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# EVOLUTION, INTELLIGENT DESIGN AND THE ESTABLISHMENT CLAUSE

Roger L. Tarbutton\*

The teaching of intelligent design (ID) in public classrooms as alternative or supplemental to contemporary evolutionary theory (Neo-Darwinism) has been widely rejected by courts on the ground that it is based on supernatural forces as opposed to scientific materialism. However, as recent advances in genetic and molecular science increasingly challenge the tenets of Neo-Darwinism, the teaching of non-random, intelligence-based alternatives should be permitted under the Establishment Clause provided such alternatives are supported by scientific evidence and are presented in a secular manner. Under existing case-law, the terms 'creation science' and 'intelligent design' are often conflated although creation science has historically been linked to biblical accounts of creation whereas ID encompasses non-random views of evolution. One judge concluded ID was a rebranding of 'creation science' by religious zealots in an attempt to make it appear more scientific.<sup>2</sup>

## I. INTELLIGENT DESIGN AND THE ESTABLISHMENT CLAUSE

In *Edwards v. Aguillard*,<sup>3</sup> the Supreme Court affirmed the holding of a Louisiana District Court that the Balanced Treatment for Creation-Science and Evolution-Science in Public School Instruction Act (the 'Act')<sup>4</sup> violated the Establishment Clause of the First Amendment. The Act defined creation science and evolution science in terms of the scientific evidence and inferences supporting each and mandated the teaching of creation science in public schools as a viable alternative to the theory of evolution.<sup>5</sup> Although the Act did not require the teaching of either, it required that if one theory was taught so must the other. In a summary judgement decision,

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<sup>2</sup> *Kitzmiller v. Dover Area Sch. Dist.*, 400 F. Supp. 2d 707, 716 (M.D. Pa. 2005).

<sup>3</sup> *Edwards v. Aguillard*, 482 U.S. 578 (1987).

<sup>4</sup> Balanced Treatment for Creation-Science and Evolution-Science in Public School Instruction Act, La. Rev. Stat. Ann. § 17:286.1-17:286.7 (1982).

<sup>5</sup> *Edwards*, 482 U.S. at 578.

the District Court held the Act violated the Establishment Clause of the United States Constitution because its overriding purpose was the advancement of a particular religious regime by prohibiting the teaching of evolution or requiring the teaching creation science.

In a brief 7-2 decision (Rehnquist and Scalia dissenting), the majority deemed the Act facially unconstitutional for failure to meet the Establishment Clause test that was established by the Court in *Lemon v. Kurtzman*.<sup>6</sup> The *Lemon* test provides that in order to pass Constitutional muster, a three pronged analysis must be met, 1) the law must have been adopted for a secular purpose, 2) the principal or primary effect of the law must neither be to advance nor to inhibit religion and 3) the statute must not result in excessive entanglement of government with religion.<sup>7</sup> Although the majority acknowledged deference was owed to the secular purpose as stated in the Act (protection of academic freedom and assisting students in their search for truth), following a review of its legislative history, the Court concluded the Act failed the first prong of the *Lemon* test because its overriding purpose was to provide advantage to a religious doctrine that rejected the factual basis of evolution.<sup>8</sup> By affirming the judgement of the lower court, the Supreme Court denied proponents of the Act the opportunity to produce scientific evidence in support of creation science at an evidentiary hearing.

In their dissent, Justices Scalia and Rehnquist argued that to meet the secular purpose prong, the legislative body is only required to demonstrate a secular purpose: and invalidation of an act or policy under the Establishment Clause is appropriate only where there is no question it was wholly motivated by religious considerations.<sup>9</sup> They further argued that because affidavits of scientific experts supporting creation science were presented at the trial court level, the proponents should have been provided an opportunity to present such evidence at an evidentiary hearing:

The only evidence in the records of the received meaning and acceptance of creation science is found in five affidavits filed by appellants. In those affidavits, two scientists, a philosopher, a theologian, and an educator, all of whom claim extensive knowledge or creation science, swear that it is essentially a collection of scientific data supporting

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<sup>6</sup> *Lemon v. Kurtzman*, 403 U.S. 602 (1971).

