**ASTR-301: Astrobiology**

Course Syllabus and additional information

**Class Schedule:** Monday and Wednesday, 3:00-4:15pm,
Location: Planetary Hall 122
Instructor: Michael E. Summers
Professor of Planetary Science and Astronomy

**Dated: August 24, 2014**

**Catalog description:** This course will provide a scientific perspective on the story of life in the universe, from the origin of the universe to the origin and evolution of life on Earth, how life in turn has influenced the evolution of the Earth, and the prospects for life elsewhere. Topics include the origin of the Earth, the origin of life, the co-evolution of life and the Earth, habitability of planets, and the search for extraterrestrial life.

**Introduction**

Astrobiology is the multidisciplinary study of the origin, evolution and distribution of life in the universe. Major questions that inform astrobiology include:

- How did life originate?
- Does life exist elsewhere in the universe?
- What controls the evolution of intelligence?
- Are there intelligent civilizations elsewhere?
- What is life’s future on Earth and beyond?

This course will provide a scientific perspective on the origin and evolution of life in the universe; the origin and evolution of life on Earth; and how life, in turn, has significantly influenced the evolution of the Earth. Topics include the origin of the solar system, possible mechanisms and sites for the origin of life, the co-evolution of life and the Earth, habitability of planets, extra-solar planets and implications for life, and the search for extraterrestrial life.

**The goals of this course are to provide the student with:**

1. an introduction to the science of astrobiology,
2. an overview of the important questions and issues that frame astrobiology,
3. a review of the relevant science (physics, chemistry, and biology) background,
4. an in-depth look at theories of the origin of life on Earth,
5. an overview of the possibilities for life elsewhere, and
6. an examination of the scientific tools of the field, including those used to search for extraterrestrial life.

7. an overview of the major techniques that have allowed the detection of numerous extra-solar planets, many of those habitable
8. an informed view of what conditions make a planet habitable
9. an overview of the results and implications from research on extremophiles for the science of astrobiology, and
10. an understanding of our current estimates for the prospects for life elsewhere.
Contact Information:
Lecturer: Michael E. Summers, Professor of Planetary Science and Astronomy
Office: Planetary Hall 233
Email msummers@gmu.edu, This is my strongly preferred means of contact.
Office Hours: Tuesday & Thursday, 2:00-3:00pm (please by appointment!)

My office hours are listed above. You can also contact me via email, or ask me after class for an appointment. You are encouraged to come visit me if you are having any problems with the course, have questions on the material, or have any questions about astronomy or science in general! It would help me tremendously if we schedule a time in advance to meet, so that I can be sure to be available and plan to allow sufficient time for discussion. I am a co-investigator on several active NASA space missions, so I do get called into unplanned and unexpected meetings frequently and thus I cannot promise to be available every day that office hours are posted, thus appointments are essential.

Course format:

(1) Lectures covering material in the required text,
(2) Homework assignments designed to illustrate various aspects of topics encountered in the lectures and readings, and
(3) Reading assignments both from the text and supplemental material
(4) Group discussion
(4) Two in-semester exams
(5) Final exam.
(6) Class lecture notes, as well as additional readings, will be posted on GMU Blackboard.

➢ You are responsible for all the material in the required text:
➢ Additional readings will be assigned from various sources.
➢ Attending class is essential to successful completion of this course.
➢ Read the assigned readings BEFORE discussion in class. Participate in classroom discussions!

Required Text:
Frontiers of Astrobiology, Edited by Chris Impey, Jonathan Lunine, and Jose Funes, Cambridge University Press, 2012. ISBN 978-1-107-00641-6. This is available at the bookstore, but also on Amazon.com at $45 new and between $30-45 used.

