

## **AST 183: Life in the Universe**

**Semester:** Fall 2020

**Prerequisites:** None

**Location:** 100% remote

**Meeting Time:** Tuesdays & Thursdays, 4:00pm – 5:15pm.

### **Instructional team:**

Dr. David Trilling (Professor): david.trilling@nau.edu

Kendall Edwards (Assistant Instructor): klg463@nau.edu

Clarke Morley (FYLI TA): dm2638@nau.edu

All emails to instructors must have “AST183” (no quotes, no spaces) in the subject line.

**Virtual office hours:** Trilling: Wednesdays 3:30—5 (BbLearn/Collaborate). Edwards: Fridays 1—3:30 (BbLearn/Collaborate). Morley: Thursdays 3—4 (BbLearn/Collaborate and Discord)

### **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, 2020)**

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, as the brilliant nuclear physicist Enrico Fermi said, “Where is everybody?” This course takes a multi-faceted approach to 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 the Liberal Studies Science and Applied Science (SAS) 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. There is a separate, stand-alone 1 credit lab class (AST184L) that satisfies the lab science requirement.

### **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:

- Demonstrate an understanding of the scientific method and how scientific research is conducted;
- Identify how biology, chemistry, geology, and astronomy all contribute to the field of astrobiology;
- Define “life” and its chemical, physical, and environmental requirements;
- Describe the origin and evolution of life on Earth;
- Critically and scientifically assess the possibility of life beyond Earth;
- Demonstrate an understanding of the structure, scale, and history of the universe; and
- 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 in-class assignments, homework, and examinations, as follows.

Attendance: An important part of the learning process revolves around your attendance, participation, and engagement both during lecture and outside of class. Come to class prepared to learn. Interruptions and inappropriate behavior will not be tolerated, as it is disrespectful to others and to the academic learning environment. Your professionalism, courtesy, and engagement in the class are critical components of your success. **Virtual class attendance is required.**

In-class exercises: We will have in-class assessments (typically multiple-choice questions) during every class period. These questions are designed to gauge your understanding of the material that is covered in lecture and in the required readings. We will also have in-class small-group discussions during most meetings. Sometimes these discussions will consist of conceptual problems or questions to work on together; in other times, they will be more discussion oriented. **In-class participation is required.**

Homework assignments: Homework assignments are designed to strengthen your understanding of the course material and to prepare for examinations. Assignments will be posted on Thursdays on BbLearn. Assignments are due by 4 p.m. on Tuesdays (see schedule). **No late homeworks will be accepted.**

Examinations: This course will consist of two non-cumulative mid-semester examinations and one cumulative final examination. Exams will consist primarily of multiple choice and matching questions, with several short-answer questions also included. **No make-up exams will be offered without prior approval from the professor.**

**Grading System:** The breakdown of points is approximately as follows, and any changes to the class scoring rubric will be discussed with the class prior to implementation:

Attendance	25 points	Mid-term examinations (50 pts. each)	100 points
In-class participation	25 points	Final examination (Cumulative)	50 points
Homework assignments (10 pts. each)	100 points	<b>TOTAL</b>	<b>300 points</b>

There are 27 course meetings this semester, but only your top 25 attendance and in-class participation scores will be counted in your final grade. There are 12 homework assignments this semester, but only your top 10 homework scores will be counted in your final grade.

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

<b>A:</b> $\geq 270$ points ( $\geq 90\%$ )	<b>D:</b> 180 – 209 (60% - 69.9%)
<b>B:</b> 240 – 269 points (80% – 89.9%)	<b>F:</b> $\leq 170$ points ( $< 60\%$ )
<b>C:</b> 210 – 239 points (70% – 79.9%)	

The instructors reserve the right to adjust this grading scale but only downward (in other words, only in the students' favor).

### **Required Materials & Technology**

**Online access:** All course materials (lecture notes, homeworks, videos, etc.) will be accessed through BbLearn. Go to [bblearn.nau.edu](http://bblearn.nau.edu) to start.

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

*(Note: You may be able to find used copies of the 3<sup>rd</sup> Edition of this text for much cheaper than the 4<sup>th</sup> Edition. Feel free to purchase this earlier edition, but be aware that some content and page numbers might be different. It is your responsibility to identify these differences and to keep up with the required readings.)*

Students are expected to complete the assigned readings (either in the textbook or provided as supplemental materials) prior to each class. These readings will provide additional information regarding the lecture materials.

You are expected to have sufficient technology to be able to attend and participate in our virtual class. This generally means computer or tablet access with a webcam. There are computer labs on campus and computers can also be used at, or checked out from, Cline Library.

### **Class, Departmental, & University Policies**

- 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 to the professor to establish a more sustainable plan for succeeding.*
- Please mute yourself during the lecture portion of the class. Of course, you can and should unmute when it is time for group discussions.



## Course Schedule

The following course schedule includes the daily lecture topics, dates of examinations, due dates for homework, and the required reading materials. Remember that all readings listed for a given lecture must be read prior to class, and students will be held responsible for the content of these readings.

This schedule is subject to change, and any significant changes will be discussed with the class prior to their implementation.

