STUDY GUIDE : BIOLOGICAL EVOLUTION AND THE KINSHIP OF ALL LIFE
By Dr. Joshua M. Moritz

VIDEO SUMMARY: The observed *fact* of evolution is that organisms have changed over time. By examining the fossil record and the DNA of various lifeforms, scientists can gather a general picture of the history of life on Earth and how it has developed through time. Natural selection has long been known as an important mechanism that drives evolutionary change. Instances of evolutionary convergence, where two or more lineages of organisms navigate to or arrive at the same evolutionary outcome from very different ancestral starting points, shows us that the path of evolution may be a lot less random than many scientists once thought.

CONTRIBUTORS

Dr. Sean B. Carroll is a professor of genetics, molecular biology, and medical genetics at the University of Wisconsin-Madison, and a researcher and vice-president for science education at the Howard Hughes Medical Institute. He is a leader in the field of evolutionary developmental biology, or "evo devo," and is the author of *Endless Forms Most Beautiful: The New Science of Evo Devo and the Making of the Animal Kingdom* (W. W. Norton, 2005).

Dr. Jeff Hardin is chair of the department of zoology at the University of Wisconsin. He is the senior author of *World of the Cell* (Pearson Education, 2015).

Dr. Neil Shubin is the Robert R. Bensley Professor of Organismal Biology and Anatomy, associate dean for academic strategy, and a member of the Committee on Evolutionary Biology at the University of Chicago. He is the author of *Your Inner Fish: A Journey into the 3.5-Billion-Year History of the Human Body* (Knopf Doubleday, 2008) and *The Universe Within: Discovering the Common History of Rocks, Planets, and People* (Pantheon Books, 2013).

DISCUSSION QUESTIONS

1. How would you define the term "evolution"? How do the scientists in the video define evolution?
2. Do you think there is an essential conflict or incompatibility between the scientific concept of evolution and the theological affirmation that God created life? Why or why not?
3. In what ways are the evolution of a species and the development of an embryo similar? From a theological perspective, do you look at these processes in the same way, or differently?

In this film, evolutionary developmental biologist Sean B. Carroll explains that "DNA is a forensic record of evolution." In a similar way, paleontologist Neil Shubin speaks of how the body of each human being is a time capsule that contains a record of important transitions in evolutionary history.

4. Consider how the genes and body of an individual human being contain a record of our evolutionary history. Are there any theological implications that emerge from this view of how humans are deeply connected to the history of all life? If so, what are the implications? If not, why not?
5. There is a long theological tradition (especially in the Christian East) that speaks of the human being as a microcosm that in some way sums up the whole of creation. Do you think Shubin and Carroll's description of the human as a record of cosmic and evolutionary history lends itself to the theological understanding of humans as a microcosm? Why or why not?

In this video, Dr. Shubin reflects that "there is something incredibly beautiful about seeing the past."

6. Do you agree or disagree with this statement? Why or why not?

In the film, a distinction is made between "Darwinism" and "evolutionary science." Some recent non-Darwinian understandings of evolution focus on cooperative mutualism and symbiotic relationships as sources of evolutionary novelty. For example, the mechanism of Horizontal Gene Transfer (HGT) involves the non-genealogical transmission of genetic material from one organism to another (e.g., between bacteria; leading to the rapid spread of antibiotic resistant strains).

7. Consider non-Darwinian understandings of evolution that focus more on cooperation than competition. Do you think theism is more compatible with these understandings of evolution than Darwinian understandings? Why or why not?
8. How do you typically hear the word "Darwinism" used, and in what circumstances? Does the word have implications or connotations for you that go beyond evolutionary science itself?

The biologists in this film all speak about "evolutionary convergence" as a phenomenon where evolution repeats itself and creates similar forms and ways of life among different lineages. One researcher in convergent evolution, Cambridge University paleobiologist Simon Conway Morris, has argued that "the phenomenon of evolutionary convergence indicates that the number of alternatives is strictly limited" and that "life navigates towards certain inevitable solutions" (Conway Morris, *Life's Solution*, 309).

9. Do you think the discovery of cases of convergence in evolution tell us anything about a direction or goal for the development of life over time? Why or why not?

