| | |
|---|---|
| **Course Acronym:** | ASTR |
| **Course Number:** | 15 |
| **Descriptive Title:** | Life in the Universe |
| **Division:** | Natural Sciences |
| **Department:** | Astronomy |
| **Course Disciplines:** | Astronomy, Physics |
| **Catalog Description:** | In this course students will learn the current ideas and theories concerning the origin and evolution of life on Earth and discuss how these ideas are influencing our search for life on other planets and moons in our solar system and elsewhere in the Galaxy. Topics covered include the chemical and biological basis of life, the search for life on other worlds, and the search for extraterrestrial intelligence (SETI). |
| **Prerequisite:** | |
| **Co-requisite:** | |
| **Recommended Preparation:** | Eligibility for English 1A |
| **Enrollment Limitation:** | |
| **Hours Lecture (per week):** | 3 |
| **Hours Laboratory (per week):** | 0 |
| **Outside Study Hours:** | 6 |
| **Total Course Hours:** | 54 |
| **Course Units:** | 3 |
| **Grading Method:** | Letter Grade only |
| **Credit Status:** | Credit, degree applicable |
| **Transfer CSU:** | Yes |
| **Effective Date:** | fall 2021 |
| **Transfer UC:** | Yes |
| **Effective Date:** | fall 2021 |
| **General Education: ECC** | Area 1 - Natural Sciences |
| **Term:** | |
| **Other:** | |
| **CSU GE:** | Area B1 - Physical Universe and its Life Forms: Physical Science |
| **Term:** | fall 2022 |
| **Other:** | |

| | |
|---|---|
| **IGETC:** | Area 5A - Physical Science |
| **Term:** | fall 2022 |
| **Other:** | |
| **Student Learning Outcomes:** | **SLO #1 Scientific Method**<br><br>Students will be able to recognize the elements of the Scientific Method in the discussion of a scientific problem.<br><br>**SLO #2 Possibility of Life**<br><br>Students will be able to evaluate the possibility of life in a given environment based on the key components of habitability.<br><br>**SLO #3 Modern Theory**<br><br>Students will be able to describe the modern theory of the evolution of life on other worlds. |
| **Course Objectives:** | 1. Elucidate the origins of the Earth in the context of structure formation in the universe, star formation in our Galaxy, and planetary system formation.<br>2. Explain the emergence of life on our planet, to the extent that it is currently understood.<br>3. Discuss the co-evolution of the Earth and its biosphere up to the present time.<br>4. Characterize the cosmic habitats that might allow for the emergence of life elsewhere in the universe.<br>5. Examine the factors that might make life either a rarity or a commonplace occurrence in the universe.<br>6. Investigate how we might undertake the search for signs of, or signals from, life elsewhere in the universe. |
| **Major Topics:** | **I. The Science of Astrobiology & its Historical Origins (3 hours, lecture)**<br><br>A. The Scientific Method<br>B. The Science of Astrobiology, & its Historical Origins<br>C. The Cosmic Arena: some perspective on the present-day universe<br>1. Constituents<br>2. homogeneity of the observable universe<br>3. distance scales and time scales<br><br>**II. Evolution of the Universe From the Big Bang to the Earth (3 hours, lecture)**<br><br>A. Gravity and structure formation<br>B. Galaxies and galaxy clusters<br>C. Stars and star clusters<br>D. The birth and death of stars<br>E. Nucleosynthesis: the formation of the elements<br>F. Formation of planetary systems - the Nebular Hypothesis<br>G. Terrestrial planets versus gas giants<br><br>**III. Sky Phenomena (4 hours, lecture)**<br><br>A. Seasons |

B. Moon phases and eclipses
C. Planetary motions
D. Heliocentric vs. Geocentric views

**IV. The Dynamic Earth: life's one known platform (4 hours, lecture)**

A. reconstructing Earth's past in the geological and fossil record
B. sequencing and dating
C. Hadean Earth
D. The Late Heavy Bombardment
E. Formation of the oceans and atmosphere
F. The Earth's interior
G. Plate tectonics
H. The Earth's magnetic field
I. Climate and climate change

**V. Life As We Know It (6 hours, lecture)**

A. Definition of life
B. The theory of evolution
C. Cells and their biochemical basis
D. Nucleic acids: DNA and RNA
E. Genes and genomes: the genetic code
F. The production and role of proteins
G. Branches on the tree of life
H. Evolution at the molecular level
I. Evolution in real time
J. Metabolism - the use and flow of energy
K. Extremophiles - what can life endure?

**VI. The Emergence of Life on Earth (3 hours, lecture)**

A. Challenges to self-replication
B. The RNA world?
C. Isotopic evidence for the earliest life forms
D. Microfossils, blue-green algae, and stromatolites
E. Where did life begin?
F. Panspermia?

**VII. Major Episodes of Niche Expansion, Species Radiation, and Evolutionary Innovation (4 hours, lecture)**

A. The appearance of eukarya
B. Oxygen - the transformation of the atmosphere
C. The Cambrian explosion
D. the advent and radiation of plants
E. the colonization of land
F. chordates to fish to amphibians to reptiles to mammals to primates
G. hominid evolution -- the lineage of homo sapiens

**VIII. Setbacks and Detours (3 hours, lecture)**

A. Major extinction events
B. Impacts and other catastrophes
C. Snowball earth
D. The P-T boundary: the mother of all extinctions
E. The K-Pg boundary and the demise of the dinosaurs
F. The current blight: humans! - climate change, habitat
G. Destruction, and the role of overpopulation

**IX. Life in Other Habitats of the Solar System (4 hours, lecture)**

A. Is water a necessity?
B. Mars as the (potential) abode of life
C. Martian meteorites and the interplanetary migration of life
D. The Jovian atmosphere
E. The oceans of Europa and other large planetary satellites
F. Titan and other satellites of the gas giant planets

