

Chemistry of the Origin of Life & Early Evolution

Model Course Syllabus

Overview & Course Objectives

The purpose of this course is to introduce students to the current scientific theories pertaining to the origin of life and early evolution. An intrinsically interdisciplinary topic, this course includes material as varied as the use of atmospheric physics to model the early Earth, to the use of genetics to map evolution and the tree of life. The material chosen for the course helps the instructor demonstrate to the students how we can use our current knowledge of biology, chemistry and physics to place limits on possible scenarios for the origin of life, and eventually solve the problem of how life began on Earth. An equally important objective of this course, particularly when taught at the undergraduate level, is to help students develop critical thinking skills, the ability to read scientific literature and to inspire them to pursue answers to big questions/challenges in science and society.

Prerequisites

Most students may enter this course with very little knowledge of origin of life research. The course has been designed such that students of any major that have completed at least one year of college level chemistry and one semester of organic chemistry will be able to follow the material presented, sometimes with the aid of additional background sources.

Course Texts & Reading

See "Literature Resources"

Lecture Structure & Teaching Pedagogy (at Georgia Tech)

This course meets twice a week (75 min/class). At the end of each class, students are given a reading assignment and required to turn in a typed summary (1-2 paragraphs) and three questions/discussion points at the beginning of the following class. It is recommended that students bring two copies of their summary and questions to class, one to turn in and one to keep for reference and note taking. At the beginning of the class a volunteer is requested to read his or her summary of the reading assignment. After the initial summary, other students in the class are encouraged to add to the summary any points that they felt were important but not expressed. When the students are satisfied that the important points and concepts of the reading have been expressed, the question and discussion portion of the class begins. Students are then welcomed to ask the questions that they had prepared before class. Because there are many concepts and experimental techniques introduced in this course, certainly more than one of each per lecture, the instructor may need to take considerable time in each class to provide background information to the students. It is also helpful to bring extra material, such as handouts and slides, to each class in anticipation of questions from the class. Reading and discussing Schopf's *Life's Origins* has typically required six to seven class periods. The students are required to begin reading one additional book on the origin of life or early evolution from a list of recommended titles (see "Literature Resources"). The purpose of having the students read a book of their choice is to both allow the students to explore a particular aspect of origin of life research that is of personal interest, and to expose the rest of the class to concepts and proposals that might not be introduced over the course of the assigned reading material. After the class has finished reading and discussing Schopf's *Life's Origins*, a series of papers are assigned from the primary literature. Typically, one scientific paper is assigned for reading at the end of the class. The discussion of some papers will require an entire class period, whereas others may only require 45 min. For those papers requiring less discussion time it has worked well to pass out a second paper on the same topic as supplementary material. The instructor then provides a summary and leads the discussion.

Major Assignments

Written Report & Oral Presentation #1

Students are provided with a list of suggested titles from which to choose a book about which to write a report. Students may also select a book not on the list. In a class of 12 or fewer students, no two students may choose the same text. Book selection is required before completion of Schopf's Life's Origins. Students are required to submit a critical written report on their chosen book in which they assess the validity of the arguments presents by the book authors in support of hypotheses relating to the origin of life and early evolution. Over the course of three classes, students will be asked to present short oral presentations. Again, the oral portion is not a summary, but a presentation of new concepts and critical review of hypotheses championed by the book authors.

Written Report & Oral Presentation #2

Students are charged with completing a scientific critique of a current theory regarding the origin of life or early evolution. Each student must choose a unique topic, which may be as focused as the problem concerning the abiotic synthesis of ribose, to as broad as the role of oxygen in evolution. Students are required to use at least three original sources from the scientific literature to support their position of support or dissent of a current hypothesis. This report, both written and oral, serves as the final exam for the course.

Grading System (used at Georgia Tech)

- 25% Quality of written summaries of assigned reading and question/discussion points. No late assignments are accepted.

- 25% Class participation. This includes attendance, participation in discussions, and volunteering to present reading summaries and introduce discussion points.

- 25% Written Report & Oral Presentation #1

- 25% Written Report & Oral Presentation #2

List of Course Topics

- Historical perspective of the search for the origin of life
- The molecules of contemporary life
- The cosmos and the nature of the early Earth
- The formation of the building blocks of life
- Prebiotic polymer formation
- The origin of biological information
- Compartmentalization, from membranes to the first cells
- Determining the age of life
- Energy as a constraint on life
- The appearance of photosynthesis
- The biological source and effects of O₂
- Early microbial colonies
- The origin of eukaryotes
- The search for the last common ancestor
- The Precambrian explosion
- The origin of the genetic code
- Synthetic biology