Week	Date	Topic	Reading	HW
1	Th, 08/13/2020	Course Introduction		HW #1 out
	Tu, 08/18/2020	The Scientific Method	Ch. 1, 2	HW #1 due
2	Th, 08/20/2020	From Atoms to Zygotes: Introduction to Inorganic and Organic Chemistry	Ch. 3.3, 5.2	HW #2 out
	Tu, 08/25/2020	Physical Structure of the Universe	Ch. 3.1-3.2	HW #2 due
3	Th, 08/27/2020	Physical Structure of the Solar System	Ch. 3.4-3.5, 4.6, 10.1, 10.3	HW #3 out
	Tu, 09/01/2020	Introduction to Terrestrial Geology	Ch. 4.1-4.4	HW #3 due
4	Th, 09/03/2020	Conditions Resulting in Life on Earth	Ch. 4.4-4.5	
	Tu, 09/08/2020	<b>EXAM #1</b>		
5	Th, 09/10/2020	Defining Life	Ch. 5.1-5.4, 9.4	HW #4 out
	Tu, 09/15/2020	The Theory of Evolution	Ch. 5.1, 5.5-5.6	HW #4 due
6	Th, 09/17/2020	Formation of Life on Earth	Ch. 6.1-6.2	HW #5 out
	Tu, 09/22/2020	Evolution (and Extinctions) of Life on Earth	Ch. 6.3-6.4	HW #5 due
7	Th, 09/24/2020	Evolution of Humans and Artificial Life	Ch. 6.5-6.6	HW #6 out
	Tu, 09/29/2020	Conditions Necessary for Life Outside of Earth?	Ch. 7.1	HW #6 due
8	Th, 10/01/2020	Life in the Inner Solar System	Ch. 7.2, 10.2	HW #7 out
	Tu, 10/06/2020	Mars: Geologic Evolution	Ch. 8.1-8.2	HW #7 due
9	Th, 10/08/2020	Mars: Environmental Evolution	Ch. 8.3-8.5	HW #8 out
	Tu, 10/13/2020	Life in the Outer Solar System?	Ch. 9	HW #8 due
10	Th, 10/15/2020	The Future of Life on Earth	Ch. 10.4-10.5	
	Tu, 10/20/2020	<b>EXAM #2</b>		
11	Th, 10/22/2020	Habitability Outside of Our Solar System	Ch. 11.1-11.3, 11.5	HW #9 out
	Tu, 10/27/2020	Habitability of Extrasolar Planets	Ch. 11.4	HW #9 due
12	Th, 10/29/2020	The Search for Extraterrestrial Life	Ch. 12.1-12.3	HW #10 out
	Tu, 11/03/2020	UFOs and Aliens	Ch. 12.4	HW #10 due
13	Th, 11/05/2020	Human Exploration of Our Solar System	<i>Supplemental Readings</i>	HW #11 out
	Tu, 11/10/2020	Interstellar Travel	Ch. 13.1-13.2	HW #11 due
14	Th, 11/12/2020	The Fermi Paradox	Ch. 13.3	HW #12 out
	Tu, 11/17/2020	<i>Should We Search for Extraterrestrial Life?</i>	<i>Supplemental Readings</i>	HW #12 due
15	Th, 11/19/2020	Final Exam Review		
	M, 11/23/2020	<b>FINAL EXAM (3:00 pm – 5:00 pm)</b>		

The following policies highlighted in red text are specific to the University's response to the COVID-19 pandemic are mandatory until further notice. These requirements and related information are on currently public health conditions and guidance may change as circumstances warrant or new information becomes available. Additional information about the University's response to the COVID-19 situation available from the **Jacks are Back!** web page available at <https://nau.edu/jacks-are-back/lumberjack-responsibilities>.

### **FACE COVERING AND PHYSICAL DISTANCING REQUIREMENTS**

Appropriate face masks or other suitable 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 in the absence of an approved accommodation arranged through Disability Resources. Failing to comply with these requirements will 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>) enables all students to actively participate in their coursework during the required day and time of a course, even if 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 RECORDS 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 hereby agree to have their image and classroom statements recorded for this purpose, and to respect the privacy of their fellow students course-mates and University-owned intellectual property (including, but not limited to, all course materials) by refraining from sharing recordings from their courses. Questions regarding restrictions on the use of audio or video classroom recordings may be addressed to the appropriate academic unit administrator.

## **Academic Deadlines**

- ADD/DROP deadline (without “W”): August 21
- WITHDRAWAL deadline without petition: October 19

## **Academic Integrity Policy**

**Please read this section carefully as each student is required to understand and comply with all Academic Integrity rules and standards. Both NAU and this Department have standards that are written and referenced below.**

- Passing other’s work off as your own (plagiarism) and cheating are not accepted at NAU and are absolutely not tolerated in this class. It is not the professor’s responsibility to attempt to describe and prohibit any and all forms of Academic Dishonesty. **It is your responsibility to uphold the highest ethical standards.** If you have any doubt or question about this policy, it is your responsibility to ask the professor in advance and to be clear about the answers and policies.
- If you are caught cheating or if any of your **assignments/exams are found suspiciously similar** (such as exact same wording on written responses— note, changing a few words or the order of certain words is still plagiarism!), **ALL** students involved will receive zero points on that assignment or exam. The bottom line: ***Do your own work and do not let others copy off of you.***
- Academic Dishonesty information will be given to the Dean of Students and a written copy of any such incident may be attached to your official NAU file. If cheating/plagiarism continue, you will receive F in the class and the Dean’s office will be notified. University Academic Integrity Policy can be found [here](#).

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## **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*), for every unit of credit, a student should expect, on average, to do a minimum of three hours of work per week, including but not limited to class time, preparation, homework, and studying.

## **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. The Equity and Access Office (EAO) responds to complaints regarding discrimination and harassment that fall under NAU's *Safe Working and Learning Environment (SWALE)* policy. EAO also assists with religious accommodations. For additional information about SWALE 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](mailto:equityandaccess@nau.edu), or via 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 Pamela Heinonen, Director of the Equity and Access Office located in Old Main (building 10), Room 113, PO Box 4083, Flagstaff, AZ 86011. 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 928-523-3312 (TTY: 928-523-1006), by fax at 928-523-9977, or by email at [pamela.heinonen@nau.edu](mailto:pamela.heinonen@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 <http://nau.edu/equity-and-access/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](mailto: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](mailto: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.