

AST 183: Life in the Universe

College of the Environment, Forestry, & Natural Sciences
Department of Astronomy and Planetary Science

Semester: Fall 2021

Prerequisites: None

Location: Virtual

Meeting Time & Format: Asynchronous Remote (3 credit hours)

Instructor: Dr. Mark Salvatore, mark.salvatore@nau.edu, (928) 523-0324

Office Hours: You must schedule an appointment for office hours! Click [here](#) for the calendar.

(Virtual) Mondays, Tuesdays, & Thursdays, 9:00am - 10:00am

Zoom Room: **850 6678 7221** | Password: **salvatore**

(In Person) Mondays, 10:00am - 11:00am

Bldg. 19 (Physical Sciences), Rm. 225A

Undergraduate Teaching Assistants (TAs): **TBD**

TA Office Hours: **TBD**

Contact Information for Class: nau.ast183@gmail.com

Course Purpose

Course will survey the scientific topics that comprise the key elements of “Astrobiology.” These include the philosophical foundations of astrobiology as a science, astronomical sources of life’s chemical building blocks and habitable environments, extremophilic organisms, the history of life on Earth, the role of asteroid/comet impacts and micro-meteoritic dust, feasibility of space travel, and the search for life in the solar system and beyond. Letter grade only.

Course Description (Fall, 2021)

The Milky Way galaxy contains approximately 250 billion stars, and the known universe is likely home to approximately one trillion galaxies. What are the chances that life is unique to one medium-sized planet around an average star, located in a minor arm of a relatively small galaxy? Or, to put it bluntly like the brilliant nuclear physicist Enrico Fermi, “where is everybody?” This course takes a multi-faceted approach at understanding life on Earth and whether life might exist elsewhere in the universe. Over the duration of the semester, this course will broadly cover a range of geological, biological, chemical, and astronomical principles that, together, encompass the relatively new field of study known as *astrobiology*.

The class is broadly split into three sections. First, we will discuss the definition of life and the conditions necessary to support life as we know it. Second, we will investigate whether life could have existed (or currently exists?) on other planetary bodies within our own solar system. Lastly, we will broaden our search for life to other solar systems and galaxies, moving away from the hard sciences and more towards a theoretical perspective on life outside of the Earth. Throughout the course, we will be reviewing the scientific method and how to differentiate between “real” and “pseudo” science.

This course satisfies a *Science and Applied Science* requirement and is designed to appeal to a broad audience. The 3-credit hour lecture (AST 183) alone satisfies a 3-hour liberal sciences requirement and, in tandem with the associated 1 credit hour lab course (AST 184L), also a lab science requirement.

To ensure rapid responses, please submit any questions, comments, or concerns related to this course through the following email address: nau.ast183@gmail.com.

Course Objectives & Learning Outcomes

This course has several objectives and learning outcomes that will be addressed during the lecture and assessed through in-class assignments, homework, and examinations. By the end of the semester, students will be able to:

1. Demonstrate an understanding of the scientific method and how scientific research is conducted;
2. Identify how biology, chemistry, geology, and astronomy all contribute to the field of astrobiology;
3. Define “life” and its chemical, physical, and environmental requirements;
4. Describe the origin and evolution of life on Earth;
5. Critically and scientifically assess the possibility of life beyond Earth;
6. Demonstrate an understanding of the structure, scale, and history of the universe; and
7. Discuss the scientific, ethical, political, and spiritual consequences of (the search for) life outside of Earth in a civil, respectful, and engaging fashion.

Assessment

Students will be assessed on the above objectives through a series of short quizzes, homework assignments, and examinations. This strategy was designed to ensure that students are rewarded for their efforts and can receive their grades rapidly. All assessment will be performed through BBLearn. The modes of assessment and how they relate to the content of this course are discussed below:

Module Quizzes (100 points): Short quizzes attached to each video module will assess student retention and understanding of the content. Quizzes are password protected, with the password for each quiz defined in the module videos. The 53 module quizzes total 106 possible points, but are only graded out of 100 points, allowing for students to make up missed points. Quizzes consist of two one-point multiple choice questions.

Homework Assignments (60 points): Homework assignments will consist of ten one-point multiple choice questions that encompass several modules. Questions will increase in difficulty to prepare students for the examinations. Homework assignments are not password protected, but are timed to encourage students to be confident in their understanding of the course content before starting the assignment. Two optional extra credit homework assignments are also available and will require additional readings to earn the extra points.

