

**PHL 278 CiS: ORIGINS OF LIFE (22979)**  
**TT 1:40-2:55 3 units Leon Johnson Hall 346**

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\_\_\_\_\_ <http://astrobiology.nasa.gov/nai/seminars/#directors> \_\_\_\_\_

**Required Texts:**

Many readings posted on D2L – see schedule for details

**Helpful Websites**

<http://news.discovery.com/videos/space-3-questions-exoplanets.html>

<http://apod.nasa.gov/apod/astropix.html>

<http://stardate.org/nightsky/meteors> and <http://www.meteorwatch.org/>

<http://www.space.com/>

<http://guides.lib.montana.edu/phl278?hs=a> (this is our class site at the library)

**Course Description & Goals:**

In this course we will examine philosophical questions regarding the nature and origins of life on Earth, as well as the sciences devoted to studying this. What are the defining characteristics of life on our planet? How might we scientifically investigate the origins of life? How is this emerging science different from more established scientific endeavors? How should scientists choose between competing theories about the origins of life? What can life as we know it tell us about the potential for extra-terrestrial life? What would constitute an “alternative form of life” and how would we recognize it if we found it? Is artificial life possible? What are the ethical and social implications of research on artificial and alternative life? In examining these questions, you will learn about interdisciplinary research regarding life happening across campus including research in biochemistry, chemistry, computer science, earth sciences, and physics. This course will push you to think critically not only about a variety theories about life, but also about the production of scientific knowledge and concepts such as evidence, explanation, and observation.

**The goals of this course will be to:**

- 1) critically evaluate a variety of theories regarding the nature and origin of life
- 2) understand how various sciences produce knowledge about the origins of life
- 3) clarify key concepts used in scientific reasoning and methodology
- 4) construct and evaluate good arguments
- 5) communicate ideas clearly
- 6) work effectively in groups

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**COURSE REQUIREMENTS:**

Grades are based on the following course requirements:

A) 7 Summary-Argument Papers; B) 20 Discussions; C) 2 Group Research Projects; D)  
Final Exam

The specifics of each assignment type are detailed on the following pages.

- **7 Summary-Argument Papers:** (1-2 pages, 20 points each, 140 points total) consisting of: a summary of the relevant current reading, and your own well-supported position on a question or issue at hand. Grades are based on: Accuracy and completeness of summary, how well your argument is supported (use evidence to support your thesis), grammar & spelling (see handout), and finesse. The papers must be a summary of current readings assigned for that week, and must provide evidence for a thesis. You choose the position that you will critique or defend, so pick topics within the current readings that interest you. Papers should never be shorter than 400 words or longer than 900 words.
- **22 Discussions:** (5 points each, 110 points total) Discussion days take place in class, and will ask you to talk about a specific topic introduced via lectures or readings. Discussions may take the form of debates or group problem solving exercises. You will have a chance to collect your thoughts and write them down before you are asked to speak. Discussions will ask you to think about specific facts covered in the readings and lectures, and philosophical questions regarding scientific method, scientific explanations, and theoretical constructs.
- **2 Group Research Papers:** about 5 pages in length, and no more than 7 pages (about 1800-2000 words) (50 points each, 100 points total) The research projects are discovery-based learning activities in which you will develop an hypothesis about life, a theory of life, or another aspect of astrobiology, specify how it might be tested or what might count as evidence for or against it (and why), present relevant evidence, and draw tentative conclusions from it. You will work in a group of 3 to 5 people, and each individual will have a distinctly different thesis, summary, objection and reply. Data and results must be collected and reported collaboratively in groups. Alien abduction is not an accepted excuse for late projects.
- **Final Exam:** (comprehensive, short answer and essay format, 60 points) Held during the final examination period. Mid-term & discussion questions will provide a good study guide for the final exam. Extra-terrestrial intelligence is not necessary to pass the final exam.
- **Get your email, and check announcements on Desire 2 Learn,** at least **every 48 hours:** important course materials, information, and clarifications will come to you by email. You are responsible for checking your email and making sure your account is working.

