



**PSCI 599: Special Topics: RNA Biology and Therapeutics**

**2 units**

**Fall 2021—Wed—10:00 AM-12:00 PM**

**Location: PSC 200**

**Course Coordinator(s):**

Zhipeng Lu: zhipengl@usc.edu

Office: PSC 300 Phone: (323) 442-0093

**Office Hours:**

By email appointment

**IT Help:**

**Blackboard is the Learning Management System (LMS) used at the USC School of Pharmacy. For 24/7 help with Blackboard:**

- Call (213) 740-5555 and choose Option 2.
- Send an e-mail to [blackboard@usc.edu](mailto:blackboard@usc.edu).
- Visit USC's Blackboard Online Help site for how-to videos and guides.
- Access additional Blackboard training videos on Lynda at <http://www.usc.edu/lynda>.
- **Zoom and Panopto may be used for lecture capture and delivery, Zoom and Poll Everywhere may be used as an audience response system, and Blackboard and ExamSoft may be used to administer quizzes and examinations.**
- For help with Zoom, visit <https://itservices.usc.edu/zoom/>.
- For help with Panopto, call the 24/7 Panopto support team at (855) 765-2341 or e-mail [support@panopto.com](mailto:support@panopto.com)
- For help with ExamSoft, call the 24/7 ExamSoft support team at (866) 429-8889, e-mail [support@examsoft.com](mailto:support@examsoft.com), or visit <https://learn.examsoft.com/about/examsoft-support>.
- You may also visit our Learning Environments Technical Support Specialists in PSC 102, M-F from 8:00 AM-4:00 PM, call (323) 442-0002, or e-mail [pharmit@usc.edu](mailto:pharmit@usc.edu).
- **For all other technology-related questions, call USC Information Technology Services at (213) 740-5555.**

## Course Description

The goal of graduate training in science is to enable students to perform rigorous and innovative research. To achieve this goal, reading, understanding and summarizing the scientific literature is a critical first step, which is followed by coming up with new ideas, formulating feasible plans, and managing the entire process. This course is designed to train students in two areas: understanding “what has been done” and proposing “what to do next”, using the field of RNA biology and therapeutics as a vehicle. Each lecture will provide an overview of a specific topic by the instructor, and is followed by student presentations of original research articles on this topic. The course will start with lectures on how to effectively communicate science in oral presentations, and how to write appealing proposals on a research problem. In later weeks, these theories will be put into practice in student presentations and proposal writing. Comments and feedbacks on these practices will be provided by both the instructor and fellow students.

On the lecture side, this 2-unit course will highlight the principles and applications of RNA chemistry, structure, methods, functions, disease relevance, and eventual drug discovery. RNA-based therapeutics has emerged as a new approach to treating human diseases in the last few years, thanks to the advances in technology and biology. In particular, this course will cover the basic chemical and physical properties of RNA, and methods for analyzing their sequences and structures, including both traditional tools and more modern high throughput sequencing based approaches. Following this introduction will be a broad survey of the diversity of RNA types in cells and their various functions in gene regulation, whose normal and abnormal activities underlie a variety of genetic and infectious diseases. The rest of the course will explore various types of RNA-based therapeutics, such as siRNAs, miRNAs, CRISPR, ribozymes, mRNA vaccines, etc.

Upon successful completion of this course, students should develop a solid and in-depth understanding of the fundamentals of RNA chemistry, biology, technology, and applications in therapeutics. More importantly, the hands-on training in oral presentations and proposal writing should prepare the students to achieve excellence in their own areas of PhD research, and lay a strong foundation for a professional careers towards both academia and pharmaceutical/biotechnology industry.

## Learning Objectives

- To understand the chemical and structural basis of RNA and methods used to study RNA.
- To describe the diversity and dynamics of RNA types, biogenesis, modifications, functions and disease relevance.
- To explain the fundamentals of RNA biotechnology and their applications in drug development
- To effectively communicate research in oral presentations and discussions
- To write clear, feasible and convincing research proposals

## Course Notes

The course is Web-Enhanced (i.e. Blackboard); Copies of lecture slides and other class information will be posted on Blackboard.