<sup>7</sup> *Edwards*, 482 U.S. at 583.

<sup>8</sup> *Id.* at 593.

<sup>9</sup> *Id.* at 614.

the theory that the physical universe and life within it appeared suddenly and have not changed substantially since appearing. These experts insist that creation science is a strictly scientific concept that can be presented without religious reference. At this point, we must assume that the Balanced Treatment Act does not require the presentation of religious doctrine.<sup>10</sup> (Citations omitted)

Subsequently, an in depth legal analysis of intelligent design was made by Judge John E. Jones III in *Kitzmiller v. Dover Area School District*.<sup>11</sup> In that case, the parents of public school children and high school science faculty filed suit against the school district challenging the constitutionality of a policy requiring the reading of the following statement to students when teaching the theory of evolution:

The Pennsylvania Academic Standards require students to learn about Darwin's Theory of Evolution and eventually take a standardized test of which evolution is a part. Because Darwin's Theory is a theory, it continues to be tested as new evidence is discovered. The Theory is not a fact. Gaps in the Theory exist for which there is no evidence. A theory is defined as a well-tested explanation that unifies a broad range of observations. Intelligent Design is an explanation of the origin of life that differs from Darwin's view. The reference book, *Of Pandas and People*, is available for students who might be interested in gaining an understanding of what Intelligent Design actually involves. With respect to any theory, students are encouraged to keep an open mind. The school leaves the discussion of the Origins of Life to individual students and their families. As a Standards-driven district, class instruction focuses upon preparing students to achieve proficiency on Standards-based assessments.<sup>12</sup>

Enjoining the policy, Judge Jones held that it violated the Establishment Clause under the Lemon test and under the religious

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<sup>10</sup> Id. at 612.

<sup>11</sup> *Kitzmiller*, 400 F. Supp. 2d at 707.

<sup>12</sup> Id. at 708-09.

Endorsement test adopted by the Supreme Court in *Allegheny v. ACLU*.<sup>13</sup> The religious Endorsement test is somewhat analogous to the "effect" prong of the Lemon test and in the public-school context has been described as follows:

School sponsorship of a religious message is impermissible because it sends the ancillary message to members of the audience who are nonadherents—that they are outsiders, not full members of the political community, and an accompanying message to adherents that they are insiders, favored members of the political community.<sup>14</sup>

The relevant issue under the Endorsement test is whether an objective observer acquainted with the text, legislative history, and implementation of the challenged policy would perceive it to endorse a religion or religious belief. After reviewing the legislative record, Judge Jones concluded that although the policy was ostensibly adopted for secular purposes, its overriding purpose was to promote religious doctrine in public classrooms and denigrate the theory of Evolution:

Although as noted Defendants have consistently asserted that the ID Policy was enacted for the secular purposes of improving science education and encouraging students to exercise critical thinking skills, the Board took none of the steps school officials would take if these stated goals had truly been their objective. The Board consulted no scientific materials. The Board contacted no scientists or scientific organizations. The Board failed to even consider the views of the District's science teachers. The Board relied solely on the legal advice from two organizations with demonstrably religious, cultural, and legal missions.<sup>15</sup>

As apparent from these cases, major impediments to judicial acceptance of ID have been the inability of its proponents to produce scientific evidence capable of distinguishing it from supernatural or

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<sup>13</sup> *Id.* at 765 (citing *Allegheny v. ACLU*, 492 U.S. 573 (1989)).

<sup>14</sup> *Santa Fe Indep. Sch. Dist. v. Doe*, 530 U.S. 290, 309-10 (2000) (citing *Lynch v. Donnelly*, 465 U.S. 668, 688 (1984) (O'Connor, J., concurring)).

