Biology 522S. Origins of Cellular Life
Spring 2025

Last updated: January 30, 2025

Meeting times and locations

Lectures: Wed, 3:05-5:35pm (BioSci 144)

Instructor

Dr. Amy K. Schmid, Office: 4105 FFSC, Email: amy.schmid@duke.edu

Synopsis

The aim of this course is to investigate, explore, understand, and evaluate the evidence for the origin of life on earth and the possibility of life on other planets. Students will read primary literature, understand and discuss competing hypotheses in the field, and write a final paper that reviews the state-of-the-art evidence for how life began and evolved.

Prerequisites

Molecular biology (Bio201 or equivalent) and inorganic chemistry. Microbiology and organic chemistry recommended but not required.

Course website

See the Biology 522S website at https://github.com/amyschmid/Spring2025-Bio522S/wiki.

Required reading

Each week, students will be required to read a few secondary review and primary research papers from the literature. Please see the bibliography at the end of the syllabus for the required reading list. The papers are available for download on the course Canvas site. Additional suggested background readings, videos, and lectures are also posted on the Wiki.

Office hours

Mondays, 3:30-4:30. **Part of your discussion grade (10 points) consists of meeting with the instructor the week prior to your discussion leadership to ok your discussion format / plan.** Instructor is also available by appointment if the Monday time slot doesn't work. Please email or meet after class to set up an appointment.

Due dates

1. *Discussion topic choice:* **January 24 at 11:59pm**.
   - Choose a discussion topic. If you already have a 2-person discussion team in mind, you can lead discussion together. If not, I can make pairs based on topic preferences.
   - List three choices from the syllabus topic list in order of preference.
   - Email your choices to the instructor. Note who your teammate is, or if you'd like to be paired based on topic choice.
2. *Discussion questions:* 3-4 questions on the required readings, due **each Sunday at 11:59pm** prior to the class meeting by email to instructor *and* discussion leaders for the week.
3. *Paper draft:* **February 26 at 11:59pm**. Email your draft in editable format (Word docx is preferable) to instructor and your peer review partner.

4. *Peer review of paper drafts:* **March 5** at 11:59pm. Email your partner your edits on their draft.
5. *Final paper:* **April 23** by 11:59pm. Email your draft in editable format to instructor.

Grading

Discussion leadership, 33%
Final Paper, 33%
Paper draft, 22%
Class participation, 11%

Format

The course is composed of reading, discussion, and writing a paper. Each week, we will read a few papers from the primary literature and a few from reviews or perspectives on the designated topic (see Bibliography at end of syllabus and the course wiki for papers). Each student will serve as discussion leader during one class period during the semester on a topic chosen from the syllabus topics list (see Topic List, below). Discussions will occasionally include a Zoom call with the author of one of the discussed papers. Students will write a term paper formatted as a short review in the journal Molecular Microbiology. A graded draft of the paper will be due at mid-term, which will be edited by the instructor and a fellow students, mimicking the peer review process. Edits will be used to revise for the final paper. Participation will require contribution of discussion questions prior to the course meeting on that topic. Active participation in discussion is expected from each student each week, which can take many forms according to your own style (e.g. active listening, speaking during discussions, small group work, writing on the white board, contributing thought questions and new papers after class to post on the course wiki, taking notes, etc.)

Learning objectives

1. Learn and understand questions and concepts important to the field of the origin of life presented in the course.
2. Discuss and learn about methods and leading hypotheses in the field from field experts during Zoom chats.
3. Become proficient in reading and interpreting the relevant primary literature. Evaluate primary literature in light of competing hypotheses and history of the field. Synthesize literature to support a primary thesis argument.
4. Communicate your methods and findings to the scientific community (your peers, your instructors) in the form of discussion leadership and a term paper. Understand and apply the importance of peer review in the form of peer evaluations.

