

actionbioscience.org lesson

To accompany the special report, reprinted from *Natural History* magazine (Issue 4/02, pgs. 73-80), "Intelligent Design?" at <http://www.actionbioscience.org/evolution/nhmag.html>

Our Universe: Designed or Evolved? (Dec. 2003)

Lesson by **Ronald Brian Watts, Ph.D.**

Professor, Dept. of Biology & Chemistry,
CEGEP De La Gaspésie et Des Îles, Gaspé, QC, Canada

Educator's section: p. 1-4
Student handout 1: p. 5
Student handout 2: p. 6-7
Supplementary handout: p. 8

Grades & Levels:

- **Handout 1:** High School (general/AP)
- **Handout 2:** Undergraduate College/University (year 1-2)

Time Recommendations: The lesson author suggests that a unit could be designed consisting of select article discussion questions and activity assignments:

- **Article discussion:** 2 class periods with or without homework time
- **Activities in student handouts:** 2 – 3 weeks to complete

NSES (USA) Content Standards, 9-12:

- NSES 1.2. Unifying Concepts & Processes: evidence, models & explanation
- NSES 2.2. Science as Inquiry: understanding about scientific inquiry
- NSES 4.3. Life Sciences: biological evolution
- NSES 5.3. Earth & Space Science: origin & evolution of the earth system
- NSES 5.4. Earth & Space Science: origin & evolution of the universe
- NSES 8.2. History & Nature of Science: nature of scientific knowledge
- NSES 8.3. History & Nature of Science: historical perspective

Note: View the NSES content standards on this site to choose other curricular applications for additional activities at: <http://www.actionbioscience.org/educators/correlationcharts.html>

Learning Objectives: Students will...

- list the main arguments for the ideas of "Intelligent Design" (ID) and "Evolution"
- evaluate each idea as to whether it would qualify as scientific hypothesis or theory
- summarize the history of each of these ideas over the last two centuries
- consider whether Intelligent Design should be taught in science courses
- examine why there is controversy over the teaching of these two ideas

Key Words Include: adaptation, Creationism, Darwin, Darwin's finches, Darwin's theory, Evolution, *HOX* genes, hypothesis, Intelligent Design (ID), Irreducible Complexity, mutation, naturalism, natural selection, science, scientific method, species, Specified Complexity, theory, *Ubx* genes, the Wedge

Preparation

Materials Required:

- Sufficient copies of the article at <http://www.actionbioscience.org/evolution/nhmag.html> for each student or student team
- For research needs: Access to school or college library and to computers with Internet connections

Article Discussion: The suggested discussion questions, on pages 2 to 4, consist of two parts. If there are time constraints, educators can select questions from each part to create their own article discussion unit.

- A. Group Discussion: Each group is responsible for reading paired viewpoints (authors are clearly paired in the online special report, e.g., Behe/Miller).
- B. Extension Questions: The class should read the entire online report. Some extension questions require time for research.

Handout 1 or 2 Activities: Assign activities from Student Handout 1 or 2, depending on grade level, for individual or group work after article discussion.

Additional Resources: To accompany Handout 1 or 2 activities, a reading list of some related books and articles has been created by the lesson author to assist with research (see Supplementary Student Handout). Also, refer students to the "learn more" and "educator resources" sections at the end of the online report; these Internet links can provide ideas/information for student activities.

Lesson Author's Note: It is not the author's intention to make a claim, judgment, statement or conclusion about the truth of any reader's personal beliefs concerning the origin of life and/or the universe. Discussion questions and other activities are intended to generate thought and inquiry only. The object of the lesson is to help students evaluate all hypotheses proposed as to their scientific value and gain a better understanding of what science is and what it is not. Teachers should make it clear that students should be respectful of each other's opinions and personal beliefs during discussion and other activities.

For Educators: Article Discussion

About the special report "Intelligent Design?" from *Natural History* magazine
<http://www.actionbioscience.org/evolution/hhmag.html>

A. Group Discussion Questions

Groups of two to four students could be formed to discuss these questions. Discussion may be concentrated in one time period or broken down into smaller periods involving consideration of 2-3 questions at a time. Ask a spokesperson for each group to summarize their discussion to the class (optional).

BEHE/MILLER VIEWS

1. What criterion does Behe use to justify his citation of Irreducible Complexity as evidence for ID?
2. How does Behe define "Irreducible Complexity"? What analogy does he use? Briefly describe his example and state the conclusion he bases on it.
3. Outline one example of a biochemical system that Behe cites as being irreducibly complex.
4. What does Miller see as the error in Behe's mousetrap analogy as an argument for ID? What is "the point" or conclusion of Miller's analysis?
5. Why do most cell researchers disagree with Behe's conclusion that complex cellular biochemical systems could not have evolved?
6. What does Miller think of the idea of a divine intelligence behind the natural world? How does this view seem to differ from Behe's?
7. What does Miller state as the ultimate failure of ID as scientific hypothesis?