<sup>15</sup> *Kitzmiller*, 400 F. Supp. 2d at 763.

religious doctrine and its use as a tool to challenge the theory of evolution. In *Edwards*, for example, statements included in the Act's legislative history that evolution is consonant with "the cardinal principle [s] of religious humanism, secular humanism, theological liberalism and atheism [sic]"; undoubtedly influenced the Court to conclude that its overriding purpose was not to educate but to revise the science curriculum by bringing it into conformity with a religious viewpoint.<sup>16</sup> Likewise, despite acknowledging the presentation of evidence that ID need not depend upon the existence of a supernatural designer, Judge Jones concluded, "It is our view that a reasonable, objective observer would after reviewing both the voluminous record in this case, and our narrative, reach the inescapable conclusion that ID is an interesting theological argument, but that it is not science."<sup>17</sup> Perhaps tongue in cheek, Judge Jones punctuated his opinion by asserting that, "Although proponents of the IDM occasionally suggest that the designer could be a space alien or a time traveling cell biologist, no serious alternative to God as the designer has been proposed by members of the IDM, including Defendants expert witnesses."<sup>18</sup>

## II. CRACKS IN THE VENEER OF NEO-DARWINISM

Modern Neo-Darwinism (a/k/a the "Modern Synthesis") is the synthesis of natural selection hypothesized by Charles Darwin (1809-1882) and genetic principles formulated by Gregor Mendel (1822-1884) in the first half of the twentieth century. Although the principles of Darwinian evolution have undeniably contributed much to our understanding of biology, the rigid application of Neo-Darwinism by its proponents to the exclusion of all other theories has in recent decades come under increasing criticism from both the scientific and non-secular communities alike. One ardent critic was Carl Woese (1928-2012), former professor of microbiology at the University of Illinois at Urbana-Champaign and winner of the Leeuwenhoek Award and National Medal of Science. His pioneering research in the field of phylogenetic taxonomy (the classification of organisms based on their genomic characteristics) led to the discovery of Archaea a previously unknown domain and prompted significant revisions to the Darwinian tree of life. Professor Woese hypothesized the universal genetic code did not evolve from a

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<sup>16</sup> *Edwards*, 482 U.S. at 592.

<sup>17</sup> *Kitzmiller*, 400 F. Supp. 2d at 745-46.

<sup>18</sup> *Id.* at 718-19.

common ancestor through natural selection as argued by Neo-Darwinists, but through collective evolution, the cooperative sharing of genetic innovations among communities of organisms through horizontal gene transfer (HGT), the lateral transfer of genetic material from one organism to another. His disdain for the hidebound stubbornness of Neo-Darwinists who steadfastly rejected such alternative mechanisms was palpable:

As for evolution, it had been developed from a phenomenological description centering around what was generally termed natural selection into the modern evolutionary synthesis through its union with Mendelian genetics. The modern evolutionary synthesis should have been the 20<sup>th</sup> century's evolutionary bastion, the forefront of research into the evolutionary process. No such luck!

The basic understanding of evolution, considered as a process, did not advance at all under its tutelage. The presumed fundamental explanation of the evolutionary process, \_natural selection: went unchanged and unchallenged from one end of the 20<sup>th</sup> century to the other. Was this because there was nothing more to understand about the nature of the evolutionary process? Hardly! Instead, the focus was not the study of the evolutionary process so much as the care and tending of the modern synthesis. Safeguarding an old concept, protecting \_truths too fragile to bear translation: is scientific anathema. (the quote here is Alfred North Whitehead's, and it continues thus: \_A science which hesitates to forget its founders is lost:). What makes the treatment of evolution by biologists of the last century insufferable scientifically is not the modern synthesis per se. Rather, it is the fact that molecular biology accepted the synthesis as a complete theory unquestioningly- thereby giving the impression that evolution was essentially a solved scientific problem with its roots lying only within the molecular paradigm.<sup>19</sup> (Citations omitted)

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<sup>19</sup> Carl R. Woese & Nigel Goldenfeld, *How the Microbial World Saved Evolution from the Scylla of Molecular Biology and the Charybdis of the Modern Synthesis*, 73 *MICROBIOLOGY AND MOLECULAR BIOLOGY REVS* 14-21 (2009).

