

**GEO 255 Life in the Universe  
Princeton University Fall 2004**

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**Proposed Syllabus**

<u>Week</u>	<u>Topics</u>
1.	Cosmic and Stellar Evolution <ol style="list-style-type: none"><li>Th. Sept. 9<sup>th</sup>-From the Big Bang to Galaxies(Turner; PU Chap. 1)</li><li>Tues. Sept. 14<sup>th</sup>-The “Life Cycle” of Stars(Turner; PU Chap. 1)</li></ol>
2.	The Materials and Environments of Life <ol style="list-style-type: none"><li>Th. Sept. 16<sup>th</sup>-The Origin and Distribution of the Elements and organic matter (Turner; PU Chap. 2)</li><li>Tues. Sept. 21<sup>st</sup>-The Formation and Early Evolution of Planetary Systems (Turner; PU Chap. 2)</li></ol>
3.	Astrophysical limits for the origin of planetary life and prebiotic chemistry and synthesis of organic matter <ol style="list-style-type: none"><li>Th. Sept. 23<sup>rd</sup>- The Astrophysical Prerequisites for Planetary Life (Turner; PU Chap. 4; GS Chap. 2)</li><li>Tues. Sept. 28<sup>th</sup>-Molecular thermodynamics of prebiotic chemistry to heterogeneous enzyme catalysis (Stiefel; PU Chap. 5; GS Chap. 1; assigned readings?)</li></ol>
4.	Exogenous organic matter, compartmentalization and the rise of RNA. <ol style="list-style-type: none"><li>Thurs. Sept. 30<sup>th</sup>-Complex organics in chondrites and comets and lipids and micelles (Landweber; PU Chap. 5; GS Chap. 1; assigned readings)</li><li>Tues. Oct. 5<sup>th</sup>-The uncertain road to the RNA World (Landweber; PU Chap. 5; GS Chap. 1; assigned readings)</li></ol>
5.	The origin of protein and the DNA world and the tree of life <ol style="list-style-type: none"><li>Thurs. Oct. 7<sup>th</sup>- Origin of protein synthesis, emergence of encryption: the genetic code (Landweber; PU Chap. 5; GS Chap. 1; assigned readings)</li><li>Tues. Oct. 12<sup>th</sup>- Thurs. Oct. 14<sup>th</sup>-Mutation, gene transfer, evolution and symbiosis (Landweber; PU Chap. 6; GS Chap. 1)</li></ol>
6.	Metabolic pathways, biogeochemical cycles, the early evolution of the earth and life. <ol style="list-style-type: none"><li>Thurs. Oct. 14<sup>th</sup>- Bioenergetics of redox reactions, metabolic pathways and biogeochemical cycles (Stiefel; PU Chap. 6; GS Chap. 1)</li></ol>

- b. Tues. Oct. 19<sup>th</sup>—The Emergence of Life on Earth, impacts, the evolution of plate tectonics, origin of the hydrosphere and the Archean atmosphere. (Onstott; PU Chap. 4; GS Chap. 2; assign take home mid-term)
7. Preparation for field trip.
- a. Thurs. Oct. 21<sup>st</sup>- Final preparations for Yellowstone trip-Field notebook. How to perform chemistry in the field. Introduction to field probes and CHEMetrics kits. How are biological samples collected and preserved? What to see in the night sky over Yellowstone. (Onstott; Windows into the Earth)

Mid-term Break-Field trip to Yellowstone National Park- Microbial life in deep sea vents and hot springs with implications for early life on Earth and Mars

8. The evolution of Photosynthesis
- a. Tues. Nov. 2<sup>nd</sup>-Field trip recap with field photos and discussion of observations and field notebooks.
  - b. Th. Nov. 4<sup>th</sup>- Chemical analysis of the molecules of life-detection of photosynthetic microbes using by fast-repetition rate fluorometer using Yellowstone microbial mats. (Dismukes and Ananyev demonstration)
9. Life on Mars
- a. Tues. Nov. 9<sup>th</sup> The origin of phototrophic life, the rise of O<sub>2</sub>, the decline of CO<sub>2</sub> and Snowball Earth (Dismukes; PU Chap. 4; assigned readings)
  - b. Th. Nov. 11<sup>th</sup>- Mars Today-Martian Atmosphere and Climate-UV radiation and photolytic reactions-the stability of water on the surface of Mars, Mars exploration and the Viking Life detection experiments. (Onstott; PU Chap. 7; GS Chap. 3)
10. Ancient Mars, Martian Meteorites and Jovian Moons
- a. Tues. Nov. 16<sup>th</sup>- Evolution of the Martian atmosphere and hydrosphere-volatile escape, radiative heat transfer with a weaker Sun, changes in obliquity and the recent Martian ice age. (Onstott; Clifford and Parker, 2001)
  - b. Th. Nov. 18<sup>th</sup>- Martian meteorites and Panspermia, Evidence for life in ALH84001-SEM-EDS analyses of Yellowstone microbial mats-how small is life, biomineralization-future Mars exploration-sample return or in situ detection? (Onstott; Melosh, 2003)
  - c. Tues. Nov. 23<sup>rd</sup>- Tues. Nov. 30<sup>th</sup>-Jupiter's satellites and Europa-tidal heating, how thick is the ice, radiolysis, and life beneath the ice. Future European missions. (Onstott; GS Chap. 4; Chyba, 2002)

Thanksgiving recess

11. Titan and Extra-solar Planets

- a. Tues. Nov. 30<sup>th</sup>-Titan-Titan's hydrocarbon rich atmosphere-surface ocean or ice-Huygens-Cassini mission. (Onstott; GS Chap. 5)
- b. Thurs. Dec. 2<sup>nd</sup>- Indirect and Direct Detection of Extrasolar Planets (Turner; PU Chap. 4; GS 6 and 7)

12. Life in the Universe

- a. Tues. Dec. 7<sup>th</sup>- Thurs. Dec. 2<sup>nd</sup>- Physical and Biological Characterization of Extrasolar Planets (Turner; GS 8)
- b. Thurs. Dec. 9<sup>th</sup>-Scientific Speculations on Extraterrestrial Life (Dismukes, Landweber, Onstott, Stiefel and Turner panel discussion)

**Texts**

Required:

An Introduction to Astrobiology 2003/2004 (Eds. Iain Gilmour and Mark A. Sephton)  
The Open University and Cambridge University Press, 358 pp. (very up to date) [GS]

Intelligent Life in the Universe, from common origins to the future of humanity. 2002 P.  
Ulmschneider. Springer, 251 pp. (this is fairly up to date) [PU]

Windows into the Earth 2000. R.B. Smith and L.J. Siegel. Oxford University Press. 141  
pp.

Suggested:

Origins of Life, 1993 The Central Concepts. D.W. Deamer and G.R. Fleischaker. Jones  
and Bartlett Publishers. 431 pp.

The Search for Life on Other Planets 1998. B. Jakosky. Cambridge University Press. 326  
pp.