DEMBSKI/PENNOCK VIEWS

1. What three kinds of explanations does Dembski see as sufficient to cover every eventuality of everyday life?
2. What sorts of criteria does Dembski think would constitute evidence for intelligent design in our universe?

3. What reason(s) does Dembski give for thinking that Darwinian natural selection could not generate specified complexity?
4. What crucial point does Pennock make about the logic of Dembski's argument that specified complexity means intelligent design? What more does science require before making such a conclusion?
5. Pennock spends much of his essay refuting Dembski's example of design inference based on the movie *Contact*. What specific points does Pennock make in this regard?
6. What specific property does Pennock believe that a scientific hypothesis must have? Does he think that Dembski's design inference hypothesis meets this criterion? Why or why not?

WELLS/SCOTT VIEWS

1. What study of Darwin's Finches demonstrated "evolution in action"? Does Wells agree or disagree? Why or why not?
2. How does Wells explain the suggestion that the development of a second pair of wings in fruit flies as a result of three genetic mutations is an example of the sort "of anatomical changes that Darwin's theory needs"?
3. Why does Scott think that Well's insistence on "design" is an inappropriate hypothesis for science? According to Scott, how does Wells misdirect readers by suggesting that "Darwin's theory cannot account for all features of living things"?
4. According to Scott, how did the studies by the Grants demonstrate that natural selection is a reality and could lead to the development of new species?
5. What is the true significance of *Ubx* genes and how would this lead to a re-interpretation of Well's four-winged fruit fly example?

B. Extension Questions

Ask each student to read the report in its entirety. Discuss it in class and/or assign questions as homework.

INTRODUCTION BY MILNER/MAESTRO

1. Who was the best-known exponent of the "argument from design"? What analogy did he use to explain his idea? When did he make this proposal?
2. What idea do most scientists agree better explains life's complexity and diversity? Who proposed this idea and when?
3. What do most biologists conclude about Intelligent Design proponents?
4. How do modern ID proponents differ from fundamentalist creationists? How are they similar?
5. Does it appear from this introduction that the effort to incorporate the ID hypothesis into science (biology) courses is meant to improve the students' understanding of science? Briefly explain your conclusion.

BEHE/MILLER VIEWS

1. What crucial point makes Behe think that natural selection (and by extension, Darwinian evolution) cannot explain the existence of complex biochemical systems in cells?
2. Do you think that (a) "Biochemistry textbooks and journal articles ... offer very little information" about how such biochemical systems "supposedly evolved" and/or that (b) "Many scientists frankly admit their bewilderment" about the origins of such systems, necessarily means that such systems were designed? Briefly explain why or why not?

3. Describe Miller's summary of Behe's biochemical "evidence" for ID. Does it seem logical to you? Why or why not?
4. Miller examines Behe's example of the bacterial flagellum and uses the example of blood clotting pathways to refute Behe's argument. Outline the crucial points of Miller's rebuttal. Do you think Miller was effective? Why or why not?

DEMBSKI/PENNOCK VIEWS

1. In what way does Dembski's idea of 'specified complexity' differ from Behe's idea of 'irreducible complexity'? Do you think that either are necessarily evidence for ID? Why or why not?
2. Do you think that Dembski's statement "... in the natural sciences one of these modes of explanation is considered superfluous – namely, design" is a fair statement? Why or why not? Check your science textbook or other resources for an explanation of what science is and how it works.
3. Why does Pennock believe that Dembski's archery and SETI analogies are "red herrings"? Could you propose modifications to either of these analogies that might indicate intelligent design?
4. Pennock mentions that Dembski has been called "the Isaac Newton of information theory." What could this description mean? Does Pennock think that it is a fair description of Dembski's work and writings? Why do you think so (or not)?

WELLS/SCOTT VIEWS

1. Wells believes that natural selection does operate but only within species leading to modifications of features already possessed by these species. What evidence exists for such a statement? Why do most biologists disagree with it?
2. Wells states that "Major evolutionary changes would require mutations that produce advantageous *anatomical* changes as well." Why do you agree or disagree? Find an example or two in literature to support your conclusion.
3. Why are the Grants' studies of Darwin's finches considered so significant by evolutionary biologists? Are there any other such examples? Briefly search scientific literature to find one or two such examples. How do they support the idea that natural selection does occur and could lead to evolution of new species?
4. Find information on *Ubx* or *HOX* genes to expand on Scott's explanation. Discuss how mutation of these genes could play a significant role in evolution.