Expectations and policies

Students are expected to:

1. **Come to class on time.**
2. Submit discussion questions and papers by their due dates.
3. Read required readings before each class period and submit discussion questions on time. Discussion questions are worth 10 points each and are treated as credit / no credit (unless they are turned in late, see below).
4. Participate in discussions and Zoom chats.
5. Be good citizens of discussion: speak to each other with respect despite differing views on certain hypotheses.
6. Adhere to the Duke Community Standard (see "Academic Integrity" below). A zero tolerance policy is in effect: any assignments violating the Standard will receive a 0 grade.

Policies on missed class time and late submissions

- Students are expected to attend and participate in every class session. Punctual arrival and participation in each discussion is worth 10 points toward your discussion grade. If you are more than 5 minutes late to class, a point will be removed for every 5 minutes that you are late. In the case of illness or extraordinary personal circumstance students should notify the instructors and their academic deans by means of a Short-Term Illness Notification Form (STINF) **before** the class session in which work is missed. Or, in the case of long-term medical or personal circumstances, students should request a letter from their academic dean.
- All assignments that are submitted late without a STINF, or instructor approval will receive 75% credit if submitted within 24 hours and half credit if submitted within 48 hours after the due date, or zero credit thereafter except in the case of SDAO accommodations. If you submit more than two STINFs in the semester, you will be asked to provide a doctor's or dean's letter explaining the circumstances.
- Please meet with the instructor in the first couple of weeks of class to discuss any SDAO accommodations.
- Students who will miss a class session due to religious observance should submit a Religious Observance Notification Form *no later than one week prior to the date of the holiday.*
- Students who are members of a varsity athletic team, and who may be required to miss some class time, should provide the instructors with a copy of their spring semester travel schedule during the first week of classes. Students should also complete an online "Notification of Varsity Athletic Participation (NOVAP)" form *no later than one week prior to each absence.*
- Students who will be travelling should notify the instructor *at least one week in advance about missed class time.*
- Students with excused absences (religious observance, athletic participation, etc.) are still expected to complete and submit homework assignments on time.

Diversity and Inclusion

In this course, you will learn about the vast diversity of life on earth in a diverse and inclusive environment for students. We celebrate and include all students who have joined us to explore these topics. Our course is inclusive of all learning styles, races, colors, religions, national origins, disabilities both hidden and visible, veteran statuses, sexual orientations, gender identities, gender expressions, sexes, neurotypes, genetic information, and ages. We will learn and use every students' preferred pronoun. As your instructor, I will do my best to foster inclusive and equitable conversations on all aspects of the material covered and to overcome any implicit biases I may have. During our discussions, let's work together to create an environment where everyone feels safe, comfortable, and that their contributions are valued.

Duke University Institutional Statement of Commitment to Diversity and Inclusion: Duke aspires to create a community built on collaboration, innovation, creativity, and belonging. Our collective success depends on the robust exchange of ideas – an exchange that is best when the rich diversity of our perspectives, backgrounds, and experiences flourishes. To achieve this exchange, it is essential that all members of the community feel secure and welcome, that the contributions of all individuals are respected, and that all voices are heard. All members of our community have a responsibility to uphold these values.

Academic Resource Center

The Academic Resource Center (ARC) offers free services to all students during their undergraduate careers at Duke. Services include Learning Consultations, Peer Tutoring and Study Groups, ADHD/LD Coaching, Outreach Workshops, and more. Because learning is a process unique to every individual, we work with each student to discover and develop their own academic strategy for success at Duke. Contact the ARC to schedule an appointment. Undergraduates in any year, studying any discipline

can benefit! Contact info: Address: 211 Academic Advising Center Building, East Campus behind Marketplace. Website: arc.duke.edu. Email: theARC@duke.edu. Tel: 919-684-5917.

Academic Integrity

All students must adhere to the Duke Community Standard (DCS): Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, and accountability. Citizens of this community commit to reflect upon these principles in all academic and non-academic endeavors, and to protect and promote a culture of integrity.

