

## Syllabus: GEOL124

### Evolution of Life and Environment on Planet Earth

CORE Physical Science (PS) Course (non Lab CORE) (3 credits)

Class Meetings:	TTh	9:30-10:45	BPS 1243
Discussions:	WEDS	3:00-3:50	PLS 1184
		4:00-4:50	PLS 1184
		5:00-5:50	PLS 1184

#### Professor James Farquhar

Phone 405-1116 (jfarquha@geol.umd.edu)

Office CHEM 0217

Office Hours: MWF 10-11:00 CHEM 0217/0230/233 and by appointment

**Course Description:** This course will examine how life has shaped Earth's physical environments, both in the contemporary Earth and over the long course of Earth history. Topics range from evidence for the origin and diversification of life and its impact on Earth environments to the mind-set and methods of the scientists who interpret it, and what those methods tell us about future interactions between life and the environment, both on Earth and in the Solar System.

In this course we will explore questions from the perspective of geological, biological, chemical, and physical scientists about:

**I. Geological evidence for life and its origin:** How did life arise from non-living material? To address this, we examine current interpretations of the record preserved in ancient rocks and suggested by their modern analogs. This, in turn, leads to the primary question: How have scientists developed their understanding of the interface between the living and non-living materials from which we and our planet are derived?

**II. How life remodels its environment (our planet):** How have the processes of life shaped and how do they continue to shape Earth's environments? Here we examine the consequences of life for the geologic realm. We survey the geologic and geochemical tools used to describe ancient environments, review what the evidence that these tools reveal tells us about how Earth's environments have changed through time, and evaluate hypotheses of the role of living things in these changes. We then apply these insights to investigations of changing present-day environments, use them to propose methods for finding life on other worlds, and consider the potential significance of such discoveries.

**III. What life is and what life does:** How do we distinguish life from non-life? We examine the basic processes of metabolism - the energy pathways of life,

and replication - the transfer of genetic information. Shifting from process to pattern, we ask what the basic subdivisions - the domains of life - are, and how scientists have identified them.

**IV. How we explore for life in our world and in other worlds:** We wrap up by examining how scientists develop Theory - higher order understandings of scientific knowledge, in this case, of how the Sun and Earth interact as a set of 'systems.' We examine how the Systems perspective enables us to predict and maybe ultimately control practical challenges like climate change and pollution, and guides our search for new types of natural resources. Above all, the course reveals that the same principles that shaped the ancient world apply in today's world, and will be relevant in our future world.

We will use in class and on-line discussion to focus on elements of each of these and we will use accessible laboratory experiments/demonstrations to explore some of the science that drives the hypotheses about these elements and the broad content units. An important goal will be to understand how scientists approach and define the questions they work on.

**Reading From:**

We will draw on two books:

- 1) A.H. Knoll, *Life on a Young Planet: The First Three Billion Years of Evolution on Earth*
- 2) K.W. Plaxco and M. Gross *Astrobiology*

These books are not text books, but they are rich resources and have a lot of valuable information that will be relevant for the course. We will start with the book by Knoll because it gives a sense of how geologists approach the question of early life, and of the methods that they use to investigate this. We will then move to the second book because it touches on the chemistry and physics and biology in a little different way and provides a foundation for the underlying questions and approaches that scientists in related disciplines bring to bear on the question of life and living systems.

**Course goals:**

I would like participants in this course:

- 1) To be aware of and able to address common misunderstandings about the nature, language, and limits of science, and to enable students to identify the deeper issues in and critically scrutinize scientific information in popular media, and reliably distinguish real from pseudo- and junk science.
- 2) To be able to read and evaluate geologic findings reported in the popular science literature (the news, magazines, and books).

3) To use observations and reasoning from geology, biology, and geochemistry to reconstruct the conditions for some or Earth's earliest environments and to compare these with prevailing hypotheses.

**Grading:** The course will be graded on the basis of three mid term exams, assignments, and participation in discussion sections. The breakdown is:

Exams (2 of 3 + final)	25 (with two stage option described below)
Assignments	15
Participation in discussions	10

The two-stage approach involves answering the question in class, and having the option of rewriting the answer in a take-home, open-book, open-notes format to recoup some of the points. If this option is chosen, the in class answer will count towards 70% of the grade and the take home part will count towards 30% of the grade.