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**Grading Scale:**

<b>A</b>	<b>93-100% 373 - 400 points</b>	<b>C</b>	<b>73-76% 292-304 points</b>
<b>A-</b>	<b>90-92% 360-372 points</b>	<b>C-</b>	<b>70-72% 280-291 points</b>
<b>B+</b>	<b>87-89% 345-359 points</b>	<b>D+</b>	<b>67-69% 265-279 points</b>
<b>B</b>	<b>83-86% 332-344 points</b>	<b>D</b>	<b>60-66% 240-264 points</b>
<b>B-</b>	<b>80-82% 320-331 points</b>	<b>F</b>	<b>0-59% 0 – 239 points</b>
<b>C+</b>	<b>77-79% 305-319 points</b>		

**ACADEMIC MISCONDUCT:** Work for this course must be completed by the person submitting it. This includes discussion work, group work, exams, and any other work submitted for credit. **Plagiarism and Academic Dishonesty are serious offenses.** Know what they are and recognize that the consequences could be worse than a failing grade on the assignment. If I discover academic misconduct, I will: 1) meet with you, 2) fill out an Academic Misconduct Notification Form, and 3) provide a written request for the Dean of Students to press charges of violation of the Student Conduct Code.

[http://www2.montana.edu/policy/student\\_conduct](http://www2.montana.edu/policy/student_conduct).

**Stay away from the internet – Do your own work – Write your own paper**

**ACADEMIC ACCOMODATIONS:** Any student eligible for and needing academic accommodations because of a disability is requested to speak to me and provide documentation as soon as possible. If you suspect that you have a disability, contact Disabled Student Services at: (406) 994-2824 (voice), (406) 994-6701 (tty), or on the web at: <http://www.montana.edu/wwwres/disability/index.shtml>

**Ground Rules & Notes on General Civility**

- 1. If a disagreement arises, present facts and evidence calmly rather than a heated and useless personal attack. Some opinions are more well-justified than others, but none merit active hostility or degradation.*
- 2. Missed papers, discussions, exams, etc., cannot be made up, but an opportunity for extra credit may be provided for those who have excused or documented absences. If you experience an extended illness or catastrophe, see me.*
- 3. If something or someone in the class is genuinely and persistently bothersome, offensive and/or inhibiting your learning process, please bring it to my attention.*
- 4. Work is generally NOT accepted by email. If there is a special circumstance, emailed work is always due at 11:59 p.m. on the stated due date. If your work does not arrive in my inbox with that time stamp (because you experience internet difficulties, your computer has problems, your computer clock is inaccurate, or for any other reason), or if we cannot open your file or if it is corrupt, you will receive 0 points for that assignment. **In other words, work submitted by email is accepted only under special circumstances and is submitted at your own risk.***

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**LEARNING OBJECTIVES & OUTCOMES:**

This course examines theories of the origin and nature of life and the properties of the emerging science dedicated to understanding life. Theories examined will include: RNA World, Metabolism World, Lipid World, Panspermia, Creationism, and the Cairns-Smith Hypothesis. Students will summarize, explain and critique the content of these contemporary theories, and construct and defend arguments as professional philosophers do. Students will explore the nature of scientific method and scientific explanation throughout the course, and confront ontological, epistemological and ethical issues that arise from the search for life here and elsewhere.