Two arguments against Neo-Darwinism often raised by ID proponents include *irreducible complexity*: and the *Cambrian Explosion*:. Irreducible complexity argues that Neo-Darwinism cannot account for the evolution of complex biological systems such as the eyes, ears, immune response and blood clotting cascade. Neo-Darwinists teach that such innovations evolve gradually from the application of natural selection (survival of the fittest) upon the genetic diversity generated by random mutations (single nucleotide base substitutions, insertions or deletions) within the DNA of precursor organisms. Most Neo-Darwinists emphasize the natural selection side of the evolutionary coin as opposed to genetic variability:

True, the raw materials for evolution--the variations between individuals--are indeed produced by chance mutations. These mutations occur willy-nilly, regardless of whether they are good or bad for the individual. But it is the filtering of that variation by natural selection that produces adaptations, and natural selection is manifestly not random. It is a powerful molding force, accumulating genes that have a greater chance of being passed on than others, and in so doing making individuals ever better to cope with their environment. It is then the unique combination of mutation and selection---chance and lawfulness---that tells how organisms become adapted.<sup>20</sup>

However, Neo-Darwinists readily acknowledge that most random mutations are detrimental and are culled from the gene pool within several generations. ID proponents therefore argue that natural selection alone cannot explain how a series of random genetic mutations (most of which are detrimental) can eventually evolve into irreducibly complex structures that depend upon the interaction of many disparate elements in order to function. In Kitzmiller, Judge Jones dismissed the irreducibly complex argument out hand, arguing it would be resolved by future scientific research:

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<sup>20</sup>JERRY A. COYNE, *WHY EVOLUTION IS TRUE*, 119 (New York: Penguin Group, Inc., 2009).



ID proponents primarily argue for design through negative arguments against evolution, as illustrated by Professor Behe's argument that "irreducibly complex" systems cannot be produced by Darwinism, or any natural, mechanisms. However, we believe that arguments against evolution are not arguments for design. Expert testimony revealed that just because scientists cannot explain today how biological systems evolved does not mean that they cannot and will not be able to explain them tomorrow.<sup>21</sup> (Citations omitted)

However, fifteen years after Kitzmiller, not only does the irreducible complexity argument persist, based on the informational nature of the molecular building blocks (DNA and RNA) upon which inheritance and genetic innovation depend, many molecular scientists now dispute that random point mutations alone are capable of generating sufficient genetic diversity to account for the evolution of modern organisms.<sup>22</sup>

Although the "Cambrian Explosion" was not addressed in the Kitzmiller decision, it is frequently cited as a "gap" in the theory of evolution by ID proponents. It references the apparent dearth of precursor organisms in the fossil record from which a plethora of new animal species evolved approximately 530 million years ago during the Cambrian geological period. Darwin himself puzzled over this apparent gap in the fossil record but was optimistic the missing fossils would eventually be discovered:

To the question why we do not find [rich fossiliferous deposits belonging to these assumed earliest periods prior to the Cambrian system], I can give no satisfactory answer ...[but w]e should not forget that only a small portion of the world is known with accuracy. ũ The case at present must remain inexplicable; and may be truly urged as a valid argument against the views here entertained.<sup>23</sup>

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<sup>21</sup> Kitzmiller, 400 F. Supp. 2d at 738.

<sup>22</sup> STEPHEN C. MEYER, *DARWIN'S DOUBT: THE EXPLOSIVE ORIGIN OF ANIMAL LIFE AND THE CASE FOR INTELLIGENT DESIGN*, 203 (New York: HarperCollins Publishers, 2013).

<sup>23</sup> CHARLES DARWIN, *ON THE ORIGIN OF SPECIES BY MEANS OF NATURAL SELECTION*, 308 (Cambridge: Harvard Univ. Press, facsimile reprint 1964 (London: John Murray, 1st ed. 1859)).