Consider Shubin's discovery of *Tiktaalik*, a fish popularly described as a "missing link" between sea and land animals. Shubin was interested in understanding how four-limbed creatures evolved from aquatic animals with fins. To answer this question, Shubin searched for a fossil in rocks that formed ~375 million years ago. This is a time period when fish are diverse and abundant in the fossil record, but land-dwelling tetrapods are unknown. , He and his research team discovered *Tiktaalik* right where they expected it to be.

10. How does this case study exemplify the predictive power of evolutionary theory?
11. Shubin has noted that with every discovery of a so-called "transitional" fossil, "two new gaps" appear. Why might the terms "transitional fossil" or "missing link" lead to misunderstandings about the nature of evolutionary change?

FURTHER RESOURCES & SUGGESTED READINGS

Online Resources:

- Video: Denis Alexander, "Creation or Evolution: Do we have to choose?" http://downloads.sms.cam.ac.uk/1653444/1653449.m4v
- Video: John Bryant, "Creation or Evolution?" http://downloads.sms.cam.ac.uk/1279905/1279909.m4v
- Article: Joshua Moritz, "God's Creation Through Evolution and the Language of Scripture" https://www.faraday.st-edmunds.cam.ac.uk/Issues_Moritz.php

On evolution and creation:

- Denis Alexander, *Creation or Evolution: Do We Have to Choose?* (Monarch Books, 2008).
- Robin Attfield, *Creation, Evolution and Meaning* (Ashgate, 2006).
- Peter J. Bowler, *Gorilla Trials and Monkey Sermons: Evolution and Christianity from Darwin to Intelligent Design* (Harvard University Press, 2007).
- Francis Collins, *The Language of God: A Scientist Presents Evidence for Belief* (Simon and Schuster, 2006).
- Darrel Falk, *Coming to Peace with Science: Bridging the Worlds Between Faith and Biology* (IVP, 2009).
- Mark Harris, *The Nature of Creation: Examining the Bible and Science* (Routledge, 2014).
- John F. Haught, *Making Sense of Evolution: Darwin, God and the Drama of Life* (WJK Press, 2010).
- Edward J. Larson, *Evolution: The Remarkable History of a Scientific Theory* (Random House, 2006).
- David Livingstone, *Darwin's Forgotten Defenders: The Encounter Between Evangelical Theology and Evolutionary Thought* (Eerdmans, 1987).
- Simon Conway Morris, *Life's Solution: Inevitable Humans in a Lonely Universe* (Cambridge Univ.Press, 2003).
- Simon Conway Morris, *The Runes of Evolution: How the Universe Became Self-Aware* (Templeton, 2014).
- Keith B. Miller, *Perspectives on an Evolving Creation* (Eerdmans, 2003).
- Kenneth Miller, *Finding Darwin's God: A Scientist's Search for Common Ground Between God and Evolution* (Cliff Street Books, 1999).

- Joshua Moritz, *Science and Religion: Beyond Warfare and Toward Understanding* (Anselm Academic, 2016).
- Martin Nowak and Sarah Coakley, eds. *Evolution, Games, and God: The Principle of Cooperation* (Harvard University Press, 2013).
- John Polkinghorne, “Scripture and an Evolving Creation,” *Science and Christian Belief* 21(2009): 163–173.
- Jeffrey Schloss and Michael Murray, “ Evolution and Theism,” in *Routledge Companion to Theism,* S. Goetz and C. Taliaferro, eds. (Routledge, 2016).

On the theological meaning of the human connection and kinship with other species:

- Richard Bauckham, *The Bible and Ecology: Rediscovering the Community of Creation* (Baylor Univ. Press, 2010).
- Richard Bauckham*, Living with Other Creatures: Green Exegesis and Theology* (Paternoster, 2012).
- Celia Deane-Drummond, *Christ and Evolution: Wonder and Wisdom* (SCM Press, 2009).
- David Clough, *On Animals: Volume I: Systematic Theology* (T&T Clark, 2012).
- Terence Fretheim, *God and World in the Old Testament: A Relational Theology of Creation* (Abingdon, 2005).
- Andrew Linzey, *Creatures of the Same God: Explorations in Animal Theology* (Lantern Books, 2009).
- Joshua Moritz, “Animals and the Image of God in the Bible and Beyond,” *Dialog: A Journal of Theology* 48:2 (2011): 134-46.

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