## Required Readings and Supplementary Materials

- Materials for reading and watching are listed as follows and divided into sections based on their relevance to each part of the course. The following text and videos are required:  
Roy Parker on Improving Graduate Training. <https://www.youtube.com/watch?v=V66qF4JMKsc>  
History of RNA biology. [https://en.wikipedia.org/wiki/History\\_of\\_RNA\\_biology](https://en.wikipedia.org/wiki/History_of_RNA_biology)  
The RNA world hypothesis. [https://en.wikipedia.org/wiki/RNA\\_world](https://en.wikipedia.org/wiki/RNA_world)  
What Is the RNA World Hypothesis? <https://www.youtube.com/watch?v=K1xnYFCZ9Yg>  
Writing research proposal: <https://grantwriting.stanford.edu/organizing-the-research-plan/>

Recommended reading and watching materials are listed as follows. Most of these talks below were presented by current HHMI investigators, providing high level overview of a particular field in RNA biology. You can

change the play speed to suit your needs. These are also great examples of effective presentations for scientific communications.

Jack Szostak, Nobel Laureate, on the RNA world hypothesis.

Part 1: The Origin of Cellular Life on Earth. <https://www.youtube.com/watch?v=PqPGOhXoprU&t=173s>

Part 2: Protocell Membranes. <https://www.youtube.com/watch?v=CJ5jh33OiOA>

Part 3: Non-enzymatic Copying of Nucleic Acid. <https://www.youtube.com/watch?v=jfq5-i8xoIU>

Thomas Cech, 1989 Nobel Laureate, on discovery of ribozymes.

Enzymes That Are Not Proteins: The Discovery of Ribozymes. <https://www.youtube.com/watch?v=HwEgcH1zsXw>

Joan Steitz, discoverer of snRNAs, talking about various RNAs.

Noncoding RNA: Large, Small and Viral. <https://www.youtube.com/watch?v=TfwMjxKMGLY&t=1397s>

David Bartel on miRNAs

Part 1: MicroRNAs: Introduction to MicroRNAs. <https://www.youtube.com/watch?v=dupzE66J8u4&t=764s>

Part 2: MicroRNAs: Regulation by Mammalian microRNAs. [https://www.youtube.com/watch?v=TcZK\\_A\\_wcWQ](https://www.youtube.com/watch?v=TcZK_A_wcWQ)

Part 3: MicroRNAs: What is a MicroRNA? <https://www.youtube.com/watch?v=ACwOtzTIFQQ>

Roy Parker on the mRNA life cycle

Part 1: mRNA Localization, Translation and Degradation. [https://www.youtube.com/watch?v=s\\_EF2Ipuva8](https://www.youtube.com/watch?v=s_EF2Ipuva8)

Part 2: P-bodies and the mRNA Cycle. <https://www.youtube.com/watch?v=THx5SgSpk6w>

Howard Chang on lncRNAs and epigenomics

Genome regulation by long noncoding RNAs. <https://www.youtube.com/watch?v=xAYXE-jplKk&t=210s>

Part 1: Epigenomic Technologies. <https://www.youtube.com/watch?v=wDjLQk3hvFk>

Part 2: lncRNA Function at the RNA Level: Xist. <https://www.youtube.com/watch?v=uNCbXXXVOCA>

Part 3: lncRNA Function at the DNA Level: PVT1. <https://www.youtube.com/watch?v=lhzeL7gR8Sg>

Anna Marie Pyle on RNA structures.

Part 1: RNA Structure. <https://www.youtube.com/watch?v=WCrIm18KQ48>

Part 2: Inside an RNA Splicing Machine. <https://www.youtube.com/watch?v=ESXo3fTThBI>

Part 3: RNA Helicases and RNA-triggered Signaling Proteins. <https://www.youtube.com/watch?v=LjCDqL8n5FO>

Cliff Brangwynne on the physics of cells, in particular states of RNA

Part 1: Liquid Phase Separation in Living Cells. <https://www.youtube.com/watch?v=AP47mlkd-h0>

Part 2: Multiphase Liquid Behavior of the Nucleus. [https://www.youtube.com/watch?v=HzG5\\_Q1whil](https://www.youtube.com/watch?v=HzG5_Q1whil)

Part 3: Using Light to Study and Control Intracellular Phase Behavior. <https://www.youtube.com/watch?v=6k8m-7y7zkY>

Derek McLachlin. Nucleic Acid Structure 5 – RNA structure. [https://www.youtube.com/watch?v=FRZSB6jR\\_Zw](https://www.youtube.com/watch?v=FRZSB6jR_Zw)

RNA autoimmunity. <https://www.youtube.com/watch?v=aPkwZ4vElyI>

Stephane Bancel. What if mRNA could be a drug? <https://www.youtube.com/watch?v=T4-DMKNT7xl>

This is a list of textbooks that serve as great references when needed.

