

# Chemistry of the Origins of Life

## Chem 7580

Spring A 2024

Tues/Thurs, 9:10-10:30; TBBC 4630

**Instructor:** Prof. Cynthia Burrows and Justin Dingman (TA)

**Email:** [burrows@chem.utah.edu](mailto:burrows@chem.utah.edu); [Justin.dingman@utah.edu](mailto:Justin.dingman@utah.edu)

**Phone Number:** 585-7290

**Office Hours:** 1:00-2:00 in TBBC 1625 and on Zoom

**Office Location:** Tues & Wed

**Zoom Office Hours Link:** tba

### Required Materials

All materials will be referenced on Canvas

### Prerequisites

One semester of undergraduate biochemistry and two semesters of undergrad organic chemistry.

### Course Description

This course will explore current theories and experiments pertaining to how life may have originally evolved on Earth or elsewhere from non-living clusters of molecules. The format will include lectures and discussions, twice weekly, in an integrated format. Presentations will be given by the course instructor, guest lecturers, and students registered in the course. Reading will be assigned from the current and recent literature.

### Course Outcomes

Students will understand what scientists currently propose as possible origins of life, including:

- Environmental factors supporting the chemistry of life processes
- Experiments in catalytic chemistry pertaining to H<sub>2</sub>, CO<sub>2</sub>, H<sub>2</sub>S and NH<sub>3</sub> supporting the synthesis of organic molecules
- Possible explanations for homochirality (e.g. D-sugars and L-amino acids)
- Synthesis and functions of RNA that support roles in an "RNA World"
- Evolution of the ribosome
- The potential role of molecular aggregates, phase separation and dynamic combinatorial networks in generating cell-like systems

### Teaching and Learning Methods

The course will consist of a series of lectures and discussions on topics relevant to prebiotic chemistry. There will be several guest lectures by experts. Students will be expected to participate in discussions. Toward the end of the course, students will make oral presentations to the rest of the class based on recent literature.

Attendance & Punctuality: This is an in-person course; attendance is required unless it is a University-designated snow date, in which case we will make emergency plans—check Canvas.

### Assignments

- There will be 5 short assignments that consist of reading the assigned literature and asking a question to be addressed by the speaker on the following day. Each question is worth 10 points and will be submitted on Canvas by 10 pm of the Wednesday due date (1/10, 1/17, 1/24, 1/31, 2/7).
- One oral presentation will be given by each student on dates Feb. 13, 15, 20 and 22 (2-3 per day). Presentations will be on an assigned topic and based on recent literature. Time ~25 minutes. More information will be forthcoming along with detailed topics. This is worth 50 points.
- A final event will take place on Feb. 27<sup>th</sup>. Format will be short essay questions. 100 points.

### Grading Policy (Evaluation Methods & Criteria)

Based on 200 points possible; most students should be able to earn As or Bs.

### Course Schedule

<u>Date</u>	<u>Topic/Discussion</u>	<u>Presenter(s)</u>
<b>Week 1:</b>		
Tues Jan 9	Course Introduction and Prebiotic Life Terms & Definitions	Burrows & Dingman
Thurs Jan 11	An Astronomy Perspective	Austin King (Phys. & Astro. U of U)
<b>Week 2:</b>		
Tues, Jan 16	Compartmentalization of Molecular Assemblies	Burrows
Thurs Jan 18	Prebiotic Catalysis in Thermal Vents	Prof. Bill Martin (U. Düsseldorf)
<b>Week 3:</b>		
Tues Jan 23	Prebiotic Metabolism	Burrows
Thurs Jan 25	Why this Genetic Code?	Burrows
<b>Week 4:</b>		
Tues Jan 30	Intro to the RNA World	Burrows
	<b>Special Seminar at 10:45, “Copying RNA without Enzymes”</b>	Prof. Jack Szostak (Univ. of Chicago)

Thurs Feb 1	RNA Aminoacylation & further disc. with...	Prof. Jack Szostak
<b>Week 5:</b>		
Tues Feb 6	Vitamins & Minerals in the Prebiotic World	Burrows
Thurs Feb 8	Prebiotic Synthesis of RNA and Peptides	Prof. Thomas Carell (LMU-Munich)
<b>Week 6:</b>		
Tues Feb 13	Homochirality on Earth	Students
Thurs Feb 15	On the Importance of Phosphorylation	Students
<b>Week 7:</b>		
Tues Feb 20	Systems Chemistry & Molecular Networks	Students
Thurs Feb 22	Lessons in Alternative Life from Extremophiles	Students
<b>Week 8:</b>		
Tues Feb 27	The Final Event (tba)	