However, as in the case of irreducible complexity, despite the development of sophisticated technologies for the collection of fossil records since the publication of *On the Origin of Species* over 150 years ago, significant gaps in the fossil records remain.<sup>24</sup>

Analogous to the Cambrian Explosion, Professor Nick Lane, a biochemist at University College London, has noted gaps: in the evolution of eukaryotic cells (cells having a nucleus) from their presumed prokaryotic predecessors (cells such as bacteria and archaea that lack a nucleus):

Life arose around half a billion years after the earth's formation perhaps 4 billion years ago, but then got stuck at the bacterial level of complexity for more than 2 billion years, half the age of our planet. Indeed bacteria have remained simple in their morphology (but not in their biochemistry) throughout 4 billion years. In stark contrast, all morphologically complex organisms—all plants, animals, fungi, seaweeds and single-celled 'protists' such as amoeba—descend from that singular ancestor about 1.5-2 billion years ago. This ancestor was recognizably a modern cell, with an exquisite internal structure and unprecedented molecular dynamism, all driven by sophisticated nanomachines encoded by thousands of new genes that are largely unknown in bacteria. There are no surviving evolutionary intermediates, no 'missing links' to give any indication of how or why these complex traits arose, just an unexplained void between the morphological simplicity of bacteria and the awesome complexity of everything else. An evolutionary black hole.<sup>25</sup>

Based on the genomic difference between eukaryotes and their presumed prokaryotic predecessors, Professor Lane has concluded the first eukaryote was most likely of chimeric origin resulting from the endosymbiotic merger of two ancient prokaryotes (a bacteria and an archaeon) and not the product of a series of random mutations as predicted by Neo-Darwinists. From the perspective of genetic diversification an endosymbiotic merger is

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<sup>24</sup> Meyer, *supra* 21, 55.

<sup>25</sup> NICK LANE, *THE VITAL QUESTION: ENERGY, EVOLUTION, AND THE ORIGINS OF COMPLEX LIFE*, 1-2 (New York: W.W. Norton & Company, Inc., 2015).

somewhat similar in outcome to horizontal gene transfer, both resulting in increased genetic variability, although the former is achieved by merger of the genomes of two single celled organisms, whereas the latter results from conjugation (the direct transfer of genetic material from one cell to another) or transduction (the indirect transfer of genetic material from one cell to another by a viral vector). Although Professor Lane acknowledges this hypothetical endosymbiotic event could not have resulted from phagocytosis (one cell engulfing another) because the internal mechanisms required had not yet evolved, he notes that endosymbiotic relationships among prokaryotic cells (bacteria living within bacteria) have been observed.<sup>26</sup>

### III. EVOLUTION AS A RESULT OF NON-RANDOM ADAPTATION

#### A. The Evolution of Genomic Information

An early proponent of non-random alternatives to the theory of evolution was the Nobel Prize winning philosopher Henri Bergson (1859-1941). In *Creative Evolution*, Professor Bergson provided a surprisingly modern analysis of the dichotomy between mechanistic (Darwinian) and finality (ID) theories of evolution:

Mechanistic theory is one which means to show us the gradual building-up of the machine under the influence of external circumstances intervening either directly by action on the tissues or indirectly by selection of the better-adapted ones. But, whatever form this theory may take, supposing it avails at all to explain the details of the parts, it throws no light on their correlation.

Then comes the doctrine of finality, which says that the parts have become brought together on a preconceived plan with a view to a certain end. In this it likens the labor of nature to that of the workman, who also proceeds by the assemblage of parts with a view to the realization of an ideal or the imitation of a model. Mechanism, here, reproaches finalism with its anthropomorphic character, and rightly. But it fails to see that itself proceeds according to this method--somewhat mutilated! True, it has got rid of

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<sup>26</sup> Id. at 181.

the end pursued or the ideal model. But it also holds that nature has worked like a human being by bringing the parts together, while a mere glance at the development of an embryo shows that life goes to work in a very different way. Life does not proceed by the association and addition of elements, but by dissociation and division.<sup>27</sup>

Without knowledge of the informational nature of the molecular building blocks (DNA and RNA) upon which inheritance and genetic variation depends, Bergson postulated the existence of *élan vital*: or *vital impetus*: in an attempt to explain the purposeful nature of biological evolution:

The impetus of life, of which we are speaking, consists in a need of creation. It cannot create absolutely, because it is confronted with matter, that is to say with the movement that is the inverse of its own. But it seizes upon this matter, which is necessity itself, and strives to introduce into it the largest possible amount of indetermination and liberty.<sup>28</sup>

