

Critical Analysis of Evolution: Accuracy in scientific content

The lesson plan consistently misrepresents the scientific method and the consensus understanding of biological evolution within the professional research community. The definitions of terms, the assertions for how science is done, and even the choice of topics are drawn from the creationist literature. This is not surprising given that the principle author for the lesson plan is a young-earth creationist. The lesson fails to reference many, peer-reviewed, current scientific publications that thoroughly refute the supposed “scientific challenges” to evolutionary theory.

	Critical Analysis of Evolution – Grade 10 (Lesson: L10-H23)	Intelligent Design Creationism sources	What scientists say:
<p>1</p> <p>pp. 313-314</p>	<p>Scientific Ways of Knowing <u>Benchmark A</u></p> <p>Explain that scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural world.</p> <p><u>Indicator 3</u></p> <p>Recognize that science is a systematic method of continuing investigation, based on observation, hypothesis testing, measurement, experimentation, and theory building, which leads to more adequate explanations of natural phenomena</p>	<p>SEAO, “<i>The evolution controversy</i>.”: “Since evolutionary theory assumes that life came about only by natural causes, it purposely (and wrongly) excludes from consideration any hypothesis that involves intelligent or supernatural causes.” (Sjogren, et al., 2003, p.4).</p> <p>Sjogren continues... “Douglas Futuyama, author of a college-level text entitled <i>Evolutionary Biology</i>, says in his preface to the student, “‘All the biological sciences rest on two central principles. One is that all life processes have an entirely physical and chemical (i.e. material) basis. The other is that all organisms and their characteristics are products of evolution.’ (Douglas J. Futuyama. <i>Evolutionary Biology, Third Edition</i>. Sinauer Associates, Inc., 1998.)</p> <p>“Futuyama comments on the revolution that this way of thinking has caused in Western thought, and then compares evolution to its apparent arch-enemy, divine creation, in a summary statement in the first chapter of the book: “‘Darwin’s evolutionary theory, published in <i>The Origin of Species</i> in 1859, consisted of the hypotheses that (a) all organisms have descended, with modification, from common ancestral forms of life, and (b) a chief agent of modification is natural selection. The implications of this theory, which revolutionized Western thought, include (a) change, rather than stasis, is the natural order; (b) biological phenomena, including those seemingly designed, can be explained by purely material causes, rather than by divine creation; (c) no evidence of purpose or goals can be found in the living world, other than in human actions (emphasis added). (Ernst Mayr. “<i>Darwin’s Influence on Modern Thought</i>.” <i>Scientific American</i>, July, 2000.)</p> <p>“Almost every current biology education book assumes evolutionary biology as its central dogma, and most of them contain statements</p>	<p>The statements quoted from Sjogren, et al. (2003) summarize one of the most fundamental and important distinctions between 1) science and the scientific method, and 2) the philosophy advocated by Intelligent Design (ID) Creationists.</p> <p>Science is restricted to observing, measuring, and testing in the natural world, as noted in the Science standards. This is not a philosophy, it is a fundamental limitation of the scientific method. As such, science cannot consider causal explanations outside the natural world.</p> <p>Intelligent Design regards the limitations of science as an expression of a philosophical perspective and not as a physical limit on methods. The quotations from Futuyama are included to support this belief. However, what Futuyama’s statements describe are the limitations of the methods of science. Thus, for example, science is not able to observe or measure “purpose or goals” in the natural world. Futuyama does not say that there are no human or divine purposes or goals; Futuyama’s point is that any inferences about such purposes and goals in the natural world are not accessible to the methods of science.</p> <p>The Ohio State Science standards specify that science is “limited to the natural world.” Further, there is no statement in the Science standards that science takes a philosophical</p>

