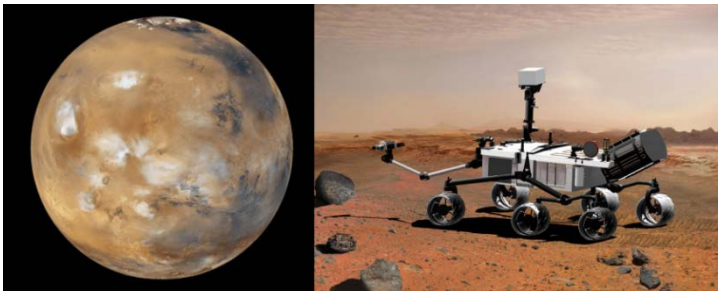
GEOL 124: Evolution of Life and Environment on Planet Earth



Ever dream of travelling to Mars? Join the scientific mission of the Mars Science Laboratory "Curiosity" rover in real time this fall to search for signs of ancient life on the red planet, while we explore evidence for the origin and evolution of life on Earth in this I-Series course. Weekly discoveries by the MSL rover on the Martian surface will be discussed and compared with those from Earth's distant past, from the origin of the solar system to the sequential origin of prokaryotic, eukaryotic, and animal life over our planet's first four billion years.

In this I-Series course titled ***Evolution of Life and Environment on Planet Earth*** we explore how life has shaped physical environments (and vice versa) over the long run of Earth history, by examining the building blocks of life, the evidence for life's origin and diversification, and the geological settings in which life arose. Using these deep-time perspectives and methodologies, we explore future interactions between life and the environment on Earth and beyond.

The current MSL rover mission is the culmination of decades of Martian speculation and exploration by NASA's Astrobiology Program, which has even deeper roots, with important discoveries by now famous scientists that span nearly 200 years. While the rate of 18th and early 19th century insights were slow and poorly coordinated, technological advances in chemical, biological, and space sciences after WWII have served to hasten the pace of astrobiological research into the origin and evolution of life on our home planet, and the search for life elsewhere in the universe, in part through detailed studies of meteorites and rover explorations of the Martian surface.

This course is taught by Professor Alan J. Kaufman of the Geology Department. Over the past 25 years, he has travelled to the four corners of the ancient Earth to study its environmental and biological evolution. In this course he will take you on a journey to deep time and space, putting discoveries on the Martian surface this fall in context of what we know about the evolution of our own planet through a long geological lens.

Syllabus

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

Class Meetings:	TTh	11:00-12:15	SPH 0308
Lab sections:	W	3:00-3:50	PLS 1162
		4:00-4:50	PLS 1162

Phone: 405-0395(office)
Office: CHEM 0217A
Office Hours: By appointment
<kaufman@umd.edu>

Graduate Teaching Assistant Sam Crossley
Office: CHEM 1225B
Office Hours: By appointment
<sdcross@umd.edu>

Course Description: This course will examine how the Earth formed, how its place in the solar system allowed for life to take hold, and how, once evolved, life shaped or was shaped by Earth's physical environments. Topics range from the Big Bang to the search for life on other planets, especially Mars, with emphasis on evidence for the co-evolution of life and environment. We will also explore the methods and techniques scientists use to explore origin of life questions, and issues of modern global change and human threats to biodiversity.

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

I. Interconnections between biology, climate, and geology in the Earth System: How did Earth's environment change in the past, and how are its components linked today? To address this, we explore the way that things work on our planet. We use simulations and scientific methods to get to the nuts and bolts of issues like the greenhouse effect, the role of ozone in the present as well as in deep time, and how biodiversity can respond to and maybe compensate for some types of changes that would upset the equilibrium state of a planet.

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 has Earth changed over time and how is it changing now: We wrap up by examining how we human beings act as biological agents to change our Earth. We frame this in the context of long and short term climate change, and examine how a systems perspective is essential in understanding the issues we face as one of life's species and that other species faced in more ancient worlds.

A note on Marquee and I-Series Courses: The I Series and Marquee series courses are designed to investigate significant issues and inspire innovative ideas, and to explore how science, technology,

engineering, and mathematics can provide solutions to present and future world challenges. They are intended to fulfill university general education requirements in a creative and contemporary way and to challenge students to apply diverse intellectual traditions to today's big issues. GEOL 124 accomplishes these goals by bridging traditional divisions between the scientific disciplines of geology, biology, chemistry and physics. It also emphasizes how a perspective of deep time provided by geology principles can be valuable for informing big-picture questions relevant to us in the world today.