*Note: This syllabus is meant to serve as an outline and guide for our course. Please note that I may modify it with reasonable notice to you. I may also modify the Course Schedule to accommodate the needs of our class. Any changes will be announced in class and posted on Canvas under Announcements.*

## University Policies

[The following statements are **required** on every course syllabus.]

1. **The Americans with Disabilities Act.** The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the Center for Disability & Access, 162 Olpin Union Building, (801) 581-5020. CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in an alternative format with prior notification to the Center for Disability & Access.

**Attendance Statement.** *Given the nature of this course, attendance is required and adjustments cannot be granted to allow non-attendance. However, if you need to seek an ADA accommodation to request an exception to this attendance policy due to a disability, please contact the Center for Disability and Access (CDA). CDA will work with us to determine what, if any, ADA accommodations are reasonable and appropriate*

**Basic Needs Student Support Statement.** Success at The University of Utah includes learning about and using available resources. The [Basic Needs Collective](#) (BNC) is a coordinated resource referral hub. They educate about and connect students to campus and community resources to help them meet their basic needs. As a central location for resource referrals

related to food, housing, health insurance, managing finances, legal services, mental health, etc., any student experiencing difficulty with basic needs is encouraged to contact them. Drop into their office located in the Union basement or schedule with them online for an in-person or virtual visit through their webpage: <https://basicneeds.utah.edu/>.

In compliance with ADA requirements, some students may need to record course content. Any recordings of course content are for personal use only, should not be shared, and should not be made publicly available. In addition, recordings should be destroyed at the conclusion of the course

2. **University Safety Statement.** The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit <https://safeu.utah.edu>
3. **Addressing Sexual Misconduct.** Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression) is a civil rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 383 South University Street, 801-581-8365, or the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585-2677(COPS).
  - a. **Lauren's Promise:** Lauren's Promise is a vow that anyone – faculty, staff, students, parents, and community members – can take to indicate to others that they represent a safe haven for sharing incidents of sexual assault, domestic violence, or stalking. Anyone who makes Lauren's Promise vows to: 1.) listen to and believe those individuals who are being threatened or experiencing sexual assault, dating violence or stalking; 2.) represent a safe haven for sharing incidents of sexual assault, domestic violence, or stalking; and 3.) change campus culture that responds poorly to dating violence and stalking. By making Lauren's Promise, individuals are helping to change campus cultures that respond poorly to dating violence and stalking throughout the nation.
4. **Academic Misconduct Statement.** It is expected that students adhere to University of Utah policies regarding academic honesty, including but not limited to refraining from cheating, plagiarizing, misrepresenting one's work, and/or inappropriately collaborating. This includes the use of generative artificial intelligence (AI) tools without citation, documentation, or authorization. Students are expected to adhere to the prescribed professional and ethical standards of the profession/discipline for which they are preparing. Any student who engages in academic dishonesty or who

violates the professional and ethical standards for their profession/discipline may be subject to academic sanctions as per the University of Utah's Student Code:  
<https://regulations.utah.edu/academics/6-410.php>

