



Evolution and Heredity Online Course for Educators

Vered Shapiro¹, Gal Yerushalmi²

Abstract

“Nothing in biology makes sense except in the light of evolution”. Indeed, modern biological sciences focus primarily on understanding the biological processes that are responsible for the diverse body plans, life styles and physiological processes observed in modern-day organisms. Yet, over the years, both educators and education plans tended to avoid teaching evolution. As there are no scientific arguments against the theory of evolution, and its importance to understanding biological processes is obvious, the main reason for this avoidance is the desire to avoid social and cultural conflicts. Nevertheless, this prolonged avoidance of this supposedly volatile subject results in a lack of modern teaching tools, making it even harder for current-day science educators to integrate it into their curriculum. To overcome this barrier we are currently developing an online open course for educators focusing on evolution and heredity, providing the teacher with lesson plans and interactive online teaching resources for their students. This timeline-based course, built as three consecutive units, tells the story of the scientific discoveries leading to the modern synthesis of evolutionary theory. The first part starts with the work of Charles Darwin and the theory of evolution and ends with the work of Gregor Mendel that ultimately provided the missing mechanism required for organisms to evolve. The second part introduces the central dogma of heredity, including the discovery of DNA and other cellular machines, and explains how these discoveries helped in understanding evolutionary processes. The third part of the course brings the students to modern day biology, when genetic engineering technology enables us to make directed changes in DNA sequences, overcoming the limitations of natural or artificial selection. We believe it is important for both students and educators to learn not just the science itself but also the history of science, and to understand how scientific theories that were once accepted are subsequently supplemented or even replaced by new findings, and how emerging technologies assist us in furthering our understanding of biology and evolution.

Keywords: Evolution, heredity, genetics, online, course, educators;

1. Introduction

The idea of teaching evolution triggers objections and generates considerable controversy. This controversy may be traced back all the way to the publication of *On the Origin of Species* by Charles Darwin in 1859. Darwin supported his ideas with countless studies and observations, including the analysis of thousands of specimens collected all over the globe. Despite initial opposition the scientific community rapidly adopted his theory, and continues to embrace it to this date [1]. The main challenge to this new view of the biological world came from conservative and religious circles. Indeed, this social and cultural conflict was predicted by Darwin himself, who realised early on that his theory clashes with the religious dogma. In a famous debate held at Oxford on July 1860, Thomas Huxley, standing for evolution, is supposed to have won the day over Bishop Samuel Wilberforce who represented the creationist view [2]. Nevertheless, the church, and other major religions, continued to oppose evolution and this opposition permeates into wider cultural, and educational, perceptions. Perhaps the best known manifestation of this conflict is a trial held on 1925 in the state of Tennessee, USA, which later became known as the Scopes Monkey trial. John Scopes, a teacher in a public school, was accused of violating a state law by teaching human evolution in class. Scopes was found guilty and fined \$100, a decision that was subsequently overturned based on a technicality [3]. The case is considered a demonstration of the influence that cultural and social norms can have on the way scientific ideas are transferred to students and future scientists.

Today the scientific evidence for evolution are by far stronger than any Darwin ever had, and the opposition, even among religious circles, reduced. Indeed, modern biological sciences, be it behavioral studies, biochemistry, or large-scale ecology, are built upon the understanding of the evolutionary processes shaping the body plan or ecosystem being studied. Nevertheless, the subject of evolution is still perceived as controversial by the general public, and the theory is rejected by large

¹ The Davidson Institute for Science Education, Israel

² The Davidson Institute for Science Education, Israel



parts of the general population in many countries [4]. Based on this perception many teachers in primary education continue to avoid this subject.

2. Vision

It is our view that this avoidance today is not only due to cultural conflict but also due to inertia. The prolonged habit of avoiding the subject led to a scarcity of accessible teaching materials, and this in turn makes it easier for teachers to persist in this avoidance. To overcome this cycle we are currently developing an online open course for teachers that tells the story of evolution and heredity through the story of the history of science. A main objective of the course being developed is to provide both teachers and students a resource for understanding the theory of evolution by learning the historical background for its development by Darwin (and his predecessors), and the works of major researchers and philosophers that followed in his footsteps. Rather than teaching science as a collection of independent units, we wish to emphasize how the theory of evolution serves as a common basis for different parts of modern biological sciences. Thus, different from existing courses and other teaching resources that can be found online, we aim to provide teachers with resources and activities that they can integrate into existing curriculums.

3. Course outline

The course will be built as three consecutive units, each providing the teacher with teaching resources. The first part starts with the work of Charles Darwin and the theory of evolution and ends with the work of Gregor Mendel that ultimately provided the missing mechanism required for organisms to evolve. The 2nd part introduces the central dogma of heredity, including the discovery of DNA and other cellular machines, and explains how these discoveries helped in understanding evolutionary processes. The 3rd part of the course brings the students to modern day biology, when genetic engineering technology enables us to make directed changes in DNA sequences, overcoming the limitations of natural or artificial selection. As part of the course development, the different units of this course will be tested by a core of STEM teachers currently working with the Davidson program for excellence in education [5], and their feedback will be used to adjust and improve course materials prior to their release to the general teaching community. Ultimately, we intend to make all the teaching resources developed for this course to be open and available for use in class, either as online activities or by printable hard copies. Each part will be designed so as to enable the integration of evolutionary ideas into different parts of the scientific curriculum, and the teacher will have the liberty to choose any or all of the units as he sees fit.

Acknowledgments

We would like to thank Carmit Pion for our techno-pedagogical expert for her help with designing the different units of the course.

References

- [1] Maynard Smith, J. "The Theory of Evolution", Cambridge, Cambridge University Press. 1993
- [2] Dawkins, R. "The Blind Watchmaker", London, Penguin Books, 1990
- [3] Szasz, F. "William B. Riley and the Fight against Teaching of Evolution in Minnesota", Minnesota History, 1969, 41:201-216
- [4] Miller, E. Scott, C. Okamoto, S. "Public Acceptance of Evolution" Science, 2006, 313:765-766
- [5] Lachish-Zalait A. et al, "The educational arm of the Weizmann Institute of Science", In this conference proceedings (2018)