Readings and other materials:

We will draw on the book by A.H. Knoll titled *Life on a Young Planet* (Princeton University Press ISBN 0-691-00978-3). This book provides context that will be relevant for the course, but it is not a textbook in the typical sense. The Knoll book will be read in conjunction with the Discussion sections.

Course goals:
Participants in this course should:

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-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 chemistry to reconstruct the conditions for some or Earth's earliest environments and to compare these with prevailing hypotheses.
4) To foster and enhance group work and activities in support of presentations, scientific investigations, and end of term reports required for the course.

Learning Goals for I-Series Courses: At the completion of an I-Series Course students will be able to:

- Look at complex questions and identify the science in the question and how it impacts and is impacted by political, social, economic, and ethical dimensions
- Understand the limits of scientific knowledge
- Critically evaluate science arguments
- Ask good questions
- Find information using various sources and evaluate the veracity of the information
- Communicate scientific ideas effectively
- Relate science to a personal situation

Grading: Given the emphasis on participation, group work, field activities, and the *Curiosity Panels* in this freshman course, the grading scheme is balanced in order to accurately reflect your time and efforts.

Midterm I	10%
Midterm II	10%
Final Examination	15%

Thus testing only represents 35% of the grade in the course. The remaining 65% is related to your general engagement in the course, including: 1) **Participation** (20%), 2) **Field Reports** (10%), 3) ***Curiosity Panels*** (25%), and **Community Research Project** (10%).

The **Participation** portion of the grade reflects:

1) Meeting course deadlines, including posting of your photo and bio on ELMS
2) Engagement with lecturers and colleagues *on-line*, *in-class*, and *in the field*,
3) Ten Discussion section quizzes, worksheets, or exercises, and
4) Preparation as a Discussion section leader or co-leader for a book chapter.

The **Field Reports** are well written 1-2 page documents using a prescribed format, including:

1) Name, date, and title
2) Objective
3) Observations, including photographs, sketches, descriptions, and/or tables
4) Conclusions, including activity relevance to the course

The grades for the four ***Curiosity Panels*** are based on both group and individual efforts. For the group, each of the panels is worth 5%. This reflects:

1) Ten separate meetings in Easton Hall,
2) Assessment of the material needed for each presentation,
3) Preparation, practice, and revision of each presentation based on group assessment,
4) Substance and organization of *in-class* presentation of the ***Curiosity Panel*** material.

The remaining 5% is a grade for individual efforts related to the ***Curiosity Panels***. These reflect:

1) Attendance and engagement in the Easton Hall meetings,
2) Submission of one or two scribe reports during the semester,
3) Style your individual *Curiosity Panel* presentation,
4) *On-line* evaluation of all *Curiosity Panel* presentations

The **Community Research Project** will include:

1) Two week diet survey
2) Collection and preparation of hair samples from two individuals
3) Formulating a hypothesis regarding your hair and that of the community
4) Analysis, graphing, and interpretation of community data
5) Ten page term paper with illustrations, tables, and references cited

Final grades will be assigned based on:

A	90-100%
B	80-89.9%
C	70-79.9%
D	60-69.9%
F	<60%

Assignments: Assignments will be the focus of Discussion sections and related to the sequence of topics and concepts, including work on the *Curiosity Panel*. Each Panel will include teams of students focused on some aspect of Martian exploration by current and past rovers and probes. Assignments will take the form of written and oral presentations given by members of each team. The end-term paper will be a maximum of 10 pages in length (double spaced 12 point Times New Roman text) with illustrations (no larger than ¼ of a page each) and references.

Group Work: Students will organize into groups in order to prepare each of the four *Curiosity Panel* presentations during the semester. Each panel will focus on some aspect of Martian exploration by current and past rovers and probes. All students in each group are expected to participate in the development of the panel talk (background research, construction of the PowerPoint or Prezi presentation, and review) although only one or two of the students will present the material during the panel. Group work will require ten scheduled meetings held in an Easton Hall lounge or study room where groups will self-organize. Chair(s) (generally the individual(s) who will give the presentation) and scribe will be assigned for each panel, and tasks for participants related to each of the presentation will be discussed. The role of the scribe is to take attendance and notes of the meeting and complete a report submitted to the course faculty within two days of the meeting. Groups may also work together in course-related research projects in the laboratory or the field or studying for exams.