Molecular Biology of the Cell. 4th edition. <https://www.ncbi.nlm.nih.gov/books/NBK21054/>, Chapters 6-8

Modern Genetic Analysis, Chapter 3, <https://www.ncbi.nlm.nih.gov/books/NBK21310/>

Biochemistry: RNA structure, <https://www.ncbi.nlm.nih.gov/books/NBK558999/>

RNA Worlds: New Tools for Deep Exploration, [https://cshperspectives.cshlp.org/site/misc/rna\\_worlds2.xhtml](https://cshperspectives.cshlp.org/site/misc/rna_worlds2.xhtml)

Handbook of RNA Biochemistry, a practical reference.

<https://onlinelibrary.wiley.com/doi/book/10.1002/9783527647064>

Additional research articles will be assigned prior to certain lectures

Intro to Unix Workshop, a great resource to get you started with sequencing analysis, an essential tool in RNA biology. <http://www.sergheimangul.com/video/>

## Description and Assessment of Assignments

Students will be graded on 2 aspects: oral presentation on a classic or recent research paper (40%) and a research proposal on a topic of the student's choice related to this course (60%). Following the first three weeks of lectures, the class will include a lecture and a student presentation of a paper related to the content of the lecture. Students who are not presenting are expected to have read the paper and prepared to ask questions and participate in the discussion. Feedback on the oral presentation will be provided during or after the presentation. Time will be budgeted during the course (the 6<sup>th</sup> and the 9<sup>th</sup> week) so that students will form groups to discuss each other's proposals and provide feedback to each other. Around the midterm, assessment of part of the proposal (specific aims and background of the proposal) will be provided to help students improve it. The grading of the entire proposal will be provided at the end of the semester.

Each student will choose a research paper from a pool given by the instructor, or any other with the approval of the instructor. The presentation will be graded based on the following criteria: (1) appearance of the slides, e.g. font size, consistency, how much information, especially complex figures and texts are shown on each slide; (2) logical transitions among the slides; (3) clarity in the oral presentations; (4) background information that help understand the importance of the subject, and the unique contributions of the work, and its broader impact in the field; (5) critical interpretation of the results; (6) answering questions from the audience; (7) time control (25 mins for the entire presentation, including discussion).

An original proposal related to one of the topics covered by the course and approved by the coordinator (Dr. Lu) is due right before the 4<sup>th</sup> lecture (by e-mail to Dr. Lu). Students should identify possible topics of the proposal, discuss them with Dr. Lu and submit an abstract of the proposal (no more than 250 words). The proposal should include 4 sections as follow: Specific Aims (exactly 1 page), Significance, Innovation, and Approach. A maximum of 4 pages may be submitted, single-spaced, 11-point Times font, 0.5 inch margins on all sides of a US letter page, including a 4-6 figures or tables (strictly enforced). Proper citation and referencing is required but not included in the 4 page limit. References should be listed numerically in the order they are cited in the text. All authors should be included in reference lists unless there are more than six (6), in which case only the first three (3) authors should be given, followed by 'et al'. In addition, the following should be included in the reference list: article titles, journal names, publication years, volume numbers, and page numbers. The Endnote software is recommended and is free of charge to USC students (<https://libguides.usc.edu/c.php?g=293765&p=1956126>).

The proposal will be graded based on the following criteria: (1) clarity of the language, figures and overall organization of each pages (e.g. avoiding large sections of text, too small or too big fonts); (2) logical presentation of the background information, rationale, significance and broad impact; (3) innovation of the proposed idea.