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		<p>reflecting the naturalistic presumptions of biology (with accompanying comparisons to theistic views of origins), similar to the quotes above.” (Sjogren, et al., 2003, pp.11-12).</p> <p>“Evolutionary biology operates on an assumption that life came about by purely natural causes, and it purposely excludes from consideration any competing hypothesis that involves intelligent or supernatural causes (see earlier quote from Futuyma).” (Sjogren, et al., 2003, p.14).</p> <p>“<i>What is science, anyway?</i>”</p> <p>“Accompanying the instruction on evidence should be a discussion of the controversy over the definition of science. Students should know that there are two basic views of the nature of science. Most scientists believe that science should restrict itself to “natural explanations for natural phenomena.” It is said that the integrity of science would be lost if non-naturalistic (supernatural) explanations were allowed, and that experimental science would lose its problem-solving power. These scientists also say that supernatural causes cannot be studied by science. Along these lines, students should know that <i>evolutionary theory is naturalistic</i>; it operates on the assumption that the origin and diversity of life can be explained solely by natural laws and random chance.</p> <p>“Students should know that an opposing viewpoint calls for a “traditional” definition of science, particularly for use in <i>historical sciences</i> like biological origins. In this view, proper use of the scientific method requires that <i>all logical</i> explanations for phenomena in nature be considered. An arbitrary decision to consider only <i>natural</i> causes restricts the objectivity of investigations. Design detection methodology is used in numerous fields to detect intelligent causes (<i>e.g.</i>, forensic science and archaeology). Supporters of a traditional definition of science believe that design detection can be used reliably to search out intelligent causation in living systems.” (Sjogren, et al., 2003, p. 61).</p>	<p>position on any topic, as such a statement would be incorrect. The statements representing Intelligent Design (in the middle column) show clearly that the philosophy of ID is not consistent with the Ohio State Science standards.</p>
2 pp. 313, & 316	<p>Pre-Assessment:</p> <ol style="list-style-type: none"> Describe what constitutes an anomaly. Why do anomalies exist in science? Are there any benefits to exploring 	<p>Anomaly</p>	<p>Anomalies are NOT ideas. An anomaly in science is a set of consistent observations (data) that do not conform to the predictions of a theory. The lesson plan definition attempts to give unsupported ideas scientific merit as valid counters to established scientific theories.</p>

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	<p>scientific anomalies?</p> <p>Student Engagement Anomalies are ideas in science that depart from the general consensus of the time. Many anomalies occur in science. In an effort to determine the cause of this deviation, scientists conduct research to collect data that will explain the phenomena. As the evidence mounts by careful analysis of the data, original ideas may change from one scientific understanding to another.</p>		<p>Without empirical support, ideas alone do not deserve attention by the scientific community.</p> <p>The section on “pre-assessment” is slanted toward “anomalies,” and does not represent the scientific process of analysis (e.g., developing predictions based on a theory and using data to test those predictions). Students are being subtly “set up” to think there are numerous, major inconsistencies in evolutionary theory, which there aren’t.</p> <p>Einstein recognized limitations in Newtonian physics and corrected them with Relativity Theory. In so doing, he did not claim to topple Newtonian ideas. Similarly, 150 years of research has not toppled Darwin’s basic concept; rather it has filled in the gaps and expanded the applicability of the theory.</p> <p>The pseudo-scientific “anomalies” presented in this lesson constitute a poorly disguised effort to promote the role of an Intelligent Designer as a replacement for the theory of evolution.</p>
<p>3 p. 314</p>	<p>Theory: A supposition or a system of ideas intended to explain something, especially one based on general principles independent of the thing to be explained.</p>		<p>“Theory” is defined incorrectly in the lesson plan as “a supposition.” Scientists use the term “theory” to mean an explanation of a very large number of observations (facts). Thus, in science a theory is more important than a fact. When theories remain successful explanations as greater and greater numbers of facts are gathered - and when they link well with theories in other areas of knowledge, they are considered “robust.” The Theory of Evolution is one of the most robust and best supported theories in all of science.</p> <p>The lesson’s definition mischaracterizes</p>