In this way, Bergson was perhaps a harbinger of the modern concept of *natural genetic engineering*:, a leading proponent of which is James A. Shapiro, professor of biochemistry and molecular biology at the University of Chicago. In lieu of focusing on random point mutations as the primary source of genetic diversity, natural genetic engineering focuses on the ability of living organisms to self-direct their evolution in non-random and adaptive ways by manipulating and reprogramming their own genetic information:

The contemporary concept of life forms as self-modifying beings coincides with the shift in biology from a mechanistic to informative view of living organisms. One of the greatest scientific ironies of the last century is the fact that molecular biology, which its pioneers expected to provide a firm chemical and physical basis for understanding life, instead uncovered powerful sensory and communication networks essential to all vital processes, such as

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<sup>27</sup> HENRI BERGSON, *CREATIVE EVOLUTION* 88-89 (Arthur Mitchell trans. The Project Gutenberg 2008) (1911) (ebook).

<sup>28</sup> *Id.*, at 251-52.

metabolism, growth, the cell cycle, cellular differentiation and multicellular morphogenesis.<sup>29</sup>

According to Professor Shapiro, systems engineering is a better metaphor for the evolutionary process than the conventional view of evolution as a selection-based random walk through the limitless space of possible DNA configurations.<sup>30</sup>

A myriad of the methods by which organisms manipulate and reprogram their genomes have been uncovered by recent scientific research. For several decades after discovery of the structure of DNA by Watson and Crick in 1953, the Neo-Darwinist view of evolution was that of a top-down process with DNA directly controlling every cell function through DNA replication, RNA transcription and protein translation (the Central Dogma of Molecular Biology:). However, recent discoveries have revealed that cellular control is much more multifaceted, interactive, and decentralized than contemplated under the Central Dogma and cells are fully capable of adapting to external and internal stimuli by self-regulating DNA expression, DNA replication, RNA transcription and protein synthesis:

Cells constantly adjust their metabolism to available nutrients, control their progress through their cell cycle to make sure that all progeny are complete at the time of division, repair damage as it occurs, and interact appropriately with other cells. In a multicellular context, they even undergo programmed cell death when suicide is beneficial to the entire population or to the multicellular organism as a whole.<sup>31</sup>

Contributing to such adaptation is horizontal gene transfer, the same mechanism theorized by Professor Woese to have contributed to evolution of the universal genetic code. HGT occurs not only among prokaryotes, but has also been documented in eukaryotes, including plants, animals, protists and fungi:

Today, we know that horizontal gene transfer is a powerful evolutionary force in the microbial world,

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<sup>29</sup> JAMES A. SHAPIRO, *EVOLUTION: A VIEW FROM THE 21ST CENTURY* 4 (New Jersey: FT Press Science, 2011).

<sup>30</sup> *Id.*, at 6.

<sup>31</sup> *Id.*, at 7.

well documented in the phylogenetic record, and one whose ecological significance is only beginning to be fully understood. Spurred on by advances in genomic technology, microbial ecology is presenting new insights into the workings of the biosphere, demanding a synthesis with the evolutionary process, and forcing evolutionary biology to pay attention. The power of horizontal gene transfer is so great that it is a major puzzle to understand why it would be that the eukaryotic world would turn its back on such a wonderful source of genetic novelty and innovation. The exciting answer, bursting through decades of dogmatic prejudice is that it hasn't. There are now compelling documentations of horizontal gene transfer in eukaryotes, not only in plants, protists, and fungi, but in animals (including mammals) as well. The evolutionary implications have not yet been worked out, but we are confident that a fully worked out theory of the evolutionary process is required in order to properly meet the changes posed initially by microbiology.<sup>32</sup> (Citations omitted)