5. *[recommended]* **Diversity Statement**. I stand in support of compassion, dignity, value-of-life, equity, inclusion and justice for all individuals regardless of color, race/ethnicity, sexual orientation, religion, language, socioeconomic status, ability, gender, gender identity or expression, immigration status, or any type of marginalization. I stand in support of making our society more inclusive, just, and equitable for all individuals. I stand against individual and systemic racism in all its various forms.
6. *[recommended]* **Undocumented Student Support Statement**. Immigration is a complex phenomenon with broad impact—those who are directly affected by it, as well as those who are indirectly affected by their relationships with family members, friends, and loved ones. If your immigration status presents obstacles to engaging in specific activities or fulfilling specific course criteria, confidential arrangements may be requested from the Dream Center. Arrangements with the Dream Center will not jeopardize your student status, your financial aid, or any other part of your residence. The Dream Center offers a wide range of resources to support undocumented students (with and without DACA) as well as students from mixed-status families. To learn more, please contact the Dream Center at 801.213.3697 or visit [dream.utah.edu](http://dream.utah.edu).
7. *[recommended]* **Drop/Withdrawal Policies**. Students may drop a course within the first two weeks of a given semester without any penalties. Students may officially withdraw (W) from a class or all classes after the drop deadline through the midpoint of a course. A "W" grade is recorded on the transcript and appropriate tuition/fees are assessed. The grade "W" is not used in calculating the student's GPA. For deadlines to withdraw from full-term, first, and second session classes, see the U's Academic Calendar.
8. *[recommended]* Other important information to consider including:
  - a. Student Code: <http://regulations.utah.edu/academics/6-400.php>
  - b. Accommodation Policy (see Section Q):  
<http://regulations.utah.edu/academics/6-100.php>
9. *[recommended]* **Student Mental Health Resources**
  - *If you need help dealing with burnout, anxiety, depression, isolation, and loneliness, or other mental health issues please, reach out. Here are some [campus mental health resources](#), including free counseling, trainings and other support.*
  - *Consider participating in a [Mental Health First Aid](#) or other [wellness-themed](#) training provided by our Center for Student Wellness and sharing these opportunities with your peers, teaching assistants and department colleagues*

- 10. [recommended] Diverse Supports for Students.** Your success at the University of Utah is important to all of us here! If you feel like you need extra support in academics, overcoming personal difficulties, or finding community, the U is here for you.

### *Student Support Services (TRIO)*

TRIO federal programs are targeted to serve and assist low-income individuals, first-generation college students, and individuals with disabilities.

Student Support Services (SSS) is a TRIO program for current or incoming undergraduate university students who are seeking their bachelor's degree and need academic assistance and other services to be successful at the University of Utah.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

#### **Student Support Services (TRIO)**

801-581-7188

[trio.utah.edu](http://trio.utah.edu)

Room 2075

1901 E. S. Campus Dr.

Salt Lake City, UT 84112

### *American Indian Students*

The AIRC works to increase American Indian student visibility and success on campus by advocating for and providing student centered programs and tools to enhance academic success, cultural events to promote personal well-being, and a supportive “home-away-from-home” space for students to grow and develop leadership skills.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

#### **American Indian Resource Center**

801-581-7019

[diversity.utah.edu/centers/airc](http://diversity.utah.edu/centers/airc)

Fort Douglas Building 622

1925 De Trobriand St.

Salt Lake City, UT 84113

### *Black Students*

Using a pan-African lens, the Black Cultural Center seeks to counteract persistent campus-wide and global anti-blackness. The Black Cultural Center works to holistically enrich, educate, and advocate for students, faculty, and staff through Black centered programming, culturally affirming educational initiatives, and retention strategies.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

**Black Cultural Center**

801-213-1441

[diversity.utah.edu/centers/bcc](https://diversity.utah.edu/centers/bcc)

Fort Douglas Building 603  
95 Fort Douglas Blvd.  
Salt Lake City, UT 84113

*Students with Children*

Our mission is to support and coordinate information, program development and services that enhance family resources as well as the availability, affordability and quality of child care for University students, faculty and staff.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

**Center for Childcare & Family Resources**

801-585-5897

[childcare.utah.edu](https://childcare.utah.edu)

408 Union Building  
200 S. Central Campus Dr.  
Salt Lake City, UT 84112

*Students with Disabilities*

The Center for Disability & Access is dedicated to serving students with disabilities by providing the opportunity for success and equal access at the University of Utah. They also strive to create an inclusive, safe, and respectful environment.

