: Yale University Press, 1982), 395.

[18]N. Eldridge, *Time Frames: The Rethinking of Darwinian Evolution and the Theory of Punctuated Equilibria* (New York: Simon and Schuster, 1985), 94.

[19]M. J. Behe, *Darwin's Black Box: The Biochemical Challenge to Evolution* (New York: The Free Press, 1996), 39-45, 59-65 ff. While it must be acknowledged that some organs conceivably could have arisen step-by-step, Behe describes a number of organs and systems that truly are "irreducibly complex." To my knowledge, no one has refuted Behe's argument based on irreducible complexity by showing that his examples could have arisen by sequential mutations, each one contributing to the survivability of the organism.

[20]Goldschmidt, *The Material Basis of Evolution*, 205-6.

[21]B. Ramm, *The Christian View of Science and Scripture* (Grand Rapids, MI: Eerdmans Publishing Company, 1954), 78.

[22]J. J. Davis, "Is Progressive Creation Still a Helpful Concept?" *Perspectives on Science and Christian Faith* 50, no. 4 (December 1998): 256-7.

[23]C. J. Collins, "How Old is the Earth? Anthropomorphic Days in Genesis 1:1-2:3," *Presbyterion: Covenant Seminary Review* 20, no. 2 (Fall 1994): 117.

[24]The PPDM hypothesis may indeed be considered a kind of macro-developmental theory along the lines called for by R. DeHaan, "Paradoxes in Darwinian Theory Resolved by a Theory of Macro-Development," *Perspectives on Science and Christian Faith* 48, no. 3 (September 1996): 154-63.

[25]"Multiple, previously silent, genetic determinants" have been discovered recently in *Drosophila*. Apparently the heat-shock protein Hsp90 suppresses their expression, but when Hsp90 is mutant or impaired these genes are activated and produce phenotypic variations. S. L. Rutherford and S. Lindquist, "Hsp90 as a capacitor for morphological evolution," *Nature* 396 (Nov. 26, 1998): 336-42. PPDM calls for just such "multiple, previously silent" genes.

[26]I welcome suggestions from others interested in PPDM regarding possible mechanisms for biological clocks that could measure time in millions of generations or years.

[27]Goldschmidt, *The Material Basis of Evolution*, 390-1.

[28]C. Tudge, *The Engineer in the Garden* (New York: Hill and Wang, 1993), 92.

[29]S. J. Gould, "Of Bamboos, Cicadas, and the Economy of Adam Smith," *Ever Since Darwin: Reflections in Natural History* (New York: W. W. Norton & Company, Inc., 1977), 97-102.

[30]Eldridge, *Time Frames*, 78-91.

[31]I base this tentative conclusion on God's statement that the world he had finished creating was "very good" (Gen. 1:31), a statement suggesting that there were no improvements to come about. But Gen. 1:31 may not bear that much weight. If, in elucidating the genome of an extant species, researchers were to discover batteries of latent genes that could not be identified with any predecessor species, we might have evidence that some PPDM was yet to unfold. The discovery of such batteries of genes would certainly be evidence in favor of the PPDM hypothesis, since no evolutionary hypothesis could account for their existence.

[32]Goldschmidt, *The Material Basis of Evolution*, 246.

[33]J. Wells, "Making Sense of Biology: The Evidence of Development by Design," *Touchstone* 12, no. 4 (July/August 1999): 51-5.

[34]To see just how different the PPDM hypothesis is from vitalism, the reader may want to skim such classics of vitalism as H. Bergson, *Creative Evolution* (New York: The Modern Library, 1944) and T. de Chardin, *The Phenomenon of Man* (New York: Perennial Library, Harper & Row, Publishers, 1975).

Descent with modification is the term Darwin used for evolution. It explains both the unity of life and the diversity of life.Â They have the same pattern of bones because all of those animals descended from a common ancestor, but the bones are not identical because they were modified for different functions -- grasping, flight, swimming, and running. â€œThe framework of bones being the same in the hand of a man, wing of a bat, fin of the porpoise, and leg of the horse, â€“ the same number of vertebrae forming the neck of the giraffe and of the elephant, - and innumerable other such facts, at once explain themselves on the theory of descent with modification with slow and slight successive modifications.â€ Objective. The aim of this paper is to review different surface modifications of dental implants and their effect on osseointegration. Common marketed as well as experimental surface modifications are discussed. Discussion. The major challenge for contemporary dental implantologists is to provide oral rehabilitation to patients with healthy bone conditions asking for rapid loading protocols or to patients with quantitatively or qualitatively compromised bone.Â Abstract. Objective. The aim of this paper is to review different surface modifications of dental implants and their effect on osseointegration. Common marketed as well as experimental surface modifications are discussed. Discussion. The major challenge for