

BSCI238B: Special Topics in Biology - Astrobiology: Abiogenesis (the Origin of Life) and Early Life

Syllabus: Spring 2020 – *subject to revision*

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Faculty Advisor: Dr. Charles Delwiche, delwiche@umd.edu

Course Description:

This course will provide students with an immersive and wide spanning introduction to the topic of abiogenesis (the origin of life) and the background necessary to understand how it *could* have happened. The course starts with the astronomical and physical background necessary to explain the baselines required for life as we know it, then dives into the conditions of the early solar system, a chemical background and the variety of proposed theories of the origins of life. We will also discuss some of the more theoretical/abstract approaches/explanations of the origin of life and extrapolate what we have learned to exoplanets. While the course cannot be conclusive, as research on the topic itself is not, the aim of this course is to provide a framework of the general scientific consensus of the steps involved in the formation of life and the research methods used to study abiogenesis today.

Course Details:

Course: BSCI238B

Course Pre-requisites: Any of the following: BSCI103, or BSCI170 (or BSCI105), or ASTR230i, or ASTR380, or BIOE120, or approval of instructor (the course is intended to be taken by students with a strong background in the natural sciences).

Credits: 1

Seats: 30

Lecture Time: Wednesday, 3:00-3:50 PM

Location: PLS 1113

Semester: Spring 2020

Textbook: Selected Readings (no textbook)

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Topics Covered:

Astronomy, Physics, and Planetary Science:

- Nucleosynthesis*
- Formation of stars, solar systems
- Stellar types and properties
- Formation and properties of our solar system*

Astrobiology

- Galactic and extrasolar habitability zones
- “Goldilocks” zones and other properties of Earth and the solar system
- The search beyond Earth for life

Chemistry, Atmospheric Chemistry, and Astrochemistry

- Photochemistry/radiochemistry of atmospheres and ices*
- Metal and clay catalysis
- Self-catalysis
- Effects of atmospheric redox potential
- Entropy, Gibbs free energy, and enthalpy*

Prebiochemistry and Biochemistry

- Properties of biomolecules/biopolymers
- Metabolism and ribozymatic/enzymatic activity
- Properties of genetic materials

Biology

- Properties of life
- Darwinian evolution
- Horizontal and vertical gene transfer and mechanisms

Math (conceptual)*

- Chaos theory*
- Information theory*

*Topics indicated with an asterisk will not be covered in full depth, but will be reviewed to the extent of their relevance

Schedule:

Class # (Day)	Topic	Assignment (point value)
1 (1/29)	Introduction, Syllabus, Basics of Astrobiology and Timeline of Earth	Assigned: HW1 – Survey for completion (7)
2 (2/5)	History of Universe/Astronomy Background and Astronomical Properties which Support Life	Due: HW1 – Survey for completion (7)
3 (2/12)	Overview of Solar System, Properties and Geological History of Earth	
4 (2/19)	Basic Properties, Materials, and Requirements of Life, Properties and Abundance of Biomolecules	Assigned: HW2 – Astronomy (12)
5 (2/26)	Astrochemistry, Atmospheric Chemistry, Radiochemistry, Energetic Favorability of Biomolecules	
6 (3/4)	Prebiotic Chemistry and Early Biochemistry, pre-RNA and RNA World, Requirements of the Earliest Possible Forms of Life, Origins, Importance of C and H ₂ O (part I)	Due: HW2 – Astronomy (12)
7 (3/11)	Prebiotic Chemistry and Early Biochemistry, etc (part II)	Assigned: HW3 – Class Discussion 1 Prep (7)
(3/18)	Spring Break: No Class	
8 (3/25)	Class Discussion – Metabolism or Self-Replication First Theories, midterm review	Due: HW3 – Class Discussion 1 Prep (7) Assigned: HW4 – Abstract/Intro Readings (12)
9 (4/1)	Midterm Exam Quiz (20) – Lectures 1 to 8, More Origins, Working Backwards – Abiogenesis Research, Genetic Methods, Rooting the Tree of Life, Microfossils & Biosignatures	Assigned: HW 5 – Origins (18)

10 (4/8)	Development of Life from LUCA, Metabolic Adaptation, Divergence of Archaea/Bacteria, Chemoautotrophy	Due: HW4 – Abstract/Intro Readings (12) Assigned: HW6 – Class Discussion 2 Prep (7)
11 (4/15)	Class Discussion – Viability of Other Solvents/Building Blocks	Due: HW6 – Class Discussion 2 Prep (7)
12 (4/22)	Drake equation, Rare/Mediocre Earth Hypotheses, Importance of Spatial and Temporal Separation, Great Filter	Due: HW5 – Origins (18)
13 (4/29)	(Possible Guest Speaker:) Chaos Theory, Information Theory, Statistical and Other Mathematical Methods	Assigned: HW7 – Mathematical Analyses (7)
14 (5/5)	Spectroscopy and Biosignatures, Implications of Discovery of Extraterrestrial or Separate Terrestrial Abiogenic Events, Panspermia	Due: HW7 – Mathematical Analyses (7)
15 (5/12)	In-Class Paragraph, Final Review, Takeaways	

Grading:

Grades for this course will be decided based on a 150-point system, with points assigned as shown below for homework assignments, in-class participation, a midterm and final exam. Letter grades will be assigned based on total points earned in class, as follows: A = ~135-150 (~89.5-100%), B = ~120-134 (~79.5-89.4%), C = 105-119 (~69.5-79.4%), D = 90-104 (~59.5-69.4%), E = 89 (~59.4%) and below. Depending upon course performance the grade cutoffs may be lowered. For a further clarification of the point value for each section, please see below.