Highly Recommended book:
The text “Astrobiology: An Interdisciplinary Approach” by J. I. Lunine, Addison-Wesley, 2002, is also highly recommended, but it is out of print so can probably be obtained used.
Course Policy and Grading:
Homework: 30%
Two exams: 30%
Final Exam: 30%
Participation: 10%

Numerical Grade Ranges:
A: 90-100%
B: 80-90%
C: 70-80%
D: 60-70%
F: Below 60%

Tentative Exam Schedule:
➢ Exam #1 – Wednesday, October 1, 3:00-4:15pm
➢ Exam #2 – Wednesday, November 12, 3:00-4:15pm

Final Exam:
➢ Final Exam – Monday, December 15, 1:30-4:15pm

IF YOU ARRIVE MORE THAN 20 MINUTES LATE FOR AN EXAM, OR AFTER ANYONE HAS FINISHED THE EXAM AND LEFT, YOU MAY NOT TAKE IT.

Anyone caught cheating on an exam or talking after the exams have been handed out will be given a zero for the exam and be referred to the George Mason University Honor Council.

The exams and quizzes are closed book, computer, phone and notes.

If you have a conflict and cannot take an exam on the scheduled day, let me know ahead of time and we can arrange an alternative test date.

Exam Makeup Policy:

Students will be permitted to submit late homework on a case-by-case basis. Late exams will be permitted if with an acceptable explanation and if performed within one week of the original exam. Make-up exams may be scheduled IN ADVANCE with instructor permission.

Important Course Dates:

Last date to add – September 2, 2014
Drop with NO tuition penalty – September 16, 2014
Drop with tuition penalty (and final drop deadline) - September 26, 2014
Course and Schedule (Tentative):

Part 1: Introduction to Astrobiology (Chapters 1, 2, 3, 4, 5, 6)
Part 2: The Origin and Evolution of Life (Chapters 7, 8, 9, 10)
Part 3: Planets and life (Chapters 10, 11, 12, 13)
Part 4: Search for Life Elsewhere (Chapter 14)
Part 5: Special Topics (Chapters 15, 16)
  ➢ Extrasolar Planets
  ➢ Mars Exploration
  ➢ Evolution of Intelligence
  ➢ SETI
  ➢ Consequences of Detection

Approximately one chapter in the Impey et al. text per week.

Chapters Include:

1) Astrobiology – A new synthesis
2) Towards a Theory of Life
3) Terran Metabolism: The First Billion Years
4) Planet Formation
5) The Early Earth
6) Evolution of a Habitable Planet
7) Our Evolving Planet: From Dark Ages to Evolutionary Renaissance
8) Early Mars: Cradle or Cauldron
9) Large Habitable Moons: Titan and Europa
10) Small Habitable Worlds
11) Searches for Habitable Exoplanets
12) Review of Known Exoplanets
13) Characterizing Exoplanet Atmospheres
14) If You Want to Talk to ET, You Must First Find ET.

Lectures: The lectures will follow the chapters of the text as shown in the Course Schedule below; additional materials that represent recent discoveries in planetary science will also be presented in class. You are responsible for all of the material covered in lecture, in addition to that presented in the text. You should read the assigned chapters BEFORE they are discussed in class; this will enable you to ask questions in class if you do not understand something.

As a rule of thumb - you should spend at least as much time studying on your own as you spend in the classroom.

Lectures and Presentations: After each lecture, I will post the lecture PowerPoint file on Blackboard containing that day's presentation, and which you can download.

Blackboard address: The course is available on Blackboard with your GMU login name and password. Select ASTR 111, Section 002.
Attendance: Because you are responsible for all materials or announcements (including exam information, and e.g., change in dates), attending class is to your benefit. Oral announcements made in class are binding and it is your responsibility to find out what has occurred in any class you might miss.

Quizzes: A very short quiz on the assigned reading will be given at the beginning of each lecture. These will typically be 3-5 questions and take about 10 minutes. The signed quiz will stand for the attendance sheet. You should expect a quiz at the beginning of each lecture period over the assigned readings for that class. The schedule of assigned chapters is given below in the course schedule.