**Successful students will have demonstrated the ability to do the following at the completion of the course:**

- Explain and describe how science contributes to analyzing the nature and origin of life, as measured by summary-argument papers, discussions, exams, and the research project
- Explain and describe scientific methods, ask the kinds of questions asked by scientists and practice common methods used to explore those questions, as measured by summary-argument papers, discussions, exams, and the group research project
- Critically think, writing and speak about issues surrounding the exploration of life's beginnings, as measured by summary-argument papers and discussions
- Independently analyze information from multiple sources, as measured by summary-argument papers and discussions
- Work effectively in small groups, as measured by the group research project and discussions

**Summary-Argument papers demand:**

- Accurate use of the English language
- Accurate use of terminology specific to philosophy and the study of the origin of life
- Identification, and avoidance of, fallacies of reasoning
- Identification & description of philosophical and scientific theories, concepts, questions & issues
- Construction of a clear, specific thesis regarding the nature and origins of life.
- Reading & understanding primary texts as demonstrated by accurate summaries of them, and the use of quotations from these texts to further an argument
- Clear presentation of reasons and evidence (found in texts or originally developed by the student) that furthers the thesis
- Avoidance of discussing irrelevant subjects
- Recognition and precise description of objections (critiques of, or potential problems with), a theory or thesis
- Presentation of a relevant, content-bearing response to such objections

**Papers, Discussions, Examinations and the Research Project demand knowledge of several philosophical and scientific theories and issues, and the arguments, principles, concepts, and questions contained in course texts, including but not limited to:**

- |                           |                                     |
|---------------------------|-------------------------------------|
| ○ RNA World               | ○ Features of Scientific Hypotheses |
| ○ Lipid World             | ○ Features of Explanation           |
| ○ Metabolism World        | ○ Hypothetico-Deductive Method      |
| ○ Creationism             | ○ Bayesian Confirmation Theory      |
| ○ Cairns-Smith Hypothesis | ○ Scientific Justification          |
| ○ Panspermia              | ○ Ethical Dilemmas                  |

**Group Research Projects demand that students:**

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- Demonstrate accurate use of the English language (grammar, spelling, clarity)
- Demonstrate critical thinking through the avoidance of fallacious or poor scientific reasoning. Demonstrate the ability to provide evidence for conclusions and point out when, and why, the evidence is incomplete.
- Use scientific and philosophical terminology learned in class.
- Introduce a scientific experiment through summarizing and pointing out the relevance of recent scientific studies in astrobiology. Explain texts, research articles, and philosophical points relevant to this specific project in a way that shows the importance of the project and justifies further work in it. This introduction is both clear and complete.
- Formulate a clear and testable hypothesis, and operationally define important terms such as “life” or “intelligence.”
- Describe and explain how data was collected, especially detailing methods used, with an emphasis on understandability and repeatability.
- Clearly and thoroughly report results.
- Summarize results.
- Interpret and analyze data in the context of theories and hypotheses.
- Draw tentative conclusions and discuss the meaning of results in a broader philosophical and scientific context.
- Detail thoughtful considerations of an objection, or opposing view. This opposing view could be a critique of the methods of data collection, a re-interpretation of the data, or a re-framing of the entire problem the student has introduced in the paper. There are many ways to oppose a view.
- Respond to the opposing view in a clear and thoughtful manner, explaining ways in which the opposition might be overcome, or has misunderstood the importance of the original project.
- Suggest further or follow-up research
- Point out philosophical critiques of, or dilemmas for, the project and its results. This includes explicit discussion of astrobiology as an emerging science, and philosophical questions that arise in the formulation of the boundaries of, and methods for, that science.

**Schedule of Readings and Topics (subject to change)**

<b>Date</b>	<b>Class Topic/Activity</b>	<b>Read for NEXT class</b>	<b>Due/Points</b>
Tues. Aug. 28	Introduction to course and Syllabus. What is philosophy? What is astrobiology? How are astrobiology and philosophy related?	The Syllabus	
Thurs. Aug. 30	<b>Planetarium Show:</b> arrive at MoR at 1:50 for “How to Build a Planet” Show lasts 45 minutes.	Bedau, “What is life?” (D2L); Cleland & Chyba, “Defining ‘Life’” (D2L)	