To uphold the Duke Community Standard, students agree:

- I will not lie, cheat, or steal in my academic endeavors;
- I will conduct myself honorably in all my endeavors; and
- I will act if the Standard is compromised.

Regardless of course delivery format, it is the responsibility of all students to understand and follow all Duke policies, including academic integrity (e.g., completing one's own work, following proper citation of sources, adhering to guidance around group work projects, and more). Ignoring these requirements is a violation of the Duke Community Standard. For more information about the community standard please refer to the documents available at: https://studentaffairs.duke.edu/conduct/about-us/duke-community-standard.

Any questions and/or concerns regarding academic integrity can be directed to the Office of Student Conduct and Community Standards at conduct@duke.edu.

Especially as it applies to written assignments and group discussion leadership, a strict adherence to the plagiarism policy described in the Community Standard will be observed. Note that, although day-to-day collaboration is encouraged, your weekly discussion questions, term papers, and your section of the discussion leadership should be entirely written in your own words. This course has a zero tolerance policy with plagiarism.

Policy on the use of generative AI.

In alignment with the goals of this course, key learning outcomes are to understand, evaluate, synthesize, and ultimately communicate concepts and hypotheses about the origin of life. However, AI can be a helpful tool for students to find primary research articles related to the topic of interest. Therefore, students are allowed to use AI before any writing content is created to help search for research articles related to weekly discussion questions and topic papers. Students may not consult AI once sources have been identified. Any writing for the paper draft, final paper, and weekly discussion questions must be entirely in your own words. Because AI can be inaccurate and biased, especially for specialized scientific fields such as those related to the origins of life, it is the student's responsibility to check all sources by other means (for example, on verified scholarly databases such as PubMed and/or Scopus) to ensure that these sources are factually correct and part of the peer reviewed literature. Any employment of AI outside of these uses is considered "unauthorized use", and is therefore in violation of Academic Integrity as per the Duke Community Standard.

COVID19 policies

The classroom COVID19 policies will follow those of Duke University (LINK) and CDC (LINK). Adherence these policies regarding COVID and any infectious diseases is required.

Classroom Emergency Procedures

Though very unlikely, there is always a possibility that there might be some type of emergency while we are in class this semester. Emergencies come in many different forms, including weather, medical, fire, and people who are intending to do harm. In most cases you will receive a DukeALERT notification by email and text if there is an emergency situation on campus, and you may also hear

the outdoor sirens. If your instructor seems not aware of an emergency situation at any point before, during or after class please stop your instructor and make them aware. There could also be dangerous activity in the immediate vicinity that Duke Police are not yet aware of. In that event, please make your instructor aware and call 911 or use the LiveSafe Mobile app to notify emergency responders.

- Weather: in the event of severe weather such as a tornado, we will seek shelter in an interior room without glass on the lowest floor of the building.
- Fire/Hazardous Materials: In the case of fire or a hazardous material spill, you should gather your personal items within reach and exit quickly. Help others as much as possible. Meet at the Camel Statue on Science Drive so your instructor knows who made it out safely. Once you are safe, call 911 or use the LiveSafe Mobile app to notify emergency responders.
- Armed/Dangerous Person: In the event of an armed or dangerous person on campus, you will need to assess your best option based on the circumstances. Unfortunately, there may not be a clear right answer. However, one of the following actions should be taken, listed in priority of consideration:
  - **Run**: Find the best escape route, leave your belongings behind, and keep your hands visible.
  - **Hide:** Hide in an area out of the individual's view, block entry to your hiding place and lock the doors, if possible.
  - **Fight:** As a last resort and only when your life is in imminent danger, attempt to incapacitate the individual. Be physical and aggressive. Use anything available around you to attack and throw things if possible.

Take time to identify the different exits in the classroom, lab, and both buildings. There are many ways in and out of the building. The next time you come to class, try different routes so that you are aware. For more information on emergency preparation visit emergency.duke.edu.