OVERVIEW BY FORREST

1. When did the Intelligent Design movement begin and why? What is its published aim?
2. What is the main aim and thrust of the "Wedge" movement? Is it really trying to propose ID as a scientific hypothesis? Why or why not?
3. Why does Forrest think that the ID proponents who have participated in this report (Behe, Dembski, and Wells) have not really shown ID to be a valid scientific hypothesis?
4. Why do the ID proponents, as Forrest states, "invest most of their efforts in swaying politicians and the public, not the scientific community"? Are their efforts legitimate science? Why or why not?
5. Forrest cites Dembski as stating that "we know naturalism is false." What do you think he means by the term "naturalism"? What rationale does he give for this being false? Is it legitimate to expect science to operate according to Dembski's justifying principles? Why or why not?

Our Universe: Designed or Evolved?

Student Handout 1

1. Reports

Choose one of the activities below. All topics are based on the online report "Intelligent Design?" at <http://www.actionbioscience.org/evolution/nhmag.html>.

- a) Re-read the description of William Paley's watchmaker analogy in the introduction to the special report.
 - Do you think that such a discovery would be good evidence for a designer?
 - Can the analogy be used to infer intelligent design in the natural world? Why or why not?
 - Is this use of inference from analogy good scientific procedure? Why or why not?
- b) Kenneth R. Miller states that "... the scientific community has been unimpressed by attempts to resurrect the so-called argument from design..."
 - Summarize one of Miller's critiques of Michael J. Behe's arguments and compare it with the original argument made by Behe.
 - Which viewpoint do you find most compelling? Why?
 - Is your own judgment here open to scientific investigation? Why or why not? Should it be?
- c) William A. Dembski argues that "... the natural sciences need to leave room for design." Why does he think so?
 - Is it true, as he states, that the natural sciences consider design superfluous as an explanation for the existence of complex life forms?
 - Does science ever acknowledge "design" as an explanation for an observed phenomenon? Under what circumstances?
 - What would be required by science to include "design" as an explanation for the complexity of living systems?
- d) Consider ID in terms of a scientific approach.
 - List the basic tenets of the scientific method.
 - Is the approach adopted by intelligent design proponents a valid scientific approach to the problem of the complexity of life?
 - Should science accept supernatural explanations for phenomena such as the development of complex biological systems? Why or why not?

2. Projects

With a partner, choose one topic to create a science-fair type poster or web page.

- a) Explain two or more origin hypotheses including Intelligent Design and Evolution. Some critique should be provided of the scientific validity of each hypothesis.
- b) Use your biology textbook to find body structures or features that appear so "perfect" or complex that ID proponents would likely say they were designed. Then do some research to determine if there are any alternative evolutionary explanations.

Our Universe: Designed or Evolved?

Student Handout 2

1. Reports

Choose one of the activities below. All topics are based on the online report "Intelligent Design?" at <http://www.actionbioscience.org/evolution/nhmag.html>.

- a) Re-read the description of William Paley's watchmaker analogy in the introduction to the special report. Do you think that such a discovery would be good evidence for Intelligent Design? Can the analogy be used to infer intelligent design in the natural world? Why or why not? Is this use of inference from analogy good scientific procedure? Why or why not?
- b) Michael J. Behe argues that complex biochemical systems, such as the cellular protein transporting mechanisms, could not have evolved through "numerous, successive, slight modifications." Do you think from reading Behe's position statement and Kenneth R. Miller's response that this is valid scientific inference? Briefly explain why or why not.
- c) Antievolutionists often state that the apparent increasing complexity of life understood as the result of complex interactions of environment (natural selection and chance) and genetic programming (including mutation and genetic recombination) violates the second law of thermodynamics. Why do they think so? How does Robert T. Pennock reply to this view? Take time to research the energy transformations in biological systems. After doing so, do you agree with Pennock? Why or why not?
- d) Jonathan Wells seems to believe that each example cited as evidence for evolution (what he calls "icons of evolution") should be able to show clearly that the features of living things are not designed. One study he attempts to demonstrate as inadequate to this task is the Grants' investigations of Darwin's finches on the Galapagos Islands. Do you agree or disagree with Wells' apparent belief in this? Does the Grants' study support Darwin's theory? Why do you think so, or think not?
- e) According to Eugenie C. Scott, Wells has misinterpreted the importance of the Grants' studies of changes in beak size in Darwin's finches. Do you agree? What important evidence does she cite to support the Darwinian explanation here but that Wells apparently missed? Scott also takes Wells to task on his explanation of the significance of mutation in the *Ubx* genes of fruit flies. Do you agree with her critique? Why or why not?

2. Projects

With a partner, choose one topic to create a presentation.