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			science in the manner promoted by Intelligent Design Creationists at the Discovery Institute
<p>4 pp. 314, & 315-316</p>	<p>Macroevolution: Large-scale evolution occurring over geologic time that results in the formation of new taxonomic groups.</p> <p>Microevolution: Evolution resulting from a succession of relatively small genetic variations that often cause the formation of new subspecies.</p> <p>In addition to the distinctions between different areas of evolutionary theory, scientists also find it helpful to distinguish amounts of biological change or evolution. Microevolution refers to evolution resulting from a succession of relatively small genetic variations that often cause the formation of new subspecies. Macroevolution refers to large-scale evolution occurring over geologic time that results in the formation of new taxonomic groups. These terms are helpful distinctions in the course of analyzing evolutionary theory. These terms have appeared in OhioLink research databases, numerous Internet sites, and biology and evolution textbooks. Though “micro” and “macro” are prefixes, it is quite clear that the scientific community recognizes and acknowledges the distinction between the words. There is more research on microevolution than there is on macroevolution. To help ensure academic clarity, this lesson</p>	<p>SEAO, <i>“The evolution controversy:”</i></p> <p>When we speak of evolution in biology, any of several definitions may be implied. Some definitions are not problematic. For instance, evolution is commonly defined as simply “change over time.” This definition is non-controversial, as no one would disagree that the living world looks different now than it has in the past. Another well-accepted definition is “minor genetic variation,” otherwise known as microevolution. Typical examples of microevolution include drug-resistance in bacteria and variations in domestic animal breeding. While there is evidence that these minor genetic variations can produce changes within species, microevolution has not been shown to produce the new body plans and parts that would be needed if life evolved from simple to more complex forms of life.</p> <p>When biologists talk about the theory of Darwinian Evolution (or macroevolution), they have a specific definition in mind. This overall claim has generated vigorous scientific controversy for over a century:</p> <p>Darwinian evolution is the theory that all living things are related by descent with modification from common ancestors. The mechanism of modification (i.e. how these changes take place) is primarily natural selection, sometimes defined as survival of the fittest, acting on random variation in the genetic makeup of replicating systems (i.e., organisms that are capable of reproducing themselves). (Sjogren, et al., 2003, p.10)</p>	<p>Once again, the lesson plan draws a set of definitions from creationist literature rather than from the world of consensus science. Scientists most often use “microevolution” to mean local geographic variation, and “macroevolution” to mean speciation and the cascade of effects that patterns of reproductive isolation produce (e.g. species selection). Microevolution (including the impetus for the mathematical theory of population genetics) was predicted by and historically grew out of macroevolutionary theory. Thus, it would be more accurate to say that there is “more research” on macroevolution than there is on microevolution, as microevolution is a subset of macroevolution.</p> <p>The distinctions between microevolution and macroevolution at the level of mechanism are not at all clear. There is a wide range of known evolutionary mechanisms and these operate at both the population level and in the establishment of new species. It is misleading to imply that microevolution and macroevolution represent two completely different problems with completely different and non-overlapping mechanisms.</p> <p>This mischaracterization of current evolutionary biology is promoted by the Rev. Jonathan Wells in his Intelligent Design Creationist polemic, <i>Icons of Evolution</i>, and in the Discovery Institute video by the same name.</p>

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	distinguishes between microevolution and macroevolution.		
6 p. 315	...the theory of universal common descent describes the historical pattern of biological change. This theory maintains that all living forms have descended from earlier living forms and ultimately from a single common ancestor. Darwin envisioned the theory of universal common descent as a necessary result of evolutionary changes in organisms and populations, and represented it in his branching tree of life.		<p>Darwin used the tree topography primarily to describe evolution within taxonomic groups of various sizes, emphasizing especially orders and classes. Although he thought it probable, Darwin specifically did not consider universal common descent to be a “necessary result” of evolution. Rather, he inferred that extant organisms had descended from a few forms, or perhaps one. Today, evidence for universal common descent <i>per se</i> is voluminous and tremendously strong. There is vigorous disagreement over some of the exact pathways and reticulations the “tree of life” has followed over the past 4 billion years.</p> <p>This faulty historical view is promoted by Jonathan Wells in his Intelligent Design Creationist polemic, <i>Icons of Evolution</i>, and in the Discovery Institute video by the same name.</p>
7 p. 315	In addition to the distinctions between different areas of evolutionary theory, scientists also find it helpful to distinguish amounts of biological change or evolution.	From the IDea Club: “the amount of biological change makes creationism a viable alternative” (http://www3.telus.net/csabc/scientific2003.htm).	This is not standard scientific terminology. A Google search of "amounts of biological change" yielded not a single result. Changing that to "amount of biological change" brought up a few things about ecology and radiation damage, then Intelligent Design and other Creationist sites, and also a few sites on computational biology (a legitimate -though highly specialized- field of science, requiring mathematical ability far beyond high school).
10 p. 317	Student Research 6. Allow the groups to pick (or assign) one of the five aspects of evolutionary theory. Assign two groups to research each aspect. The aspects are: Aspect 1: Homology (anatomical and molecular)	Chapters in Rev. Jonathan Wells’ <i>Icons of Evolution</i> and the lesson aspects: 3. Darwin’s Tree of Life (aspect 2) 4. Homology (aspect 1) 6. Fossils/Cambrian (aspect 2) 7. Peppered Moths (aspect 4) 9. Mutations/Variation (aspect 3)	Four of five aspects in this lesson correspond to material in <i>Icons of Evolution</i> . “Aspect 5: Endosymbiosis” appears to draw on material from Behe’s <i>Darwin’s Black Box</i> .