Examinations (140 points): Timed and with questions increasing in difficulty, exams are designed to assess students' ability to synthesize content from multiple nodes. Exams consist of two midterm (40 one-point multiple choice questions) and one cumulative final (60 one-point multiple choice questions).

Category		Number of Assignments	Number of Questions	Total Points	Time Limit
Module Quizzes		53	2	100*	5 mins
Homework Assignments		8	10	60**	15 mins
Examinations	Midterm	2	40	80	60 mins
	Final	1	60	60	90 mins
		64	300	300	

*Six extra credit points available.

**Twenty extra credit points available.

Your course grade will be based on the total points earned, and a letter grade will be assigned using the grading scale below:

A: ≥ 270 points ($\geq 90\%$)

B: 240 – 269 points (80% – 89.9%)

C: 210 – 239 points (70% – 79.9%)

D: 180 – 209 (60% - 69.9%)

F: < 180 points (< 60%)

Materials & Technology

REQUIRED: Regular and stable internet access to stay engaged on YouTube and BBLearn.

OPTIONAL: Bennett., J., & S. Shostak (2016), Life in the Universe (4th Edition). Pearson, San Francisco, CA. ISBN: 978-0-13-408908-9.

(Note: This textbook will serve as a supplement to the online nodes and modules, and students will not be responsible for materials not covered in the modules and only discussed in the text. Students may also be able to find used copies of the 3rd Edition of this text for much cheaper than the 4th Edition, but be aware that some content and page numbers might be different.)

Class, Departmental, & University Policies

- Additional policies can be found in the final pages of this document. This course falls under all departmental and university policies unless otherwise stated in this document.
- This course requires each student to pay particular attention to time management. See the suggested schedule below to determine how your progress compares to an even pace through the semester.
- The completion of one module quiz will lead to the opening of the next module quiz, requiring students to complete the course in its designed order. Homework assignments and exams will also automatically open when students have completed the covered modules.
- All assignments are timed and will automatically submit and prevent you from finishing the assignment when time expires. Keep track of time and submit before time expires to minimize lost points.
- Please disclose any disabilities or special requirements to the NAU Disabilities Resources Office, who will contact me privately regarding any accommodations. I want to make sure that every student has an equal opportunity to learn and succeed!
- Don't cheat. You're paying good money to learn, and if you don't appreciate the knowledge gained right now, you will in the future. ***If you feel like you need to cheat in order to succeed in this class, come talk with me to establish a more sustainable plan for succeeding.***