- a) Prepare a report, web page, or other illustrated presentation that contrasts a Darwinian view with a view from Intelligent Design using one of the following biological systems: bird flight, four-winged fruit fly, vertebrate eye, bacterial flagella, blood clotting enzyme cascade (or suggest your own system).
- b) Find 8 web sites (some site ideas are provided in "learn more links" at the end of the online report), evenly split between the ID and the Evolution positions (4 of each). Analyze them as to the quality & persuasiveness of their arguments/information and as to the evidence for the position(s) taken & the scientific acceptability of this evidence. The "Worksheet for Analysis of Web Sites" on page 7 may be used for each site. A report should be prepared summarizing the findings.

Our Universe: Designed or Evolved? Supplementary Student Handout

Reading List (books & articles)

- 1) Behe, Michael J. 1996. *Darwin's Black Box: The Biochemical Challenge to Evolution*. A Touchstone Book, Simon & Schuster, New York, NY, 319 pp. [ISBN: 0-684-83493-6]
Behe's classic work which raised the hypothesis that many complex biochemical pathways and microbiological structures are "irreducibly complex" and, as such, must have been designed.
- 2) Dennett, Daniel C. 1995. *Darwin's Dangerous Idea: Evolution and the Meanings of Life*. Simon & Schuster, New York, NY, 587 pp. [ISBN:0-684-80290-2]
This book takes a philosophical approach to the implications and impact of the Theory of Evolution by Natural Selection (Darwinism). Dennett challenges the views of some famous evolutionary scientists as well as creationists and others who reject the idea outright.
- 3) Dover, Gabriel. 2000. *Dear Mr. Darwin: Letters on the Evolution of Life and Human Nature*. Weidenfeld & Nicolson, London, UK, 284 pp. [ISBN: 0-297-84259-5]
This is an imagined two-way correspondence between the author (a geneticist) and Charles Darwin. They discuss the findings of modern genetics and their impact on our understanding of evolution.
- 4) Fortey, Richard. 1997. *Life: A Natural History of the First Four Billion Years of Life on Earth*. Alfred A. Knopf, New York, NY, 349 pp. [ISBN: 0-965-034097]
This is a very readable background reference on our current understanding of the history of life from the earliest microbes of four-billion years ago to human beings today.
- 5) Gould, Stephen Jay. 1999. *Rocks Of Ages: Science and Religion in the Fullness of Life*. Ballantine Books, New York, NY, 249 pp. [ISBN: 0-345-45050-X]
Gould's examination of the division and conflict that seems to exist between religion and science. He proposes that the two "magesteria" can and should exist along side each other.
- 6) Jones, Steve, 1999. *Darwin's Ghost: The Origin of Species (updated)*. Doubleday Canada (Random House Canada Ltd.), Toronto, ON, 406 pp. [ISBN: 0-385-25909-3 pbk]
Modern updated version of Darwin's *The Origin of Species* which incorporates modern genetic discoveries as well as our improved understanding of the operation of natural selection itself.
- 7) Martin, B. and F. Martin. 2003. "Neither Intelligent Nor Designed." *Skeptical Inquirer* 27(6): 45-49.
The article explains how the concept of Intelligent Design has deep and long standing roots in theology but does not satisfy the falsification of predictions criterion of a scientific hypothesis.
- 8) Miller, K. R. 1999. *Finding Darwin's God: A Scientist's Search for Common Ground Between God and Evolution*. Cliff Street Books, (Harper Collins Pub.) NY, NY, 351 pp. [ISBN: 0-06-093049-7]
This eminent evolutionary scientist explains how he finds no conflict between modern evolutionary ideas and the holding of religious belief in a supreme being.
- 9) Palumbi, Stephen R. 2001. *The Evolution Explosion: How Humans Cause Rapid Evolutionary Change*. W. W. Norton & Company, New York, NY, 287 pp. [ISBN: 0-393-02011-8]
The author discusses and explains cases of rapid-fire evolution spurred on by or as "side effects" of the technological efforts of humankind, such as antibiotic resistance and HIV.
- 10) Weiner, Jonathan. 1994. *The Beak Of The Finch: A Story of Evolution in Our Time*, Alfred A. Knopf, New York, NY, 342 pp. [ISBN: 0-697-40003-6]
Although the greater part of this landmark book explains the work of Peter and Rosemary Grant on Darwin's finches, it provides a summary of the history and development of the theory of evolution.
- 11) Zimmer, Carl. 2001. *Evolution: The Triumph of an Idea* (companion book to the PBS *Evolution* series). HarperCollins Publishers, New York, NY, 384 pp. [ISBN: 0-06-019906-7]
This highly illustrated book tells the story of the theory of evolution from Darwin to our time and the relevance of the idea of evolution to our lives today.