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	Aspect 2: Fossil Record Aspect 3: Anti-Biotic Resistance Aspect 4: Peppered Moths Aspect 5: Endosymbiosis	<p>10. Fossils/Directed Evolution (aspect 2) SEAO, <i>“The evolution controversy:”</i> The three major types of evidence that are used to support evolutionary theory (macroevolution) are the fossil record, homologies, and embryology. The principal features of the fossil record are the abrupt appearance of new species (<i>e.g.</i>, the Cambrian explosion), stasis (equilibrium) over long periods of time, and then extinction. This discontinuous pattern is more consistent with the theory of intelligent design. Homologies are similarities in structure and form among different organisms. Homologies may suggest either a common ancestry or a common designer (archetype), depending on how the evidence is interpreted. The argument from embryology proposes that similarities in the stages of developing embryos from different species suggest a common ancestry. However, the findings of modern embryology show that embryos from different organisms are different at all stages of development. (Sjogren, et al., 2003, p.5)</p> <p>With regard to teaching the evidence, we suggest that at least three types be covered – fossils, homologies, and embryology. Modern definitions of science are typically naturalistic, <i>e.g.</i>, science is finding “natural explanations for natural phenomena.” Students should know that this type of definition is controversial, and that science also has the capability to empirically detect when non-naturalistic (<i>e.g.</i>, intelligent) causes may be at work. We believe that teachers should have the freedom to discuss scientific alternatives to evolution, if they so choose, and that they should not be required to provide only a “natural explanation” of how life arose on earth. (Sjogren, et al., 2003, p.5)</p>	
34 p. 326	<p>Aspect 1: Homology <u>Brief Challenging Sample Answer:</u> Some scientists think similarities in anatomical and genetic structure reflect similar functional needs in different animals, not common ancestry. The nucleotide sequence of hemoglobin DNA is very similar between chimps and humans, but this may be because they provide the same function for both animals. Also, if similar anatomical structures really are the result of a shared evolutionary</p>		<p>The challenging sample answer does not consider the significant genetic data that has revealed deep similarities between highly divergent animal groups. These are the HOX genes, and these genes show a consistent pattern of gene duplication and modification moving from the most primitive multicellular animals to the most derived. This genetic data provides an independent source of data in support of common descent. The role of gene regulation is ignored by this critique.</p>