Course Tutorials:

Tutorials serve as a brief review and/or refresher of focused topics that the students have likely encountered previously in their education, but usually in a different context. For example, most physics students have taken a course in Thermodynamics or at least have covered the key thermodynamic concepts in their Freshman Intro to Physics course. Yet I’ve found that almost all physics students can benefit from a review.

The Thermo tutorial reviews the Ideal Gas Law, State Variables (like Temperature, Pressure, Internal Energy, Entropy, Enthalpy, Gibbs energy) the First and Second Laws, Adiabatic and diabatic processes, the concept of a heat engine, heat capacities and their relationship to atomic/molecular properties, and phase changes.

Tutorials usually takes about half an hour or so and provides enough refresher to then tackle the applications to the atmosphere.

Tentative Course Tutorials (We probably won’t get through all of these)

1) Overview of the solar system and planets
2) Essential concepts from physics
3) Essential chemistry
4) Essential biology
5) What is life?
6) Origin of life theories
7) What is meant by habitability
8) What is intelligence
9) SETI

Please be on time. Arriving late may negate your opportunity to take the quiz and be counted in attendance.

Course Blackboard website: https://gmu.blackboard.com/
Course format:

In class:

1. Short (10 minute or less) quizzes over assigned reading at the beginning of each lecture period. The quizzes also count as course participation.
2. Brief Review of previous lecture.
3. Lecture covering the relevant assigned chapter in the text.
4. Occasional discussion questions in class.
5. Homework assignments from the text (due one week from date assigned)
6. Two in-semester exams
7. Final Exam

Homework: is due one week after it is assigned.
Late Homework: You will lose 5% each day that an assignment is late.

Course Schedule (pending changes due to weather or university closures):

YOU SHOULD READ THESE CHAPTERS BEFORE THE DATES THEY ARE TO BE DISCUSSED IN CLASS – IN PART BECAUSE THE CHAPTER MATERIAL WILL CONSTITUTE THE QUIZ QUESTIONS.

Week 1: 8/25, 8/27 – Chapter 1: Astrobiology-A New Synthesis
Week 2: 9/1, 9/3 – Chapter 2: Towards a Theory of Life
Week 3: 9/8, 9/10 – Chapter 3: Terran Metabolism – The First Billion Years
Week 4: 9/15, 9/17 – Chapter 4: Planet Formation
Week 5: 9/22, 9/24 – Chapter 5: The Early Earth
Week 6: 9/29, 10/1 – Monday: Chapter 6: Evolution of a Habitable Planet
Wednesday: Exam #1

Week 7: 10/6, 10/8 – Chapter 7: Our Evolving Planet
Week 8: 10/15 – Chapter 8: Early Mars-Cradle of Life?
Week 9: 10/20, 10/22 – Chapter 9: Large Habitable Moons
Week 10: 10/27, 10/29 – Chapter 10: Small Worlds and Habitability
Week 11: 11/3, 11/5 – Chapter 11: Search for Habitable Planets
Week 12: 11/10, 11/12 – Monday: Chapter 12, Review of known Exoplanets.
Wednesday: Exam #2

Week 13: 11/17, 11/19 – Chapter 13: Characterizing Exoplanet Exospheres
Week 14: 11/30, 12/2 – Chapter 14: Talking to ET

Tentative Exam Schedule:
October 1 (Thursday) – Exam #1 (Chapters 1 through 6)
November 12 (Thursday) – Exam #2 (Chapters 7 through 12)

Final Exam:
Monday, December 15, 1:30-4:15pm (The final exam will be comprehensive).
Exam Makeup Policy:

Students may be permitted to submit late homework on a case-by-case basis depending upon circumstances at the discretion of the instructor. Late exams will be permitted with an acceptable explanation and if performed within one week of the original exam. Make-up exams must be scheduled **IN ADVANCE** with instructor permission.