## Methods

### Teaching Methods

#### Before Event

- Online lecture
- Assigned reading/writing (texts)
- Assigned reading (journal or papers)
- Online activity

#### During Event

- Classroom lecture
- Group activity
- Student presentation

- Panel discussion

**After Event**

- Recorded lecture
- Reflection

**Assessment Methods**

**Examination**

- Oral
- Short answer
- Essay

**In Class**

- Oral presentation
- Attendance

**Longer term**

- Reflective writing
- Term paper
- Observation

**Grading Breakdown**

Assignment	Percent
Oral presentation	40
Written proposal	60

**Grading Scale**

A	95-100
A-	90-94
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	59 and below

**Additional Policies**

**Policy Regarding Class Recordings**

All class recordings (Zoom, Panopto, etc.) are accessible only to students currently enrolled in the class, instructors, and TAs. These recordings may not be shared or used for purposes outside of this course. Students are also not permitted to record or distribute any course materials or activities on their own without the instructor’s permission. Please refer to the University guidance towards the appropriate use and handling of these recordings under existing SCampus policies in Part C on class notes ([policy.usc.edu/scampus/](http://policy.usc.edu/scampus/)).

**Policy Regarding Assignments and Examinations**

The following actions are all violations of academic integrity and subject to disciplinary action.

- a. Any use or attempted use of external assistance in the completion of an academic assignment and/or during an examination, or any behavior that defeats the intent of an examination or other classwork or assignment, unless expressly permitted by the instructor.
- b. The following are examples of unacceptable behaviors: communicating with fellow students during an exam, copying or attempting to copy material from another student's exam; allowing another student to copy from an exam or assignment; possession or use of unauthorized notes, calculator, or other materials during exams and/or unauthorized removal of exam materials.
- c. Additional examples of academic misconduct can be found in SCampus in Part B, Section 11, "Behavior Violating University Standards" [policy.usc.edu/scampus/](http://policy.usc.edu/scampus/).

### **Policy Regarding Missed Examinations**

The policy for this course will follow the policy contained within the Academic Policies and Procedures section of the PharmD/Graduate Student Handbook located on the [USC School of Pharmacy Intranet](#). Students who miss an examination are referred to this policy.

### **Technological Requirements and Software Updates**

Students may be required to bring an internet-enabled device with browser capabilities, such as a cell phone, tablet, or laptop to class. During class time, it is expected that students will use their devices only to participate in activities guided by the instructor. Use of devices for other purposes is not permitted during class time.

The USC School of Pharmacy recommends that students purchase a computer that meets, at minimum, the "medium" level hardware requirements that are also recommended for faculty and staff:

<https://itservices.usc.edu/recommendations/>.

Students who use Zoom should be running the latest version of Zoom available at <https://zoom.us/download>.

Students who use ExamSoft will also be required to have the latest version of Examplify installed on their laptops at all times compatible with their operating system. Occasional updates to the software may be asked of you throughout the year. It is your responsibility to read your USC e-mails regarding Examplify and follow the instructions as listed.

### **Policy on Learning & Assessment Feedback (LAF)**

Feedback on examinations will be provided using the following methods. Please indicate which method(s) you will use in the course.

- In-office review (with specific conditions to be defined for each assessment)

### **Learning Experience Evaluation Notes:**

A 15 min time will be allocated for evaluation of the learning experience in the final lecture.

### **University Policy on Absences**

University policy grants students excused absences from class for observance of religious holy days. Faculty are asked to be responsive to requests when students contact them IN ADVANCE to request such an excused absence. The student should be given an opportunity to make up missed work because of religious observance. Students are advised to scan their syllabi at the beginning of each course to detect potential conflicts with their religious observances. Please note that this applies only to the sort of holy day that necessitates absence from class and/or whose religious requirements clearly conflict with aspects of academic performance.

### **School of Pharmacy Policy for Written Assignments Regarding Citation Style**

All written assignments in the course should use the uniform style of the School of Pharmacy for formatting in-text citations and reference lists. This style corresponds to the AMA (American Medical Association) format and can be found through this following guide <https://libguides.usc.edu/ama11> and handout

[https://libguides.usc.edu/ld.php?content\\_id=54130825](https://libguides.usc.edu/ld.php?content_id=54130825). The complete AMA Manual of Style is also available as an e-book at [tinyurl.com/y9oqj4ht](https://tinyurl.com/y9oqj4ht).