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	<p>ancestry, then similar anatomical structures should be produced by related genes and patterns of embryological development. However, sometimes, similar anatomical structures in different animals are built from different genes and by different pathways of embryological development. Scientists can use these different anatomical structures and genes to build versions of Darwin family trees that will not match each other. This shows that diverse forms of life may have different ancestry.</p>		
<p>35 p. 326</p>	<p>Aspect 2: Fossil Record Citations #8, 10, 11 and 29 in the General Tips Section may provide a starting point for student research. It is suggested that students employ additional resources in their research.</p>	<p><i>fossil record</i></p>	<p>No Citations directly applicable to Aspect 2 are recommended in the header of that aspect. Of the four Citations listed there, one is irrelevant to the aspect (#10), one deals with evolution of developmental processes (#11), one (#8) is the 1st Edition of a book that went through five subsequent editions, and one (#29) is a good, but generic, “teaching evolution” reference. There is an enormous amount of good material on the fossil record freely available, but none of that material is supplied in this Lesson Plan.</p> <p>The American Geological Institute and the Paleontological Society have produced an excellent introduction to evolution and the fossil record which can be downloaded at: http://www.agiweb.org/news/evolution.pdf</p>
<p>36 p. 326</p>	<p>Aspect 2: Fossil Record Brief Supporting Sample Answer: The fossil record shows an increase in the complexity of living forms from simple one-celled organisms, to the first simple plants and animals, to the diverse and complex organisms that live on Earth today. This pattern</p>	<p><i>observed complexity</i></p>	<p>The increase in observed complexity is not the basis for common descent, which is what “later forms evolved from early simple forms” means. Among the main bases for the theory of common descent are (1) the distribution of homologous organs and structures (2) the observed biogeographical distribution of species, (3) the many transitional forms</p>

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	suggests that later forms evolved from earlier simple forms over long periods of geological time.		<p>observed in the fossil record, and (4) the concordance of phylogenetic trees constructed from morphological and molecular data. The observed change in complexity over geological time has no particular bearing on the theory of common descent.</p> <p>Simple, unicellular organisms are still the most abundant lifeforms, found in all environments across the globe.</p>
37 p. 326	<p>Aspect 2: Fossil Record Brief <u>Supporting Sample Answer:</u> Macroevolution is the large-scale evolution occurring over geologic time that results in the formation of new taxonomic groups. The slow transformations are reflected in transitional fossils such as <i>Archaeopteryx</i> (a reptile-like bird) and mammal-like reptiles. These transitional fossils bridge the gap from one species to another species and from one branch on the tree of life to another.</p>		<p>The sample answer assumes that evolution requires "slow transformations." What is meant by "slow" is never defined. In fact, evolution proceeds at different rates, and the fossil record can help to some extent in determining what those rates are. This is again an attempt to narrow the definition of "evolution" in order to make it easier to argue against. The reference to <i>Archaeopteryx</i> ignores that there are now a whole collection of bird-like and feathered dinosaurs, and not just a single transitional form. The last sentence muddles the understanding of both evolution and taxonomy (the methods by which organisms are classified and grouped). Firstly, higher taxonomic groups are groupings constructed using some particular classification methodology. Secondly, transitional forms are recognized as we move down the tree of life into the past, not by trying to jump from limb to limb.</p>
38 p. 327	<p>Aspect 2: Fossil Record Brief <u>Challenging Sample Answer:</u> Transitional fossils are rare in the fossil record. A growing number of scientists now question that <i>Archaeopteryx</i> and other transitional fossils really are transitional forms.</p>	<i>no citation</i>	<p>No Citation supports this assertion, and the assertion is false. Disagreement is over which precise group is ancestral, not over whether the fossil is transitional. Most fossils are transitional.</p> <p>This challenging answer confuses the issue of direct ancestor-descendant relationships with transitional morphologies. Direct ancestor-</p>