**X. Moving Beyond the Solar System: What Constitutes Habitability (4 hours, lecture)**

A. Niches: liquid, solid, and gaseous media. Surfaces
B. Habitable zones around the Sun and other stars
C. The role of planetary size: holding an atmosphere
D. The greenhouse effect and runaway planetary warming
E. Evolution of the Sun, and the migration of the habitable zone
F. The last days of the Earth
G. The role of the central star: lifetime, mass, and stellar temperature
H. Brown dwarf stars?
I. The problems with multiple star systems

**XI. Extrasolar Planets (4 hours, lecture)**

A. The recent explosive discovery of "exoplanets" techniques used to discover planets, and their biases
B. Hot Jupiters and planetary migration
C. The importance of heavy elements - metallicity
D. The technical challenge of finding terrestrial planets are terrestrial planets rare?
E. The greater challenge of finding evidence for life on terrestrial planets

**XII. Cosmic Threats and Cosmic Assists to the Progression of Life (3 hours, lecture)**

A. Bombardments - asteroids, comets, and other rogue bodies

   the protective role of Jovian planets
B. Is the Moon a factor?
C. Supernovae and gamma-ray bursts
D. Radiation background from the Galaxy
E. Thermal, orbital, and climatological instability

**XIII. Intelligent Life in the Cosmos (3 hours, lecture)**

A. definition of "intelligence" - an inevitable consequence of evolution

| | |
|---|---|
| | B. How commonplace is it? - the Drake Equation<br><br>The endurance & stability of intelligent species and their civilizations<br>C. Energy use, and the long-term impact of intelligent species on their environments; Dyson Spheres<br>D. The impact of population; sustainability and the stewardship of resources<br><br>**XIV. SETI: the Search for Extra Terrestrial Intelligence (3 hours, lecture)**<br><br>A. Search strategies for intentional signals - beacons<br>B. Leakage radiation<br>C. Likely time scales - the technological status of potential<br>D. communication partners<br>E. UFOs<br><br>**XV. Interstellar Travel and Colonization of the Galaxy (3 hours, lecture)**<br><br>A. Physical limitations to travel between the stars<br>B. Energy considerations<br>C. Science fiction shortcuts<br>D. Motivations for colonization<br>E. The Fermi Paradox - where are they?<br>F. Facing one of two stunning conclusions: We Are Alone, or We<br>G. Are Not Alone.<br>H. Implications |
| **Total Lecture Hours:** | 54 |
| **Total Laboratory Hours:** | 0 |
| **Total Hours:** | 54 |
| **Primary Method of Evaluation:** | 1) Substantial writing assignments |
| **Typical Assignment Using Primary Method of Evaluation:** | In a well-reasoned paragraph or more, explain how habitable zones differ among stars of different mass. The answer should reflect your understanding of the material and also include a quantitative solution for a thorough explanation. No page limit is required. The correctness is what will be evaluated. |
| **Critical Thinking Assignment 1:** | In a few paragraphs, identify and describe four crucial events in evolutionary history without which our current existence would have been highly unlikely. Explain your reasoning clearly. |
| **Critical Thinking Assignment 2:** | Mathematically, make your own estimate of a value for each of the four terms in the modified Drake equation. Explain how you arrived at each estimate, and then use your estimates to calculate N. Show all your steps. |
| **Other Evaluation Methods:** | Completion, Essay Exams, Homework Problems, Matching Items, Multiple Choice, Other Exams, Quizzes, Term or Other Papers, True/False |
| **Instructional Methods:** | Demonstration, Discussion, Group Activities, Lecture, Multimedia presentations |
| **If other:** | Internet Presentation/Resources |

| | |
|---|---|
| **Work Outside of Class:** | Answer questions, Problem solving activity, Required reading, Skill practice, Study, Written work (such as essay/composition/report/analysis/research) |
| **If Other:** | |
| **Up-To-Date Representative Textbooks:** | Jeffrey Bennett & Seth Shostak. Life in the Universe. 4 ed. Pearson/Addison Wesley, 2017. (Discipline Standard) |
| **Alternative Textbooks:** | |
| **Required Supplementary Readings:** | |
| **Other Required Materials:** | |
| **Requisite:** | |
| **Category:** | |
| **Requisite course(s): List both prerequisites and corequisites in this box.** | |
| **Requisite and Matching skill(s):Bold the requisite skill. List the corresponding course objective under each skill(s).** | |
| **Requisite Skill:** | |
| **Requisite Skill and Matching Skill(s): Bold the requisite skill(s). If applicable** | |
| **Requisite course:** | |
| **Requisite and Matching skill(s):Bold the requisite skill. List the corresponding course objective under each skill(s).** | |
| **Requisite Skill:** | Eligibility for English 1A |
| **Requisite Skill and Matching skill(s): Bold the requisite skill. List the corresponding course objective under each skill(s). If applicable** | **A student needs to have well-developed reading skills to understand and interpret information provided in their textbooks.**<br><br>Summarize, analyze, evaluate and synthesize college-level texts.<br><br>**Students needs to be able to write a paragraph, essay, or paper about a technical subject.**<br><br>Write a well-reasoned, well-supported expository essay that demonstrates application of the academic writing process. |

| | |
|---|---|
| **Enrollment Limitations and Category:** | |
| **Enrollment Limitations Impact:** | |
| **Course Created by:** | Shimonee Kadakia |
| **Date:** | 02/06/2018 |
| **Original Board Approval Date:** | |
| **Last Reviewed and/or Revised by:** | Shimonee Kadakia |
| **Date:** | 04/27/2023 |
| **Last Board Approval Date:** | 07/17/2023 effective FALL 2024 |