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	<b>Unit 1: Defining Life</b>		
Tues Sept. 4	The beginning of the universe. How to define terms: Necessary & sufficient conditions Family Resemblance, Pros Hen Unity Human Prototype Concepts Top down and Bottom up Methods	Schrodinger “What is Life?” (D2L)	<b>Discussion (5)</b>
Thurs. Sept. 6	Defining “life” Some leading notions of life Fieldwork: identify and discuss different living things and how we know or decide that they are living. Begin to discuss group projects	Fallacies handout on D2L	<b>Discussion (5):</b> Fieldwork
Tues. Sept. 11	Arguments, Deduction, Induction Good and bad theories Giving reasons for a view Fallacies	Hume Enquiry ch. 4.2, Hempel “The Role of Induction in Scientific Enquiry”, & Goodman “The New Riddle of Induction” on D2L	<b>Discussion (5):</b> Arguments & Fallacies
	<b>Unit 2: Philosophy of Science</b>		
Thurs. Sept. 13	Philosophy of Science Induction and its critics Grue Ravens Paradox	Popper “ Science: Conjectures and Refutations” & Gould “Sex, Drugs, Disasters and the Extinction of the Dinosaurs,” & Quine “Two Dogmas of Empiricism” on D2L	<b>Paper #1 Due (15)</b> <b>On defining 'life'</b>
Tues. Sept. 18	Falsification, Empirical Statements, Testability		<b>Discussion (5)</b>
Thurs. Sept. 20 Stephen (Sara out of town)	Mars Fieldwork: develop a testable theory about extra-terrestrial life Excerpts from NOVA Origins: “Where did we Come From?”	Kuhn “The Structure of Scientific Revolutions” & Quine “Ontological Relativity” on D2L	<b>Discussion (5)</b> Fieldwork
Tues. Sept. 25	Quine, inscrutability of reference and indeterminacy of translation Kuhn and Paradigm Shifts		

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Thurs. Sept. 27	Space Public Outreach Team: Mission to Mars!	Behe "Evidence for Intelligent Design" & excerpts: Descartes' Meditation 3 on D2L	
	<b>Unit 3: Six Theories</b>		
	<b>Theory 1: Intelligent Design</b>		
Tues. Oct. 2	Intelligent Design Ontological, Cosmological, Design Arguments "Banana Man" "No Intelligence Allowed"		<b>Paper #2 (15) On philosophy of science</b>
Thurs. Oct. 4	NOVA "ID on Trial"	Warmflash & Weiss "Did Life Come from Another World?" Scientific American Nov. 2005 and Crick & Orgel "Directed Panspermia"	<b>Discussion (5)</b>
Extra Credit	Movie "Inherit the Wind" Movie "No Intelligence Allowed" Movie "Paul" Watch Futurama "Reincarnation" (Season 6, Episode 26) especially the second segment (between about minute 11 & minute 18)	Watch up to two of these and describe the events that take place that are relevant to arguments for and against Intelligent Design as studied in class.	
	<b>Theory #2: Panspermia</b>		
Tues. Oct. 9	#2 Panspermia: Many Theories	Morris "Aliens Like Us?" and Vaidya "Critique on Vindication of Panspermia"	
Thurs. Oct. 11	<a href="http://www.panspermia-theory.com/videos/">http://www.panspermia-theory.com/videos/</a> develop reasons for and against Panspermia	Cairns-Smith <u>Seven Clues to The Origin of Life</u> , chapters 10, 11 and 12 on D2L	<b>Discussion (5)</b>
Extra Credit	Star Trek Next Gen: Season 6 #20 "The Chase"		