## Statement on Academic Conduct and Support Systems

### Academic Conduct

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, “Behavior Violating University Standards” [policy.usc.edu/scampus/](http://policy.usc.edu/scampus/). Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, [policy.usc.edu/scientific-misconduct](http://policy.usc.edu/scientific-misconduct).

### Support Systems

*Counseling and Mental Health - (213) 740-9355 – 24/7 on call*

[studenthealth.usc.edu/counseling](http://studenthealth.usc.edu/counseling)

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

*National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call*

[suicidepreventionlifeline.org](http://suicidepreventionlifeline.org)

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

*Relationship and Sexual Violence Prevention and Services (RSVP) - (213) 740-9355(WELL), press “0” after hours – 24/7 on call*

[studenthealth.usc.edu/sexual-assault](http://studenthealth.usc.edu/sexual-assault)

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

*Office of Equity and Diversity (OED)- (213) 740-5086 | Title IX – (213) 821-8298*

[equity.usc.edu](http://equity.usc.edu), [titleix.usc.edu](http://titleix.usc.edu)

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following protected characteristics: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations. The university also prohibits sexual assault, non-consensual sexual contact, sexual misconduct, intimate partner violence, stalking, malicious dissuasion, retaliation, and violation of interim measures.

*Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298*

[usc-advocate.symplicity.com/care\\_report](http://usc-advocate.symplicity.com/care_report)

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity | Title IX for appropriate investigation, supportive measures, and response.

*The Office of Student Accessibility Services (OSAS) - (213) 740-0776*

[dsp.usc.edu](http://dsp.usc.edu)

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

*Campus Support & Intervention - (213) 821-4710*

[campussupport.usc.edu](http://campussupport.usc.edu)

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.



Diversity at USC - (213) 740-2101

[diversity.usc.edu](http://diversity.usc.edu)

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

[dps.usc.edu](http://dps.usc.edu), [emergency.usc.edu](http://emergency.usc.edu)

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call

[dps.usc.edu](http://dps.usc.edu)

Non-emergency assistance or information.

### About Your Instructor(s)

Zhipeng Lu, PhD, Assistant Professor of Pharmacology and Pharmaceutical Sciences. Dr. Lu is an expert in RNA biology and his current research focuses on developing novel chemical and computational tools for understanding RNA structures, interactions and functions in human diseases. See more detailed profiles at <https://pharmacyschool.usc.edu/directory/?expert=zhipeng.luphd>, and <https://zhipenglulab.org/>.

### Summary of Course Schedule

Date	Lecturer	Event
Wed 08/25/21	Zhipeng Lu	Course orientation and basics of scientific presentation.
Wed 09/01/21	Zhipeng Lu	Writing clear and convincing research proposals.
Wed 09/08/21	Zhipeng Lu	RNA chemistry
Wed 09/15/21	Zhipeng Lu	RNA sequence analysis, experiments and computation
Wed 09/22/21	Zhipeng Lu	RNA structure analysis, computational tools
Wed 09/29/21	Zhipeng Lu	RNA structure analysis, chemical probing and crosslinking
Wed 10/06/21	Zhipeng Lu	RNA modifications and functions.
Wed 10/13/21	Zhipeng Lu	RNA biology, mRNA processing and translation
Wed 10/20/21	Zhipeng Lu	RNA biology, siRNAs, miRNAs, circular RNAs, lncRNAs.
Wed 10/27/21	Zhipeng Lu	RNA biology, ncRNAs in various biological contexts
Wed 11/03/21	Zhipeng Lu	RNA in human genetic diseases
Wed 11/10/21	Zhipeng Lu	RNA in human infectious diseases
Wed 11/17/21	Zhipeng Lu	RNA drugs, siRNAs, miRNAs, ribozymes,
Wed 12/01/21	Zhipeng Lu	RNA drugs, CRISPR, mRNA vaccines

