ASTRONOMY 151: Life in the Universe
Spring Semester 2007

Instructor:	Dr. H. Paul Shuch, Visiting Professor of Physics & Astronomy
Email:	shuch@lycoming.edu
Academic website	http://shuch.net

Lecture:	MWF 11:30 AM – 12:35 PM, Room C-303
Laboratory:	Tuesday, 9:45 – 11:35 AM *or* 1:00 – 2:50 PM, Room C-301
Office Hours:	MWF 1:00 – 2:00 PM, Room D-304

Texts: Life in the Universe, 2nd Ed., Bennet, Shostak, & Jakowski, Addison Wesley, 2006
Life in the Universe Activities Manual, Prather, Offerdahl, & Slater, Pearson, 2003
Tune In the Universe! CD-ROM, Shuch, ARRL, 2001

Supplemental Reading: Rare Earth, Ward & Brownlee, Copernicus Books, 2000
If The Universe Is Teeming With Aliens... Where Is Everybody?
Stephen Webb, Copernicus Books, 2002
(Both available as a package from Amazon.com online)

Catalog description:

Astrobiology is the broad study of life in space. It is an emerging interdisciplinary field that deals with all aspects of life in the universe: its origin, evolution, distribution, and future. Using the only known case (Earth) as a representative example, this Distribution Course invokes the physical and biological sciences as windows into the emergence of life from non-living matter; reasons why we might imagine a universe teeming with life; and introduces scientific tools for seeking credible evidence of such life on other worlds. *Four hours of lecture and two hours of laboratory per week. Prerequisites: any one laboratory science course.*

Learning outcomes:

Upon successful completion of this course, students will:

1. discuss how current cosmological findings suggest a Universe teeming with life.
2. quantify each of the seven factors of the Drake Equation.
3. support, and refute, the Rare Earth Hypothesis.
4. critique alternative explanations for the Fermi Paradox.
5. design and implement innovative SETI strategies.
6. evaluate the cultural, societal, and spiritual implications of extraterrestrial contact.

Lecture Topics:

1. Big-bang cosmology
2. Stellar evolution – the main sequence
3. Planetology and the detection of exoplanets
4. Habitable zones
5. Oxidizing and reducing atmospheres
6. Unicellular life and panspermia
7. The effects of oceans and moons
8. Complexity and intelligence
9. The emergence of technology
10. Communications: a cosmic imperative?
11. The Fermi Paradox
12. SETI search strategies
13. Instrumentation for optical and radio detections
14. What happens after Contact?
15. Cultural, societal, and spiritual implications

Laboratory exercises:

1. Size of the universe
2. The nature of life
3. Life in extreme environments on Earth
4. Geologic and biologic time
5. Genetic engineering
6. The importance of water for life
7. Remote sensing
8. Terraforming
9. Defining habitable zones
10. Rare Earth hypothesis
11. Detection of extra-solar planets
12. The Drake Equation
13. Is there anybody out there?

Grading scheme:

Laboratory Activities	20%
Quizzes	20%
Research Project	20%
Midterm	20%
Final	20%
Total	100%

Laboratory component:

No, we will not be creating life in a test tube – at least, not this semester. Nor, given equipment limitations, will we be engineering planetary environments in our laboratory. Our explorations, as outlined in the assigned Activities Manual, are somewhat more prosaic. Working in small groups, we will gain preliminary exposure to the primary tools of the trade. I do not expect Nobel-quality research to come out of the Lycoming College laboratories. But, I am prepared to have you surprise me.

Quiz component:

Brief weekly quizzes will give you an opportunity to demonstrate your ability to qualitatively and quantitatively apply the principles studied in class. They will also permit you to gauge your own progress and understanding.

Homework problems will be assigned from each chapter. As we go over the material in that chapter, you should work progressively on those problems. I do *not* collect and grade your homework. It is expected that you will work through the problems, and seek assistance with those that you do not fully understand. You *will* see some of these problems again in weekly quizzes, as well as on exams, so it behooves you to complete all assigned homework problems! Extra credit will be given for unusual or elegant solutions, so be creative.

Research Component:

Because astrobiology is an emerging discipline, most of the big questions have yet to be answered. Your textbooks and supplemental readings are merely a snapshot of the known state of the discipline at a particular moment in time. In order to ferret out the most current information about contemporary research, theories, and findings in astrobiology, students will need to read the latest articles in scholarly journals, and identify *credible* web resources.

During this semester, you will be assigned a relevant research topic for which not all the answers are known, and asked to delve into the literature, in order to prepare a summary report of current thinking and findings. Your report will be prepared at a level suitable for publication in *Acta Astronautica* or a similar peer-reviewed scholarly journal. An oral report will be presented to the entire class. Journal submission is encouraged, with significant extra credit accruing to those students whose papers are accepted for publication.

Examination components:

A single midterm exam, and a comprehensive final exam, will be comprised of problems similar to those in the homework sets, plus questions similar to those found at the end of chapters. These require a short answer, and test your qualitative knowledge of the physical theory discussed in that chapter. Examinations will be devoted equally to quantitative problem solving and qualitative short answer questions.

The final exam will be of the take-home variety. The final will be handed out a reasonable amount of time in advance of the period during the finals week selected by the Registrar for the final examination. That period is when your final exam solution must be turned in.

Professor's Comments:

Though astrobiology is an emerging field, it is not entirely new. The first scientific life-in-the-universe conference was held at the National Radio Astronomy Observatory, Green Bank WV, in 1961. For about four decades now, conferences touching on the topics of this course have been sponsored periodically by the International Astronomical Union. A permanent Study Group for these matters has been established within the International Academy of Astronautics. My credentials to offer this course are as follows: I have been a regular speaker at various IAU Conferences, I am a member of the IAA, and I co-chair its above-mentioned Study Group.

In the past, these meetings fell under the heading of "Bioastronomy." "Astrobiology" is merely NASA's latest buzzword for this ongoing research. Nevertheless, as an academic discipline, astrobiology is only recently arrived on the scene. Few Colleges or Universities currently offer astrobiology courses – and still fewer at the undergraduate level. Thus, you can consider yourself as standing on the pier, looking out across largely uncharted waters. May you help to bring order and understanding to the regions where once there be only dragons.

Revised 23 October 2006