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			<p>descendant relationships are very difficult to identify in the fossil record; the general patterns of the evolutionary tree are not. Transitional forms are surprisingly common (as the scientific literature documents) and a powerful support for common descent.</p>
<p>39 p. 327</p>	<p>Aspect 2: Fossil Record Brief <u>Challenging Sample Answer:</u> Transitional fossils are rare in the fossil record. A growing number of scientists now question that <i>Archaeopteryx</i> and other transitional fossils really are transitional forms. The fossil record as a whole shows that major evolutionary changes took place suddenly over brief periods of time followed by longer periods of “stasis” during which no significant change in form or transitional organisms appeared (Punctuated Equilibria). The “Cambrian explosion” of animal phyla is the best known, but not the only example, of the sudden appearance of new biological forms in the fossil record.</p>	<p>Discovery Institute, Center for (the Renewal of) Science and Culture, Web Curriculum, Science Education Resources:</p> <p>The Discovery Institute published (on the Internet) an educational curriculum promoting Intelligent Design in <i>March, 2000</i>, (Forrest & Gross, 2004). These materials have since been restricted or are completely unavailable. See Forrest and Gross, (2004), for the details. From the archives maintained by Forrest and Gross:</p> <p>Key features of the Cambrian explosion</p> <ol style="list-style-type: none"> 1. Geologically Sudden: Occurred within a <u>very narrow window of time</u> (as brief as 5 million years) 2. Morphologically Radical: Exhibits amazing morphological breadth and completeness at higher <u>taxonomic levels</u> 3. Informationally Discontinuous: Unsurpassed leap upward in specified complexity (information content) 4. No clear transitional intermediates leading up to Cambrian animals <p>To say that the fauna of the Cambrian period represent a dramatic leap upward in specified complexity of the biological world, implies the absence of clear transitional intermediates between Cambrian animals and those simpler living forms found in lower strata. Indeed, in almost all cases, the body plans and structures present in Cambrian period animals have no clear causal antecedents in earlier strata. Some have argued that perhaps the Ediacaran fauna hold out some hope in this regard, but as we will show below those hopes now seem remote. In any case, the origin of the Ediacaran fossils themselves constitute a profound mystery for precisely the same reason, namely, no clear intermediates exist between the relatively complex Ediacaran animals and the simpler bacteria and algae that preceded them.</p>	<p>Since estimates of the duration of the Cambrian diversification range from 5 million years ago to 35 million years ago, “sudden” misrepresents the rate of change. “Sudden” here seems to imply the absence of predecessors -- otherwise it would not be a challenge to the occurrence of transitional forms. However, there are Precambrian and early Cambrian fossil forms that share characteristics of two or more living phyla, or only possess some of the defining characters of living phyla. The Cambrian diversification did not involve the first appearance of all living phyla but only perhaps eight or so phyla - and some of these may have had Precambrian representatives. The actual first appearances of fossil representatives of modern animal phyla range from the late Precambrian to the Recent.</p> <p>At best, the sample answer confuses a highly debatable interpretation with the actual data of the fossil record. In addition, “forms” is not a technical term in biology; its use here is ambiguous and connotes a religious philosophy.</p>
<p>40</p>	<p>Aspect 3: Antibiotic Resistance</p>	<p><i>no citation</i></p>	<p>There are no references offered for this lesson. The writer refers teachers and students to an</p>

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p. 327			<p>expanded set of citations in the General Tips Section; however, none of these citations address the subject of antibiotic resistance.</p> <p>The Public Broadcasting System’s (PBS) web site version of its award-winning series on Evolution includes an on-line library of resources related to the evolution of antibiotic resistance. http://www.pbs.org/wgbh/evolution/index.html</p>
41 p. 327	<p>Aspect 4: Peppered Moths (<i>Biston betularia</i>): Citations #5, 26 and 44 in the General Tips Section may provide a starting point for student research. It is suggested that students employ additional resources in their research.</p>		<p>The three recommended citations are from the mid-1980s. Considerable new research has been published on that question raised in aspect #4 since 1986. Until removed by the Board of Education, the most recent citation was #44, Wells’ Intelligent Design Creationist polemic. Wells badly misrepresents the state of research in this aspect and omits the evidence that contradicts his unsupported claims.</p> <p>References #5 and # 26 are not readily accessible to the average high school Biology class. An internet search of the keywords “peppered, moth, and evolution” returned 1 appropriate site, 8 inappropriate sites (mostly creationists sites), and one site which should only be used under teacher guidance.</p>
42 p. 328	<p>Aspect 4: Peppered Moths (<i>Biston betularia</i>) <u>Brief Challenging Sample Answer:</u> Scientists have learned that peppered moths do not actually rest on tree trunks.</p>		<p>Scientists have in fact learned exactly the opposite. The results of the relevant field studies were published in Majerus, (1998). The study of peppered moths and other melanic species was never intended as an example of speciation -- other studies address that question. The study of peppered moths, particularly with the addition of the more recent work, provides an excellent point of discussion for how natural selection works in natural populations. Using it in the manner demonstrated in this lesson significantly misrepresents the research.</p>