Course Structure, Nodes, Modules, and Assignments

1. **Node #1: Course Introduction**
 - 1.1. Module 1.1: Course Syllabus, Structure, and Expectations
2. **Node #2: The Fundamentals**
 - 2.1. Module 2.1: Science vs. Pseudoscience
 - 2.2. Module 2.2: The Scientific Method and the Theory of Gravity
 - 2.3. Module 2.3: Introduction to Chemistry
 - 2.4. Module 2.4: Introduction to Biology
 - 2.5. Module 2.5: Introduction to Geology
 - 2.6. Module 2.6: How Do We Study Outer Space?
3. **Node #3: The Structure of Space and Our Place Within It**
 - 3.1. Module 3.1: The Scale of the Universe and Our Place Within It
 - 3.2. Module 3.2: The Big Bang
 - 3.3. Module 3.3: Recycling of Stellar Materials
 - 3.4. Module 3.4: The Nebular Theory
 - 3.5. Module 3.5: Habitable Zones
 - 3.6. Module 3.6: Dark Matter and Dark Energy
4. **Node #4: The Formation and Evolution of Earth**
 - 4.1. Module 4.1: Geologic Time
 - 4.2. Module 4.2: Earth Accretion, Formation, and Differentiation
 - 4.3. Module 4.3: Plate Tectonics
 - 4.4. Module 4.4: Earth's Atmosphere and Magnetic Field
 - 4.5. Module 4.5: The Formation of the Moon
5. **Node #5: Conditions Necessary for Life on a Planet**
 - 5.1. Module 5.1: Habitable Environments
 - 5.2. Module 5.2: Why is Life Carbon-Based?
 - 5.3. Module 5.3: The Role of Water in Habitability
6. **Node #6: The Formation of Life on Earth**
 - 6.1. Module 6.1: When Did Life Begin?
 - 6.2. Module 6.2: Where and How Did Life Begin?
 - 6.3. Module 6.3: What Did Early Life Look Like?
 - 6.4. Module 6.4: The Energy for Life
 - 6.5. Module 6.5: Metabolism and DNA
 - 6.6. Module 6.6: RNA World
 - 6.7. Module 6.7: Panspermia
7. **Node #7: The Evolution of Life on Earth**
 - 7.1. Module 7.1: The Theory of Evolution
 - 7.2. Module 7.2: Human Evolution
 - 7.3. Module 7.3: Major Evolutionary Events in Earth History
 - 7.4. Module 7.4: Mass Extinctions
 - 7.5. Module 7.5: Artificial Life
 - 7.6. Module 7.6: The Future of Life on Earth
8. **Node #8: The Habitability of Other Planets in Our Solar System**
 - 8.1. Module 8.1: Mercury
 - 8.2. Module 8.2: Venus
 - 8.3. Module 8.3: The Moon
 - 8.4. Module 8.4: Asteroids and Comets
 - 8.5. Module 8.5: Mars
 - 8.6. Module 8.6: The Jupiter System
 - 8.7. Module 8.7: The Saturn System
 - 8.8. Module 8.8: The Uranus and Neptune Systems
9. **Node #9: The Habitability of Exoplanets and Other Distant Life**
 - 9.1. Module 9.1: Properties of Stars
 - 9.2. Module 9.2: Discovering and Studying Exoplanets
 - 9.3. Module 9.3: Solar System Similarities
 - 9.4. Module 9.4: Surface vs. Subsurface Habitability
 - 9.5. Module 9.5: Intelligence
 - 9.6. Module 9.6: The Drake Equation
10. **Node #10: Space Exploration and the Search for Life**
 - 10.1. Module 10.1: The History of Space Exploration
 - 10.2. Module 10.2: The Present and Future of Space Exploration
 - 10.3. Module 10.3: Interstellar Travel
11. **Node #11: UFOs, Aliens, and the Fermi Paradox**
 - 11.1. Module 11.1: UFOs and Evidence for Alien Visitations
 - 11.2. Module 11.2: The Fermi Paradox
 - 11.3. Module 11.3: *Should We Search for Extraterrestrial Life?*
12. **Node #12: Course Conclusion**
 - 12.1. Module 12.1: Course Wrap-Up

Suggested Course Schedule

The following course schedule is simply a suggestion to ensure that you are not falling behind. All assignments must be completed by **5pm on Friday, December 10, 2021**.

Module Quiz / Assignment	Suggested Due Date	Module Quiz / Assignment	Suggested Due Date
1.1: Course Introduction	8/23	7.1: The Theory of Evolution	10/18
2.1: Science vs. Pseudoscience	8/25	7.2: Human Evolution	10/20
2.2: The Scientific Method	8/27	7.3: Major Evolutionary Events	10/22
2.3: Introduction to Chemistry	8/29	7.4: Mass Extinctions	10/24
2.4: Introduction to Biology	8/31	7.5: Artificial Life	10/26
2.5: Introduction to Geology	9/2	7.6: The Future of Life on Earth	10/28
2.6: <i>How Do We Study Space?</i>	9/4	HW #4 (Modules 7.1 - 7.6)	10/29
3.1: The Scale of the Universe	9/6	8.1: Mercury	10/30
3.2: The Big Bang	9/8	8.2: Venus	11/1
3.3: Recycling of Stellar Materials	9/10	8.3: The Moon	11/3
3.4: The Nebular Theory	9/12	8.4: Asteroids and Comets	11/5
3.5: Habitable Zones	9/14	8.5: Mars	11/7
3.6: Dark Matter and Dark Energy	9/16	8.6: The Jupiter System	11/9
HW #1 (Modules 2.1 - 3.6)	9/17	8.7: The Saturn System	11/11
4.1: Geologic Time	9/18	8.8: Uranus / Neptune Systems	11/13
4.2: Earth Formation	9/20	Exam #2 (Nodes 5 - 8)	11/14
4.3: Plate Tectonics	9/22	HW #5 (Modules 8.1 - 8.8)	11/14
4.4: Earth's Atmosphere	9/24	9.1: Properties of Stars	11/15
4.5: Formation of the Moon	9/26	9.2: Exoplanets	11/17
Exam #1 (Nodes 2 - 4)	9/27	9.3: Solar System Similarities	11/19
5.1: Habitable Environments	9/28	9.4: Surface vs. Subsurface	11/21
5.2: Why is Life Carbon-Based?	9/30	9.5: Intelligence	11/23
5.3: The Role of Water	10/2	9.6: The Drake Equation	11/25
HW #2 (Modules 4.1 - 5.3)	10/3	10.1: History of Space Exploration	11/27
6.1: When Did Life Begin?	10/4	10.2: Present / Future of Space Exp.	11/29
6.2: Where/How Did Life Begin?	10/6	10.3: Interstellar Travel	12/1
6.3: What Did Early Life Look Like?	10/8	HW #6 (Modules 9.1 - 10.3)	12/2
6.4: The Energy for Life	10/10	11.1: UFOs and Alien Visitations	12/3
6.5: Metabolism and DNA	10/12	11.2: The Fermi Paradox	12/5
6.6: <i>RNA World</i>	10/14	11.3: Searching for Extraterrestrial Life	12/7
6.7: Panspermia	10/16	12.1: Course Wrap-Up	12/9
HW #3 (Modules 6.1 - 6.7)	10/17	Final Exam (Cumulative, All Nodes)	12/10