**IF YOU ARRIVE MORE THAN 20 MINUTES LATE FOR AN EXAM, OR AFTER ANYONE HAS FINISHED THE EXAM AND LEFT, YOU MAY NOT TAKE IT.**

Anyone caught cheating on an exam or talking in class after the exams have been handed out will be given a zero for the exam and be referred to the George Mason University Honor Council.

The exams are closed book, computer, phone, and notes.

**USE OF A CELL PHONE DURING EXAMS OR QUIZZES WILL CONSTITUTE CHEATING AND TREATED AS SUCH.**

If you have a conflict and cannot take an exam on the scheduled day, let me know ahead of time and we can arrange an alternative test date.

**Important Course Dates:**
- Last date to add – **September 2, 2014**
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**Additional, albeit some more advanced, recommended books:**

**Introduction to Astrophysics: The Stars,** by Jean Dufay and Owen Gingerich, Dover, 2012.


Useful and sometimes fun astronomy websites:

**Space News**
http://www.space.com

**Astronomy Picture of the Day (APOD)**
http://apod.nasa.gov/apod/astropix.html

**Bad Astronomy**
http://www.slate.com/blogs/bad_astronomy.html

**The Space Calendar**
http://www2.jpl.nasa.gov/calendar/

**Earth Science Picture of the Day (EPOD)**
http://epod.usra.edu

**The Astrobiology Magazine**
http://www.astrobio.net

**National Aeronautics and Space Administration**
http://www.nasa.gov

**The NASA Watch Website**
http://www.nasawatch.com

**The NASA Astrobiology Institute**
http://nai.nasa.gov/

**NASA: Updates on all US space missions**
www.nasa.gov

**ARES – Mars Airplane**
http://marsairplane.larc.nasa.gov/

**New Horizons – Pluto mission**
http://pluto.jhuapl.edu/

**Aeronomy of Ice in the Mesosphere – AIM**
http://aim.hamptonu.edu/
The Exo-planet Encyclopedia
http://exoplanet.eu/

The George Mason University Observatory
http://spacs.gmu.edu/category/observatory/

The SETI Institute
http://www.seti.org

The Kepler Website
www.kepler.nasa.gov

Citizen Science Projects and Information

The Galaxy Zoo
http://www.galaxyzoo.org

SETI at home
http://setiathome.berkeley.edu

Citizen Science Projects

Classroom conduct: Discussions, whether face-to-face or electronic, should be conducted with a high level of respectful civil discourse. Disruptive behavior in the classroom environment will not be tolerated and may result in a student being asked to leave the classroom or temporarily barred from participating in class and/or on-line activities. Cell phones and pagers should be turned off before entering the classroom (unless there is a potential family emergency involved.)

In order to comply with student privacy laws, faculty and students need to use their GMU email accounts when corresponding with each other and the instructor.

Religious Holidays and Observations:

http://ulife.gmu.edu/calendar/religious-holiday-calendar/ is available to help minimize difficulties for students of different faiths. It is the student's responsibility to speak to the instructor in advance should their religious observances impact their participation in class activities and assignments.

Policy on use of personal Technology in the classroom:

Laptops are permitted only for use only for this course and its related activities. Email and web surfing are not allowed, and are distracting to both the student and his or her classmates. Please use common courtesy and do not use your laptop for any activities other than those related to this course.
Cellphones must be turned off or on vibrate. Please do not take calls or text in the lectures. If you use your cell phone you will be asked to leave the class and not return during that period.

**Classmate Contacts:**

It is suggested that you get the names, email and telephone numbers of at least two classmates.

Please do this on the first day of classes - this connects you with others in the class, gives you someone to contact about questions, and helps to build a community in the classroom.

**Religious Holidays and Observations:**

http://ulife.gmu.edu/calendar/religious-holiday-calendar/ is available to help minimize difficulties for students of different faiths. It is the student's responsibility to speak to the instructor in advance should their religious observances impact their participation in class activities and assignments.