Other mechanisms by which genomes have been found to adapt to internal or external stimuli include homologous recombination repair of double strand DNA breaks, DNA transposons (jumping genes) that move genetic segments from one DNA site in the cell to another, long terminal repeat (LTR) and non-LTR retro-elements, retro-splicing of group II introns, inteins, and diversity generating retro-elements.<sup>33</sup> In addition, protein encoding regions of DNA can be activated or deactivated by extra-nuclear (epigenetic) processes such as genomic compaction and chromatin formatting independent of DNA sequence providing an additional multi-generational pathway for genomic variability.<sup>34</sup> A specific example of self-directed cell adaption discovered in bacteria is the SOS response, a complex reparative response to DNA damage that stimulates the expression of repair, recombination, and cell division inhibition proteins.<sup>35</sup> It has been discovered that even unicellular organisms are capable of adapting to environmental stimuli through

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<sup>32</sup> Woese & Goldenfeld, *supra* 18, at 20.

<sup>33</sup> Shapiro, *supra* 28, at 44-45.

<sup>34</sup> *Id.* at 31-36.

<sup>35</sup> *Id.* at 16-17.

associative learning (classical and/or operant conditioning).<sup>36</sup> Once learned, adaptive behavior may become permanently incorporated into the organism's genome through a phenomenon known as the Baldwin Effect:

Species may form suddenly, organisms (particularly animals) play an active role in the evolution of their descendants and genes often follow rather than lead evolutionary change. The evidence suggests that the conditions of development can radically affect an organism's characteristics, thereby challenging the third prop of Neo-Darwinist orthodoxy that development is irrelevant to an understanding of evolution.<sup>37</sup>

An area of genomic research that may be of particular relevance to the Cambrian Explosion is whole genome duplication (WGD), a process of genetic duplication (hyperploidy) that results from the interspecific hybridization (or mating) of distinct species to produce hybrid offspring. WGD can double, triple, or even octuplet the DNA of offspring thereby greatly increasing genomic variability and perhaps playing a direct role in the emergence of new species:

The evidence shows that interspecific hybridization and WGD are key events in the formation of synthetic species, something that has not been achieved by selection. WGD events have been documented in widely divergent taxonomic groups, including protozoa, yeasts, vertebrates and flowering plants. Thus, we have to include hybridization and genome doublings in our catalog of exceptions to normal vertical inheritance as major triggers of evolutionary change.<sup>38</sup>

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<sup>36</sup> Marc van Duijn, *Phylogenetic Origins of Biological Cognition: Convergent Patterns in the Early Evolution of Learning*, 7 J. OF THE ROYAL SOC'Y. (Mar. 28, 2017), <http://dx.doi.org/10.1098/rsfs.2016.0158>.

<sup>37</sup> Patrick Bateson, *The Evolution of Evolutionary Theory*, 18 EUR. REV. 287, 294 (2010).

<sup>38</sup> Shapiro, *supra* 28, at 126.

## B. The Evolution of Bioenergy

As previously indicated, Professor Lane has hypothesized the first eukaryote resulted from the endosymbiotic merger of an ancient bacterium and archaeon between 1.5 and 2 billion years ago and did not result from a random series of genetic mutations as predicted by Neo-Darwinism. Professor Lane theorizes this fortuitous (or adaptive, depending upon perspective) event led to the evolution of mitochondria from the bacterial endosymbiont providing surplus biochemical energy in the form of ATP (the molecular currency of cellular energy) required for the later evolution of sophisticated internal cell structures and organelles such as the cell nucleus and spindle that are characteristic of eukaryotes:

Mitochondria lost nearly all of their genes. We have retained just 13 protein-coding genes, along with all other animals. Assuming that the mitochondria derived from ancestors that were not dissimilar to modern  $\alpha$ -proteobacteria, they must have started out with around 4,000 genes. Over evolutionary time, they lost more than 99% of their genome. By our calculation above, if 100 endosymbionts lost 99% of their genes, the energy savings would be close to 1 trillion ATP's over a 24 hour life cycle, or a staggering 12 million per second! But mitochondria don't save energy. They make ATP. Mitochondria are just as good at making ATP as their free-living ancestors, but they reduced the costly bacterial overheads massively. In effect, eukaryotic cells have multibacteria power, but save on the costs of protein synthesis. Or rather, they divert the costs of protein synthesis.<sup>39</sup>

In addition to benefiting from this increase in free energy, Professor Lane theorizes that some of the excess genetic material from the bacterial endosymbiont was eventually absorbed into the DNA of the host cell where it could be reprogrammed for the evolution of internal structures and organelles:

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<sup>39</sup> Lane, *supra* 24, 184-85.