**Assignments:** Assignments will be the focus of discussion sections and related to the sequence of topics and concepts. The discussion section assignments will assume a variety of formats, including team and individual assignments (4-5 students in each team). The problems will include evaluation of specific experiments, demonstrations, also work in review with subtopics related to the lecture, and analyses of current issues in terms of hypothesis falsification and identification of logical fallacies. Assignments will take the form of written and oral presentations given by members of the discussion section.

**Academic Accommodations:** If you have a documented disability, you should contact Disability Support Services 0126 Shoemaker Hall. Each semester students with documented disabilities should apply to DSS for accommodation request forms which you can provide to your professors as proof of your eligibility for accommodations. The rules for eligibility and the types of accommodations a student may request can be reviewed on the DSS web site at [http://www.counseling.umd.edu/DSS/receiving\\_serv.html](http://www.counseling.umd.edu/DSS/receiving_serv.html).

**Religious Observances:** The University System of Maryland policy provides that students should not be penalized because of observances of their religious beliefs, students shall be given an opportunity, whenever feasible, to make up within a reasonable time any academic assignment that is missed due to individual participation in religious observances. It is the responsibility of the student to inform the instructor of any intended absences for religious observances in advance. Notice should be provided as soon as possible but no later than the end of the schedule adjustment period. Faculty should further remind students that prior notification is especially important in connection with final exams, since failure to reschedule a final exam before the conclusion of the final examination period may result in loss of credits during the semester. The

problem is especially likely to arise when final exams are scheduled on Saturdays.

**Academic integrity:** The University of Maryland has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit <http://www.studenthonorcouncil.umd.edu/whatis.html>

The University of Maryland is one of a small number of universities with a student-administered Honors Code and an Honors Pledge, available on the web at <http://www.jpo.umd.edu/aca/honorpledge.html>. The code prohibits students from cheating on exams, plagiarizing papers, submitting the same paper for credit in two courses without authorization, buying papers, submitting fraudulent documents, and forging signatures. The University Senate encourages instructors to ask students to write the following signed statement on each examination or assignment: "I pledge on my honor that I have not given or received any unauthorized assistance on this examination (or assignment)."

**Lectures and Reading:** The titles refer to the chapter titles in the books that should be read before the lecture: Three lectures (number 7, number 15, and number 29) are not tied to reading in the books

**TOPIC I: Geological evidence for life and its origin**

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|--------------------------------------|------|
| 1. Orientation                       | 8/30 |
| 2. In the Beginning                  | 9/4  |
| 3. The Tree of Life                  | 9/6  |
| 4. Life's Signature in Ancient Rocks | 9/11 |
| 5. Earliest Glimmers of Life         | 9/13 |
| 6. Emergence of Life                 | 9/18 |
| 7. Earliest evidence for life        | 9/20 |
| 8. Mid Term 1                        | 9/25 |

**TOPIC II: How life remodels its environment (our planet)**

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|--------------------------------------------------------|-------|
| 9. Oxygen Revolution                                   | 9/27  |
| 10. Cyanobacteria: Life's Microbial Heroes             | 10/2  |
| 11. Origins of Eukaryotic Cells                        | 10/4  |
| 12. Animals Take the Stage                             | 10/9  |
| 13. Cambrian Redux                                     | 10/11 |
| 14. Dynamic Earth, permissive Ecology                  | 10/16 |
| 15. How has life shaped this planet- Winogradsky redux | 10/18 |
| 16. Mid Term 2                                         | 10/23 |

**TOPIC III: What life is and what life does**

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|------------------------|-------|
| 17. What is Life:      | 10/25 |
| 18. Habitable Universe | 10/30 |
| 19. Habitable Planet   | 11/1  |
| 20. Primordial Soup    | 11/6  |
| 21. Spark of Life      | 11/8  |
| 22. Molecules to Cells | 11/13 |
| 23. Mid Term 3         | 11/15 |

**TOPIC IV: How we explore for life in our world and in other worlds**

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|-----------------------------------------------------|-------|
| 24. Concise History of Life on Earth                | 11/20 |
| 25. Life on the Edge                                | 11/27 |
| 26. Habitable Worlds in the Solar System and Beyond | 11/29 |
| 27. Search for Extraterrestrial Life                | 12/4  |
| 28. Paleontology and Astra                          | 12/6  |
| 29. Review/Catch up                                 | 12/11 |
| 30. Exam 8-11am                                     | 12/14 |