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			This erroneous claim comes from the Rev. Jonathan Wells’ book <i>Icons of Evolution</i> , although the reference to the source has been deleted by the Board of Education.
43 p. 328	<p>Aspect 5: Endosymbiosis (formation of cellular organelles)</p> <p><u>Brief Challenging Sample Answer:</u></p> <p>Laboratory tests have not yet demonstrated that small bacteria (prokaryotic cells) can change into separate organelles, such as mitochondria and chloroplasts within larger bacterial cells. When smaller bacterial cells (prokaryotes) are absorbed by larger bacterial cells, they are usually destroyed by digestion. Although some bacterial cells (prokaryotes) can occasionally live in eukaryotes, scientists have not observed these cells changing into organelles such as mitochondria or chloroplasts.</p>	<p>Behe, M. <i>Darwin’s black box</i>. (pp.188-189):</p> <p>"Periodically over the last two decades Margulis and other scientists have proposed that other cellular compartments / components are the result of symbiosis. These proposals are not so widely accepted [as Margulis' earlier proposal regarding symbiosis]. For purposes of argument, however, let's suppose that the symbiosis Margulis envisions was in fact a common occurrence throughout the history of life. The important question for us biochemists is, can symbiosis explain the origin of complex biochemical systems?</p> <p>“Clearly it cannot. The essence of symbiosis is the joining of two separate cells, or two separate systems, both of which are already functioning. In the mitochondrion scenario, one preexisting viable cell entered a symbiotic relationship with another such cell. Neither Margulis nor anyone else has offered a detailed explanation of how the preexisting cells originated. Proponents of the symbiotic theory of mitochondria explicitly assume that the invading cells could already produce energy from foodstuffs; they explicitly assume that the host cell already was able to maintain a stable internal environment that would benefit the symbiont.</p> <p>“Because symbiosis starts with complex, already-functioning systems, it cannot account for the fundamental biochemical systems we have discussed in this book. Symbiosis theory may have important points to make about the development of life on earth, but it cannot explain the ultimate origins of complex systems.”</p> <p><i>The evolution controversy:</i></p> <p>"DNA contains coded instructions needed for assembly of proteins in living cells and for carrying out the processes associated with life. The great question to be addressed in determining how life originated is “where did the instructions (i.e., biological information) come from?” This is a great mystery. Biologists have no satisfactory answer as to how this information could have arisen by natural causes. Intelligent sources are the only known entities that can produce such instructions</p>	<p>This is a common argument used by creationists of all stripes. They demand that evolutionary processes be demonstrated in their entirety in a controlled laboratory setting. That is not the manner in which evolutionary processes are reconstructed. Rather they rely on multiple observations from a wide range of disciplines that together provide a powerful and compelling theory. Such challenges are akin to demanding that scientists synthesize a granite rock in the lab before the molten origin of igneous rocks can be accepted.</p>

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		<p>or information. (Sjogren, et al., 2003, p.4)</p> <p>A large number of biological systems have the characteristic known as “irreducible complexity.” An irreducibly complex system (<i>e.g.</i>, the bacterial flagellum) has a large number of necessary interacting parts, the removal of any one of which causes the system to cease its function. Gradual Darwinian mechanisms do not have the capacity to generate irreducibly complex systems. This suggests that purposeful design by intelligence is a more likely explanation for their origin. Living systems are in many ways analogous to human-made machines. Since we know that mechanical machines are made by intelligent engineers, it is reasonable to infer that “living machines” are also the product of intelligent design. (Sjogren, et al., 2003, p.4)</p> <p>If evolution is the true explanation for the diversity of life, then there must be one or more naturalistic mechanisms that are capable of generating new features (novel body plans and body parts). Natural selection and genetic mutation, the primary Darwinian mechanisms, have not clearly shown themselves capable of generating these new features. A more reasonable explanation of new features would be design by intelligence. (Sjogren, et al., 2003, p.5)</p>	

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