Some of these genes continued to encode the same proteins, carrying out the same old job, so there was no energy savings there. But some of them were no longer needed, either by the host cell or the endosymbiont. They arrived in the nucleus as genetic free- booters, free to change their function, unconstrained as yet by selection. These superfluous stretches of DNA are the genetic raw material for the eukaryotic evolution. Some of them spawned whole families of genes that could specialize for new disparate tasks. We know that the earliest eukaryotes had about 3,000 new gene families compared with bacteria.<sup>40</sup>

#### IV. CONCLUSION

In light of recent scientific evidence of the ability of living organisms to self-direct their evolution by manipulating and reprogramming their genomes as illustrated by the research of Professor Shapiro and others, a strong foundation exists for the teaching of secular, intelligence-based theories of evolution in public schools under the Establishment Clause. Although some ID proponents contend natural genetic engineering begs the question how such adaptive capacity originated in the first place,<sup>41</sup> Professor Shapiro considers this to be fertile ground for future scientific research:

Evolution is life's way of dealing with the unpredictable. We have seen that principle most clearly at work in the adaptive immune system, where antibodies have to be synthesized that can recognize unknown invaders. The fact that future adaptive needs are unknown does not mean that filling those needs has to be a blind process. In immune system natural genetic engineering and in evolutionary change in general, we have been able to discern regular features of genome restructuring that facilitate the production of novel molecular tools with an enhanced likelihood of real-world utility. A measure of success for the more informational

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<sup>40</sup> Id. at 185.

<sup>41</sup> Meyer, *supra* 25, 335.

perspective sketched out in this book will be the extent of future research into the cognitive cellular operations that have led to successful evolutionary inventions.<sup>42</sup>

Similarly, some Neo-Darwinists claim natural genetic engineering lies outside the scope of legitimate scientific inquiry:

There is a convincing (perhaps overwhelming) case for the role of basic engineering principles in genome evolution. We now have many clear examples of genome restructuring by natural genetic engineering functions. Nonetheless, the phrase natural genetic engineering has proven troublesome to many scientists as they believe it supports the Intelligent Design argument. As one Nobel Laureate put it after a seminar. "If there is natural genetic engineering, that means there has to be an engineer.": This empirically derived concept seems to many scientists to violate the principles of naturalism that exclude any role for a guiding intelligence outside of nature.<sup>43</sup>

However, if natural selection plays a less prominent role in the evolutionary process than claimed by Neo-Darwinists, research into natural genetic engineering may lead to valuable new insights into genomic evolution.

Great strides have been made since Darwin and Bergson grappled with the theory of evolution over one hundred years ago. Powerful new tools capable of plumbing the secrets of the genome undreamt of during their lifetimes now shed light on the origin and evolution of life. To great extent the direction of future scientific research depends upon the subject matter taught in public schools and the ability of scientists to attract government and private funding. As in any profession, such decisions are subject to vagaries of peer pressure and competition. Unfortunately, as noted by Professor Woese, legitimate areas of scientific research perceived to be outside the mainstream of Neo-Darwinism have at times been shunned from consideration. Conformity, when reinforced by the authority of law is anathema to scientific progress. Vigilance must therefore be exercised by courts to ensure that the Establishment

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<sup>42</sup> Shapiro, *supra* 28, 147.

<sup>43</sup> *Id.* at 134.

Clause is employed not as a sword for the promotion of scientific dogma but as a shield from religious persecution:

There must be no barriers for freedom of inquiry. There is no place for dogma in science. The scientist is free, and must be free to ask any question, to doubt any assertion, to seek for any evidence, to correct any errors.<sup>44</sup>

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<sup>44</sup> J. ROBERT OPPENHEIMER, *THE OPEN MIND* 114 (Simon and Schuster, Inc. 1955).