COVID-19 REQUIREMENTS AND INFORMATION

The following statements in red set forth in this document's first section are specific to NAU's response to the COVID-19 situation. The requirements outlined below are mandatory until further notice. They are based upon current public health conditions and guidance and may change as circumstances warrant or new information becomes available. Additional information about the University's response to COVID-19 is available from the **Jacks are Back!** web page located at <https://nau.edu/jacks-are-back/lumberjack-responsibilities>.

FACE COVERING AND PHYSICAL DISTANCING REQUIREMENTS

Appropriate face masks or other suitable face coverings must be worn by all individuals when present in classrooms, laboratories, studios, and other dedicated educational spaces. To maximize the benefits of physical distancing as an important strategy to help reduce community transmission of the SARS-CoV-2 virus, instructors may implement mandatory student seating arrangements or specific seat assignments. Instructors may remove students who do not cooperate with these requirements from the instructional space in the absence of an approved accommodation arranged through Disability Resources. Failing to comply with these requirements may constitute a violation of the university's *Disruptive Behavior in an Instructional Setting* policy available at <https://nau.edu/university-policy-library/disruptive-behavior>.

USE NAUFLEX TO HELP MAINTAIN PHYSICAL DISTANCING

NAUFlex (available at <https://nau.edu/nauflex/student>) is designed to help all students actively participate in their coursework during the required day and time of a course when they are not physically present in the classroom. This course design model allows students to be fully engaged with faculty and peers and receive the high-quality educational experience for which NAU is known.

CLASS SESSION RECORDINGS FOR STUDENTS AND FACULTY USE ONLY

Certain class sessions may be audio or video recorded to help reinforce live instruction during the COVID-19 pandemic. These recordings are for the sole use of the instructor and students enrolled in the course. Recordings will be stored in approved, accessible repositories. By enrolling, students agree to have their image and classroom statements recorded for this purpose, to respect the privacy of their fellow students, and university-owned intellectual property (including, but not limited to, all course materials) by not sharing recordings from their courses. Questions regarding restrictions on the use of classroom audio or video recordings may be addressed to the appropriate academic unit administrator.

SYLLABUS POLICY STATEMENTS

ACADEMIC INTEGRITY

NAU expects every student to firmly adhere to a strong ethical code of academic integrity in all their scholarly pursuits. The primary attributes of academic integrity are honesty, trustworthiness, fairness, and responsibility. As a student, you are expected to submit original work while giving proper credit to other people's ideas or contributions. Acting with academic integrity means completing your assignments independently while truthfully acknowledging all sources of information, or collaboration with others when appropriate. When you submit your work, you are implicitly declaring that the work is your own. Academic integrity is expected not only during formal coursework, but in all your relationships or interactions that are connected to the educational enterprise. All forms of academic deceit such as plagiarism, cheating, collusion, falsification or fabrication of results or records, permitting your work to be submitted by another, or inappropriately recycling your own work from one class to another, constitute academic misconduct that may result in serious disciplinary consequences. All students and faculty members are responsible for reporting suspected instances of academic misconduct. All students are encouraged to complete NAU's online academic integrity workshop available in the E-Learning Center and should review the full *Academic Integrity* policy available at <https://policy.nau.edu/policy/policy.aspx?num=100601>.