## Expanded Course Schedule

Date	Lecturer	Event
Wed 08/25/21	Zhipeng Lu	<p>Course orientation and basics of scientific presentation.</p> <p>Roy Parker on Improving Graduate Training.  <a href="https://www.youtube.com/watch?v=V66qF4JMKsc">https://www.youtube.com/watch?v=V66qF4JMKsc</a></p>
Wed 09/01/21	Zhipeng Lu	<p>Writing clear and convincing research proposals.</p> <p>Writing research proposal:  <a href="https://grantwriting.stanford.edu/organizing-the-research-plan/">https://grantwriting.stanford.edu/organizing-the-research-plan/</a>            A good way to learn a new skill is to emulate others' successes.            NIAID has graciously made available many previously funded grant applications: <a href="https://www.niaid.nih.gov/grants-contracts/sample-applications">https://www.niaid.nih.gov/grants-contracts/sample-applications</a>. Please take a look and read a few of them very carefully. The research grants (especially R01) and training and career awards (especially K01 and F31) are the most relevant ones. We will primarily cover R01 format in the lectures. Take this one as an example: <a href="https://www.niaid.nih.gov/sites/default/files/1-R01-AI121500-01A1_Gordon_Application.pdf">https://www.niaid.nih.gov/sites/default/files/1-R01-AI121500-01A1_Gordon_Application.pdf</a>. Focus on the science sections, abstract on page 6 and narrative on page 7 (published in NIH Reporter), introduction on page 39 (only for re-submission), specific aims on page 40, and research strategy on page 41-52 (12-pages standard format). The exact page numbers for each section may be different in other grants.</p>
Wed 09/08/21	Zhipeng Lu	<p>RNA chemistry</p> <p>Reading and Watching:            History of RNA biology.  <a href="https://en.wikipedia.org/wiki/History_of_RNA_biology">https://en.wikipedia.org/wiki/History_of_RNA_biology</a>            The RNA world hypothesis.  <a href="https://en.wikipedia.org/wiki/RNA_world">https://en.wikipedia.org/wiki/RNA_world</a>            What Is the RNA World Hypothesis?  <a href="https://www.youtube.com/watch?v=K1xnYFCZ9Yg">https://www.youtube.com/watch?v=K1xnYFCZ9Yg</a></p> <p>Jack Szostak, Nobel Laureate, on the RNA world hypothesis.            Part 1: The Origin of Cellular Life on Earth.  <a href="https://www.youtube.com/watch?v=PqPGOhXoprU&amp;t=173s">https://www.youtube.com/watch?v=PqPGOhXoprU&amp;t=173s</a>            Part 2: Protocell Membranes. <a href="https://www.youtube.com/watch?v=CJ5jh330iOA">https://www.youtube.com/watch?v=CJ5jh330iOA</a>            Part 3: Non-enzymatic Copying of Nucleic Acid.  <a href="https://www.youtube.com/watch?v=jfq5-i8xoIU">https://www.youtube.com/watch?v=jfq5-i8xoIU</a></p> <p>Cliff Brangwynne on the physics of cells, in particular states of RNA            Part 1: Liquid Phase Separation in Living Cells.  <a href="https://www.youtube.com/watch?v=AP47mlkd-h0">https://www.youtube.com/watch?v=AP47mlkd-h0</a>            Part 2: Multiphase Liquid Behavior of the Nucleus.  <a href="https://www.youtube.com/watch?v=HzG5_Q1whil">https://www.youtube.com/watch?v=HzG5_Q1whil</a>            Part 3: Using Light to Study and Control Intracellular Phase Behavior. <a href="https://www.youtube.com/watch?v=6k8m-7y7zkY">https://www.youtube.com/watch?v=6k8m-7y7zkY</a></p>