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	<b>Theory #3: Cairns-Smith &amp; Clay</b>		
Tues. Oct. 16 Stephen	#3 Clay and the origin of life <a href="http://www.arn.org/docs/meyer/sm_theoclay.htm">http://www.arn.org/docs/meyer/sm_theoclay.htm</a>	Iris Fry <u>The Emergence of Life on Earth</u> 126-129 on Google Books Wills & Bada <u>The Spark of Life</u> 101-105 on Google Books Thaxton & Meyer “Theoretical Clay Feet” webpage to the left	<b>Paper #3 (15)</b> <b>Creationism or Panspermia</b> <b>Discussion (5)</b>
Thurs. Oct. 18 Stephen	Clay, continued Encounters at the End of the World Disc 1 (Antarctic extremophiles)	“Life Began when Evolution Began” by Tessera, on D2L Segre et al. “The Lipid World” on D2L	<b>Discussion (5)</b> Fieldwork/Lab
Oct. 20	Orionid Meteor Shower!		
	<b>Theory #4: Lipid World</b>		
Tues. Oct. 23 Stephen	Lipid World: Science Excerpts from Doron Lancet Video: “Lipid World and Systems PreBiology”		<b>Discussion (5)</b>
Thurs. Oct. 25 Stephen	Lipid World: Philosophy Soap Lab	Read Scientific American article “Is a Virus Alive?” and Ricardo & Szostak “Life on Earth” on D2L for Tues.	<b>Discussion (5)</b> Lab
	<b>Theory #5: RNA World</b>		
Tues. Oct. 30 Stephen	RNA World Excerpts from John Maynard Smith Video “The Origins of Life”		<b>Discussion (5)</b> <b>Paper #4 Due (15) on Lipid or Clay</b>
Thurs. Nov. 1 Stephen	RNA World DNA Lab	Shapiro, Robert. (2007) “A Simpler Origin for Life” (D2L)	<b>Discussion (5)</b> Lab



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	<b>Theory #6: Metabolism World</b>		
Tues. Nov. 6	No class; election day! Vote!		
Thurs. Nov. 8 Stephen	Metabolism World: Science (Sara out of town)	Lesley Orgel, “The Implausibility Metabolic Cycles on the Prebiotic Earth.” (D2L)	<b>Discussion (5) Lab</b>
Tues. Nov. 13	Metabolism World: Critiques Begin Artificial Life Craig Venter	Bedau, Chapters 1 & 3 on Artificial Life & Cranor on Artificial Life for Thur (D2L)	<b>Discussion (5) Group Project #1 Due (50)</b>
	<b>Unit 4: Ethics &amp; Artificial Life</b>		
Thurs. Nov. 15	Artificial life Artificial life lab	Turing Test article M. A. Bedau and E. C. Parke, <i>The prospect of protocells: social and ethical implications of the recreation of life.</i> (D2L)	<b>Discussion (5) Paper #5 Due (15) RNA vs. Metabolism</b>
Nov. 17	Leonid Meteor Shower!		
	<b>Unit 5: Intelligence</b>		
Tues. Nov. 20	Drake Equation, Intelligence IQ Test Lab The Ethics of SETI	Articles by Jensen, Fagan, Scientific American Issue Morison “SETI in the New Millennium” on D2L	<b>Discussion (5)</b>
Extra Credit	Nova Origins (2004) “Where are the Aliens?”		
Thurs. Nov. 22	No Class – Enjoy!	Thanksgiving Holiday	
Tues. Nov. 27	Finish Intelligence	Schnall “Disgust as Embodied Moral Judgment” and Prinz “The Emotional Basis of Moral Judgment” on D2L	<b>Discussion (5)</b>
Thurs. Nov. 29	Aliens in the Media Human Moral Response		<b>Discussion (5) Paper #6 Due (10) on IQ</b>

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Tues. Dec. 4 Stephenson	China's Space Station, Who Owns Mars?		<b>Discussion (5)</b> <b>Paper #7 Due (10) on Ethics</b>
Thurs. Dec. 6	Review for Final Exam		<b>Group Project #2 Due (50)</b>
Wed. Dec. 12 4:00- 5:50 pm	Final Exam		<b>Final (50)</b>