Assignment	Point Value	Percentage Value	
Homework 1, 3, 6, 7	7 points each (28 total)	4.67% (18.67% total)	Total HW: 70 points - 46.67%
Homework 2, 4	12 points each (24 total)	8% (16% total)	
Homework 5	18 points	12%	
In-Class Participation	2 points per class (30 total)	1.33% (20%)	Total Participation: 30 points - 20%
Midterm Quiz	20 points	13.33%	Total Quizzes: 50 points - 33.33%
Final Quiz	30 points	20%	
Total Points	150 points	100%	

Class Format:

The structure of this course is primarily lecture-focused, with some form of lecture most class periods. The student facilitator will give the lectures in the classroom each period, with a possibility of one or more guest speakers throughout the semester. The two exceptions to the lecture format are classes 8 and 11 on the class schedule above, which will consist of an introduction to the topic from the student facilitator followed by an active discussion on the topic, which will include all of the students as well.

Homework:

Homework in this course serves to supplement the course in some cases, and in others as a means of practicing and recalling the course material in different contexts as discussed in class. Homework assignments 1, 3, and 6 are individual assignments, and 7 is a group assignment. All of these will be quicker and more straightforward. Due to the dynamic nature of the class and the necessity of covering many different fields to provide necessary background for study of abiogenesis, it is not expected that every student will come in with a strong background in each field. For this reason, homework assignments 2, 4, 5, and 7 may be done in groups of up to 4 students and turned in as a collaborative group effort. Homework assignments will be assigned and posted at least a day before each class indicated on the schedule. Homework assignments are to be turned in, in paper, either printed or handwritten at the beginning of the class they are due. For group assignments, they must be turned in handwritten with clear participation and a signature from every group member. Any suspected incidents of academic dishonesty will be referred to the Honor Council. Questions about homework can be asked at the end of the class period or over email to the student facilitator.

In-Class Participation and Attendance Policy:

Attendance to every class period is recommended and is incentivized through a system of in-class participation points. For each lecture class period, there will be a quick quiz (miniquiz) to answer in the last few minutes of class time, for a total of two points. One point will be awarded to students for simply turning in this quiz with their name on it, and a second point will be awarded for the correct answer. The question will be based off a topic or fact which was bolded or otherwise emphasized in the lecture presentation and is meant to encourage students to actively take notes. If a student is present and receives the test but is unable to answer the test question, the student may instead ask an insightful question related to a topic mentioned in that class period. For lecture questions, these questions do not have to reflect mastery of the course material but should show that the student is paying attention in class and seeks to broaden/deepen their knowledge of the lecture material. For discussions (classes 8 and 11), the student facilitator will write a question during the class period based on the topics discussed. The same point system will be utilized for these discussion quizzes but writing a question will not be allowed for points, as any possible questions should instead be asked during the class period to help stimulate class discussion. An extra point will be available to all students during class discussions for active participation and preparedness.

Laptop/Cell Phone Policy: While laptops may be useful for some students in class, they also serve as a great potential source for distraction of the student with the laptop and those around them. For this reason, laptops will be permitted in class, but aside from the case of accommodations, students using laptops are strongly requested to sit behind all other students without them. Cell phones are not permitted in class, aside from non-disruptively recording lectures or for accommodations. Students who attend classes but use phones or laptops for non-instructional aiding purposes will not earn any in-class participation points for that class period.

Absence Policy: In the case of planned excused absences, including religious observances, requests must be made by the end of the schedule adjustment period. For these cases, an alternate arrangement can be made for the student to earn the participation points. In the case of unexcused absences, students forfeit the in-class participation points. In the case of unplanned, excusable absences, please email the student facilitator as soon as possible. Disability accommodation must be requested prior to the end of the schedule adjustment period, and accommodation must be arranged at least one week prior to the requested accommodation. The instructors reserve the right to assign a makeup exam/quiz of equivalent difficulty to the original to students who miss the scheduled exam time due to excused absences. This makeup exam/quiz may be offered in a range of formats and is not limited to the same format as the original.

Examinations/Quizzes:

This class will have a total of two quizzes over the semester, a midterm (dubbed the “midterm quiz”), and a final (dubbed the “final quiz”). The first quiz, which will take up 20 minutes of class time, will briefly test material covered during the first half of the semester, with approximately one question per class. The second, a final quiz, will be cumulative and will cover material from the entire semester, with a strong emphasis on material covered after the midterm exam. The final quiz will take place during the scheduled exam block but will take 40 minutes. Both exams will have mixed answering formats. A single note sheet (front and back) will be allowed for each exam, and students may prepare for both tests by preparing any material onto this notesheet, to be brought with them during the quizzes. Either typed, handwritten, or mixed formats are acceptable. As mentioned in the section above, makeup exam/quizzes may be offered in a different format as the original.

Excused Absence and Academic Accommodations:

See the section titled "Attendance, Absences, or Missed Assignments" available at [Course Related Policies](#).

Disability Support Accommodations:

As stated in the absence policy above, the student facilitator must be made aware of any disability accommodations by the end of the schedule adjustment period to arrange support for these accommodations as needed. For more information, see the section titled "Accessibility" available at [Course Related Policies](#).

Academic Integrity:

Note that academic dishonesty includes not only cheating, fabrication, and plagiarism, but also includes helping other students commit acts of academic dishonesty by allowing them to obtain copies of your work. In short, all submitted work must be your own. Cases of academic dishonesty will be pursued to the fullest extent possible as stipulated by the [Office of Student Conduct](#). 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>.

Course Evaluations:

If you have a suggestion for improving this class, don't hesitate to tell the instructor or TAs during the semester. At the end of the semester, please don't forget to provide your feedback using the campus-wide CourseEvalUM system. Your comments will help make this class better.