**Students with Disabilities:**

If you are a student with a disability and/or you need academic accommodations, please see me and contact the Office of Disability Resources at 703/993-2474.

All academic accommodations must be arranged through that office.

**George Mason University Honor Code:**

GMU is an Honor Code university; please see the University Catalog for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely.

What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else’s work in an aspect of the performance of that task, you will give full credit in the proper, accepted form.

Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind), please ask for guidance and clarification.
To promote a stronger sense of mutual responsibility, respect, trust, and fairness among all members of the George Mason University community and with the desire for greater academic and personal achievement, we, the student members of the University Community have set forth this:

*Student members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work.*

If you have questions about the meaning of these terms please ask. We expect you to hold to this standard by carefully citing sources used in your work and by doing your own work on tests and individual assignments.

At a minimum follow these guidelines:

- Work identified as individual should be strictly your own.
- Cheating on exams or presenting another’s work as your own (plagiarism) will result in a zero grade for the assignment.
- Material that is drawn from written or electronic sources must be appropriately cited. For on-line discussion it is usually enough to simply reference a text page or web site. In a more formal paper a bibliography and appropriate in-text citations are mandatory. If in doubt about how to do this contact an instructor.

http://www.gmu.edu/departments/unilife/pages/honorcode.html

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Laptops are permitted only for use only for this course and its related activities. Email and web surfing are not allowed, and are distracting to both the student and his or her classmates. Please use common courtesy and do not use your laptop for any activities other than those related to this course.

**Cellphones must be turned off or on vibrate.** Please do not take calls or text in the lectures. If you use your cell phone you will be asked to leave the class and not return during that class period.

**Useful Campus Resources:**
University Catalog: [http://catalog.gmu.edu/](http://catalog.gmu.edu/)
University Policies: [http://universitypolicy.gmu.edu/](http://universitypolicy.gmu.edu/)

**University Writing Center**

Offers both in-person and online writing assistance for students, including online writing guides, reference guides, and style manuals. Additionally, the Writing Center provides assistance to faculty who are interested in holding in-class writing workshops, developing effective writing assignments, or evaluating students’ writing.
| **Counseling and Psychological Services** | Offers faculty and staff consultation about how to help students that experience difficulties that impact their learning, including how to respond to students in crisis. In particular, the Mason Cares, faculty referral guide, and students of concern are primary resources for faculty and staff. Students can take advantage of psychological services, a variety of learning services, multicultural services, and educational programs that support students’ educational goals. |
| **Academic Advising and Transfer Center** | Advises students who are thinking about changing majors or who need assistance with their transition to Mason from another institution. |
| **English Language Institute** | Holds workshops for students whose first language is not English. |

Learning Services provides a variety of experience based learning opportunities through which students explore a wide range of academic concerns, including those listed below. Presentations on a variety of academic skill topics are available to the university community. The programs are open to all George Mason University students free of charge. Services are confidential and use of these services does not become part of the student’s academic record.

- The **Academic Counseling Program** provides individual support to students with learning differences such as attention deficit disorder or learning disabilities.
- **Academic Skills Workshops** and individual study skills counseling provide learning experiences to improve academic skills.
- The **Certificate in Academic Skills Program** provides a structured, yet individualized program of study to develop academic skills.
- The **Tutor Referral Program** maintains a roster of undergraduate and graduate students available to provide fee-for-service tutoring assistance. Learning Services staff members are available to consult with faculty and staff regarding student learning needs.

| **Office of Diversity, Inclusion and Multicultural Education (ODIME)** Serves students, cultural organizations, and the Mason community by promoting an environment that fosters and values human understanding and diversity. ODIME seeks to provide services and programs that will instill university-wide appreciation for diverse perspectives and ensure equal levels of inclusion, participation, and retention of underrepresented student groups in their quest for a quality. |