Topic List

Please refer to the course wiki for detailed bibliography and downloadable PDFs of the readings
Click here for zoom link for class office hours. In person office hours are also possible, just let Prof Schmid know 24 hrs in advance.

- **January 15. Definition of life**
  - Sagan chapter from the Nature of Life; Koshland, 2002.
- **January 22. Signs of life: From the early Earth to first biosignatures**
  - *Primary:* Oparin 1924.
  - *Review:* Watch PBS NOVA: "Origins: Earth is Born", Young Sun, Early Earth and the Origins of Life book, Chapters 2 and 3.
  - *Supplementary:* Dodd et al. 2017
  - Discussion leader choices due on FRIDAY 1/29
- **January 29. Prebiotic chemistry: Experimental synthesis**
  - *Primary:* Miller 1953
  - *Review:* Lane Vital Question pg 89-102, Harold In search of cell history pg 164-175.
- **February 5.** *No class. Prof. Schmid away in the field.*
- **Febraury 12. RNA world and protocells**
  - *Primary:* Attwater et al., 2018; Mansy et al., 2008.
  - *Review:* Gilbert, 1986; Joyce et al., 2002; Jack Szostak iBiology lecture.
  - Short workshop on peer review.
- **February 19. Metabolism first hypothesis**
  - *Primary:* Kelley et al., 2001.
  - *Review:* Lane and Martin, 2012; Lane online lecture.
  - Zoom: Nick Lane (3:40pm)
- **February 26. LUCA**
  - *Primary:* Weiss et al., 2016a; Zaremba-Niedzwiedzka et al., 2017
  - *Review:* Martin et al., 2016, Gogarten and Deamer, 2016; Weiss et al., 2016b.
  - Student-led discussions begin
  - Discussion leaders: Arnav Barve and Vibhav Nandagiri
  - Paper drafts due
- **March 5. Photosynthesis and Atmospheric oxygenation**
  - *Primary:* Zerkle et al., 2017.
  - *Review:* Lane Oxygen, ch. 2-3.
  - Discussion leaders: Frank Lin and David Zhu
  - Peer review paper draft edits due back to your randomly assigned, anonymous partner.
- ***March 12. Spring Break. No class.***
- **March 19. Discovery of the *Archaea***
  - *Primary:* Woese and Fox, 1977; Woese et al., 1990.
  - *Review:* Woese, 1987.
  - Discussion leaders: Sydney Nowak and Rachel Tan
- **March 26. Rooting the tree of life**
  - *Primary:* Raymann et al., 2015
  - *Review:* Eme et al., 2017; Williams et al., 2013.
  - Discussion leaders: Chinelo Agwuegbo and Vidita Shah
- **April 2. Eukaryogenesis**
  - *Primary:* Imachi et al., 2020; Rodrigues-Oliveria et al., 2022
  - *Review:* Gray, 2017; Lopez-Garcia 2015
  - Discussion leaders: Anna Hill Meares and Asia Marks
- **April 9. The problem of the "lipid divide"**
  - *Primary:* Villnueva et al., 2021; Caforio et al., 2018.
  - *Review:* Lombard et al., 2012
  - Zoom with Prof Villanueva
  - Discussion leaders: Porter Petruzziello and Melat Woldetensae

- **April 16. Extremophiles**
  - *Primary:* Belilla et al., 2019.
  - *Review:* Rothschild and Mancinelli, 2001.
  - Discussion leaders: Grace Hall and Prof Schmid
  - Last student-led discussion of the semester.
- **April 23. Astrobiology**
  - *Primary:* Vreeland et al., 2000; Goordial et al., 2016.
  - *Review:* Webb and DiRuggiero chapter, Polyextremophiles (eBook);
  - Final papers due
  - Discussion leaders: Hishi Ulak and Sydney Tomlak
  - Zoom: Dr. Bonnie Baxter