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.

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.

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.shc.umd.edu.

To further exhibit your commitment to academic integrity, remember to sign the Honor Pledge on all examinations and assignments: **"I pledge on my honor that I have not given or received any unauthorized assistance on this examination (or assignment)."**

Course Evaluation: CourseEvalUM Fall 2015: Your participation in the evaluation of courses through CourseEvalUM is a responsibility you hold as a student member of our academic community. Your feedback is confidential and important to the improvement of teaching and learning at the University as well as to the tenure and promotion process. CourseEvalUM will be open for you to complete your evaluations for fall semester courses in early December. Please go directly to the website (www.courseevalum.umd.edu) to complete your evaluations. By completing all of your evaluations each semester, you will have the privilege of accessing online, at Testudo, the evaluation reports for the thousands of courses for which 70% or more students submitted their evaluations.

Calendar for EVOLUTION OF LIFE AND ENVIRONMENT ON PLANET EARTH
Fall semester 2016

Date		**Lecture (*Activity*)**
Aug.	30	Landing on Mars: An Introduction to the Solar System **(*Solar System Model*)**
	31	Discussion (Research Port and UMD Resources)
Sept.	1	Back to the Future: Understanding Deep Time ***(Community Research Project)***
	6	Electromagnetic Radiation and the Big Bang
	7	Discussion (Chapter 1: In the Beginning?)
	8	Synthesis of the Elements and the Solar System ***(Meteorite Collection)***
	13	Life's Signature in Ancient Rocks
	14	Discussion (Chapter 3: Life's Signature in Ancient Rocks)
	15	Formation and Circulation of the Solid Earth
	20	***(Campus Field Trip)***
	21	Discussion (Chapter 4: The Earliest Glimmers of Life)
	22	The Mobile Earth: Continental Drift and Plate Tectonics
	27	(***Midterm Exam I)***
	28	Discussion (Chapter 2: The Tree of Life)
	29	Environments of the Primordial Earth ***(Bobcat Hill)***
Oct.	4	(***Curiosity Panel I)***
	5	Discussion (Chapter 5: The Emergence of Life)

	6	Hypotheses on the Origin of Life
	11	Life without Oxygen: The Microbial World of the Archean
	12	Discussion (Chapter 6: The Oxygen Revolution)
	13	The Base of the Food Chain: Photosynthesis Writ Large
	18	Take a Deep Breath: Respiration and the Origin of Eukaryotes
	19	Discussion (Chapter 7: The Cyanobacteria, Life's Microbial Heroes)
	20	The Great Oxidation Event
	25	(***Curiosity Panel II***)
	26	Discussion (Chapter 8: The Origins of Eukaryotic Cells)
	27	Snowball Earth Hypothesis: Global Glaciation
Nov.	1	***Midterm Exam II***
	2	Discussion (Chapter 9: Fossils of Early Eukaryotes)
	3	The Origin of Animals
	8	The Cambrian Explosion
	9	Discussion (Chapter 10: Animals Take the Stage)
	10	(***Curiosity Panel III***)
	12	***(Saturday) Field Trip to the Smithsonian Museum***
	15	Mass Extinctions of Animal Life
	16	Discussion (Chapter 11: Cambrian Redux)
	17	The Community Research Project
	22	***Geochemical Laboratory Tour: Chemistry Building***
	23	***Thanksgiving (no discussion section)***
	24	***Thanksgiving (no lecture)***
	29	Modern Problems: Ozone Depletion and Global Warming
	30	Discussion (Chapter 12: Dynamic Earth, Permissive Ecology)
Dec.	1	Modern Problems: Ozone Depletion and Global Warming
	6	(***Curiosity Panel IV***)
	7	Discussion (The Community Research Project: Data compilation, graphing, and analysis)
	8	Course Review

Final Exam: Wednesday, December 14th, 8-10 a.m.
Term paper due by midnight on Wednesday, December 14th