For more information about what support they provide and links to other resources, view their website or contact:

**Center for Disability & Access**

801-581-5020

[disability.utah.edu](https://disability.utah.edu)

162 Union Building  
200 S. Central Campus Dr.  
Salt Lake City, UT 84112

*Students across Intersectional Identities and Experiences*

The Center for Equity & Student Belonging (CESB) creates community and advocates for academic success and belonging for students across inter-sectional identities and

experiences among our African, African American, Black, Native, Indigenous, American Indian, Asian, Asian American, Latinx, Chicanx, Pacific Islander, Multiracial, LGBTQ+, Neurodiverse and Disabled students of color.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

**Center for Equity and Student Belonging (CESB)**

801-581-8151

[diversity.utah.edu/centers/CESB/](https://diversity.utah.edu/centers/CESB/)

235 Union Building

200 S. Central Campus Dr.

Salt Lake City, UT 84112

*English as a Second/Additional Language (ESL) Students*

If you are an English language learner, there are several resources on campus available to help you develop your English writing and language skills. Feel free to contact:

**Writing Center**

801-587-9122

[writingcenter.utah.edu](https://writingcenter.utah.edu)

2701 Marriott Library

295 S 1500 E

Salt Lake City, UT 84112

**English Language Institute**

801-581-4600

[continue.utah.edu/eli](https://continue.utah.edu/eli)

540 Arapeen Dr.

Salt Lake City, UT 84108

*Undocumented Students*

Immigration is a complex phenomenon with broad impact—those who are directly affected by it, as well as those who are indirectly affected by their relationships with family members, friends, and loved ones. If your immigration status presents obstacles that prevent you from engaging in specific activities or fulfilling specific course criteria, confidential arrangements may be requested from the Dream Center.

**Arrangements with the Dream Center will not jeopardize your student status, your financial aid, or any other part of your residence.** The Dream Center offers a wide range of resources to support undocumented students (with and without DACA) as well as students from mixed-status families.



For more information about what support they provide and links to other resources, view their website or contact:

**Dream Center**

801-581-3470

[dream.utah.edu](http://dream.utah.edu)

1120 Annex (Wing B)  
1901 E. S. Campus Dr.  
Salt Lake City, UT 84112

*LGBTQ+ Students*

The LGBTQ+ Resource Center acts in accountability with the campus community by identifying the needs of people with a queer range of [a]gender and [a]sexual experiences and responding with university-wide services.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

**LGBTQ+ Resource Center**

801-587-7973

[lgbt.utah.edu](http://lgbt.utah.edu) (Links to an external site.)

409 Union Building  
200 S. Central Campus Dr.  
Salt Lake City, UT 84112

*Veterans & Military Students*

The mission of the Veterans Support Center is to improve and enhance the individual and academic success of veterans, service members, and their family members who attend the university; to help them receive the benefits they earned; and to serve as a liaison between the student veteran community and the university.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

**Veterans Support Center**

801-587-7722

[veteranscenter.utah.edu](http://veteranscenter.utah.edu) (Links to an external site.)

418 Union Building  
200 S. Central Campus Dr.  
Salt Lake City, UT 84112

## *Women*

The Women's Resource Center (WRC) at the University of Utah serves as the central resource for educational and support services for women. Honoring the complexities of women's identities, the WRC facilitates choices and changes through programs, counseling, and training grounded in a commitment to advance social justice and equality.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

### **Women's Resource Center**

801-581-8030

[womenscenter.utah.edu](http://womenscenter.utah.edu)

411 Union Building

200 S. Central Campus Dr.

Salt Lake City, UT 84112

## *Food Pantry*

The University of Utah food pantry provides non-perishable, nourishing food for our students, their families, faculty, and staff.

For more information about what support they provide and links to other resources, view their website:

### **Feed U Pantry**

[feedufoodpantry@gmail.com](mailto:feedufoodpantry@gmail.com)

[union.utah.edu/resources-spaces/feed-u-pantry/hours-about-us/](http://union.utah.edu/resources-spaces/feed-u-pantry/hours-about-us/)

Union Building (Pantry is located on the basement level)

200 S. Central Campus Dr.

Salt Lake City, UT 84112

## *Tutoring*

The Learning Center offers free services to currently-enrolled University of Utah students.

For more information about what support they provide and links to other resources, view their website.

### **Learning Center**

801-581-5153

[learningcenter.utah.edu](http://learningcenter.utah.edu)

1705 J. Willard Marriott Library

295 S. 1500 E  
Salt Lake City, UT 84112

*Other Student Groups at the U*

To learn more about some of the other resource groups available at the U, check out:

[getinvolved.utah.edu/](http://getinvolved.utah.edu/)

[studentsuccess.utah.edu/resources/student-support](http://studentsuccess.utah.edu/resources/student-support)