Date	Lecturer	Event
Wed 09/15/21	Zhipeng Lu	RNA sequence analysis, experiments and computation  Intro to Unix Workshop, a great resource to get you started with sequencing analysis, an essential tool in RNA biology. <a href="http://www.sergheimangul.com/video/">http://www.sergheimangul.com/video/</a>
Wed 09/22/21	Zhipeng Lu	RNA structure analysis, computational tools  student presentations
Wed 09/29/21	Zhipeng Lu	RNA structure analysis, chemical probing and crosslinking  student presentations group discussions of proposal and feedback: specific aims page Watching material: Anna Marie Pyle on RNA structures. Part 1: RNA Structure. <a href="https://www.youtube.com/watch?v=WCrIm18KQ48">https://www.youtube.com/watch?v=WCrIm18KQ48</a> Part 2: Inside an RNA Splicing Machine. <a href="https://www.youtube.com/watch?v=ESXo3fTThBI">https://www.youtube.com/watch?v=ESXo3fTThBI</a> Part 3: RNA Helicases and RNA-triggered Signaling Proteins. <a href="https://www.youtube.com/watch?v=LjCDqL8n5F0">https://www.youtube.com/watch?v=LjCDqL8n5F0</a>
Wed 10/06/21	Zhipeng Lu	RNA modifications and functions.  student presentations
Wed 10/13/21	Zhipeng Lu	RNA biology, mRNA processing and translation  student presentations Watching material: Roy Parker on the mRNA life cycle Part 1: mRNA Localization, Translation and Degradation. <a href="https://www.youtube.com/watch?v=s_EF2lpuva8">https://www.youtube.com/watch?v=s_EF2lpuva8</a> Part 2: P-bodies and the mRNA Cycle. <a href="https://www.youtube.com/watch?v=THx5SgSpk6w">https://www.youtube.com/watch?v=THx5SgSpk6w</a>
Wed 10/20/21	Zhipeng Lu	RNA biology, siRNAs, miRNAs, circular RNAs, lncRNAs.  student presentations Group discussion of proposals: significance + innovation (mid-term feedback) watching material: David Bartel on miRNAs Part 1: MicroRNAs: Introduction to MicroRNAs. <a href="https://www.youtube.com/watch?v=dupzE66J8u4&amp;t=764s">https://www.youtube.com/watch?v=dupzE66J8u4&amp;t=764s</a> Part 2: MicroRNAs: Regulation by Mammalian microRNAs. <a href="https://www.youtube.com/watch?v=TcZK_A_wcWQ">https://www.youtube.com/watch?v=TcZK_A_wcWQ</a> Part 3: MicroRNAs: What is a MicroRNA? <a href="https://www.youtube.com/watch?v=ACwOtzTiFQQ">https://www.youtube.com/watch?v=ACwOtzTiFQQ</a>

Date	Lecturer	Event
Wed 10/27/21	Zhipeng Lu	RNA biology, ncRNAs in various biological contexts  student presentations Watching material: Thomas Cech, 1989 Nobel Laureate, on discovery of ribozymes. Enzymes That Are Not Proteins: The Discovery of Ribozymes. <a href="https://www.youtube.com/watch?v=HwEgcH1zsXw">https://www.youtube.com/watch?v=HwEgcH1zsXw</a>
Wed 11/03/21	Zhipeng Lu	RNA in human genetic diseases  student presentations Howard Chang on lncRNAs and epigenomics Genome regulation by long noncoding RNAs. <a href="https://www.youtube.com/watch?v=xAYXE-iplKk&amp;t=210s">https://www.youtube.com/watch?v=xAYXE-iplKk&amp;t=210s</a> Part 1: Epigenomic Technologies. <a href="https://www.youtube.com/watch?v=wDjLQk3hvFk">https://www.youtube.com/watch?v=wDjLQk3hvFk</a> Part 2: lncRNA Function at the RNA Level: Xist. <a href="https://www.youtube.com/watch?v=uNCbXXXVOCA">https://www.youtube.com/watch?v=uNCbXXXVOCA</a> Part 3: lncRNA Function at the DNA Level: PVT1. <a href="https://www.youtube.com/watch?v=lhzeL7gR8Sg">https://www.youtube.com/watch?v=lhzeL7gR8Sg</a>
Wed 11/10/21	Zhipeng Lu	RNA in human infectious diseases  student presentation Group discussion of research proposal: approach Watching material: Joan Steitz, discoverer of snRNAs, talking about various RNAs. Noncoding RNA: Large, Small and Viral. <a href="https://www.youtube.com/watch?v=TfwMjxKMGLY&amp;t=1397s">https://www.youtube.com/watch?v=TfwMjxKMGLY&amp;t=1397s</a>
Wed 11/17/21	Zhipeng Lu	RNA drugs, siRNAs, miRNAs, ribozymes,  student presentations
Wed 12/01/21	Zhipeng Lu	RNA drugs, CRISPR, mRNA vaccines  student presentations End of semester, group discussion of the entire research proposal Watching material: Stephane Bancel. What if mRNA could be a drug? <a href="https://www.youtube.com/watch?v=T4-DMKNT7xI">https://www.youtube.com/watch?v=T4-DMKNT7xI</a>