COURSE TIME COMMITMENT

Pursuant to Arizona Board of Regents guidance (ABOR Policy 2-224, *Academic Credit*), each unit of credit requires a minimum of 45 hours of work by students, including but not limited to, class time, preparation, homework, and studying. For example, for a 3-credit course a student should expect to work at least 8.5 hours each week in a 16-week session and a minimum of 33 hours per week for a 3-credit course in a 4-week session.

DISRUPTIVE BEHAVIOR

Membership in NAU's academic community entails a special obligation to maintain class environments that are conducive to learning, whether instruction is taking place in the classroom, a laboratory or clinical setting, during course-related fieldwork, or online. Students have the obligation to engage in the educational process in a manner that does not interfere with normal class activities or violate the rights of others. Instructors have the authority and responsibility to address disruptive behavior that interferes with student learning, which can include the involuntary withdrawal of a student from a course with a grade of "W". For additional information, see NAU's *Disruptive Behavior in an Instructional Setting* policy at <https://nau.edu/university-policy-library/disruptive-behavior>.

NONDISCRIMINATION AND ANTI-HARASSMENT

NAU prohibits discrimination and harassment based on sex, gender, gender identity, race, color, age, national origin, religion, sexual orientation, disability, or veteran status. Due to potentially unethical consequences, certain consensual amorous or sexual relationships between faculty and students are also prohibited as set forth in the *Consensual Romantic and Sexual Relationships* policy. The Equity and Access Office (EAO) responds to complaints regarding discrimination and harassment that fall under NAU's *Nondiscrimination and Anti-Harassment* policy. EAO also assists with religious accommodations. For additional information about nondiscrimination or anti-harassment or to file a complaint, contact EAO located in Old Main (building 10), Room 113, PO Box 4083, Flagstaff, AZ 86011, or by phone at 928-523-3312 (TTY: 928-523-1006), fax at 928-523-9977, email at equityandaccess@nau.edu, or visit the EAO website at <https://nau.edu/equity-and-access>.

TITLE IX

Title IX is the primary federal law that prohibits discrimination on the basis of sex or gender in educational programs or activities. Sex discrimination for this purpose includes sexual harassment, sexual assault or relationship violence, and stalking (including cyber-stalking). Title IX requires that universities appoint a "Title IX Coordinator" to monitor the institution's compliance with this important civil rights law. NAU's Title IX Coordinator is Elyce C. Morris. The Title IX Coordinator is available to meet with any student to discuss any Title IX issue or concern. You may contact the Title IX Coordinator by phone at 928-523-3515, by fax at 928-523-0640, or by email at elyce.morris@nau.edu. In furtherance of its Title IX obligations, NAU will promptly investigate and equitably resolve all reports of sex or gender-based discrimination, harassment, or sexual misconduct and will eliminate any hostile environment as defined by law. Additional important information about Title IX and related student resources, including how to request immediate help or confidential support following an act of sexual violence, is available at <https://in.nau.edu/title-ix>.

ACCESSIBILITY

Professional disability specialists are available at Disability Resources to facilitate a range of academic support services and accommodations for students with disabilities. If you have a documented disability, you can request assistance by contacting Disability Resources at 928-523-8773 (voice), 928-523-6906 (TTY), 928-523-8747 (fax), or dr@nau.edu (e-mail). Once eligibility has been determined, students register with Disability Resources every semester to activate their approved accommodations. Although a student may request an accommodation at any time, it is best to initiate the application process at least four weeks before a student wishes to receive an accommodation. Students may begin the accommodation process by submitting a self-identification form online at <https://nau.edu/disability-resources/student-eligibility-process> or by contacting Disability Resources. The Director of Disability Resources, Jamie Axelrod, serves as NAU's Americans with Disabilities Act Coordinator and Section 504 Compliance Officer. He can be reached at jamie.axelrod@nau.edu.

SENSITIVE COURSE MATERIALS

University education aims to expand student understanding and awareness. Thus, it necessarily involves engagement with a wide range of information, ideas, and creative representations. In their college studies, students can expect to encounter and to critically appraise materials that may differ from and perhaps challenge familiar understandings, ideas, and beliefs. Students are encouraged to discuss these matters with faculty.