# Introduction to Biotechnology: Detecting & Treating Disease (BIO 132S)

**Mon/Wed 10:30 am – 12:30 pm | 4 units | STLC 115**

## TEACHING TEAM

### Instructor

**Jae Chung, PhD** | chungjae@stanford.edu | **Pronouns: he/him**

***How to reach me?*** **Meet by appointment (email to schedule) or after class on Mondays and Wednesdays**

Feel free to email me to find a time to meet. I'm more than happy to have informal conversations or discussions about anything related to the course, or your journey in science! I am here as a resource to support you. Feel free to call me "Jae", "Dr. Chung" or "Dr. Jae" during class and in writing - whatever you feel comfortable with!

### Head Teaching Assistant

**Arvie Violette** | rviolett@stanford.edu | **Pronouns: she/her**

***How to reach me?*** **Office Hours: TBD**

I will be hosting office hours every Thursday at the Y2E2 Coupa Cafe. Come eat lunch with me and let's chat! You can also schedule an appointment with me via email. I am a rising third year PhD student in the Biophysics program, and recent Stanford alum (B.S. Bioengineering '23). This is my third year teaching BIO132S! My previous research experiences are vast, spanning many corners of bioengineering including the microbiome, vaccines, biologics, biomaterials, and embryology. I've also spent some time in the biotechnology industry at places like Twist Bioscience and Lonza Biologics. Currently, I study the biochemistry and biophysics of antibody maturation post-vaccination in the Peter S. Kim lab.

### Teaching Assistants

**Arvind Muruganantham** | arvindm@stanford.edu | **Pronouns: he/him**

***How to reach me?*** **Office Hours: TBD**

Hello! I am a first-year PhD student in stem cell biology & regenerative medicine working on machine learning for protein design in the Peter S. Kim lab. Before Stanford, I worked on stem cell-derived embryo models, kidney disease models, cancer biomarkers, and cancer epigenetics. I went to Baylor University for my undergraduate degree and the University of Cambridge for my masters. I have broad interests and love discussing new advances in science and technology. I would love to chat with you during my office hours at Voyager on Thursdays!

**Jenny Ji** | jennyji@stanford.edu | **Pronouns: she/her**

***How to reach me?*** **Office Hours: TBD**

Hi everyone! I am a second year PhD student in bioengineering developing aptamer and antibody-based biosensors for continuous biomarker monitoring in Professor Tom Soh's lab. I completed my undergraduate at Caltech in 2023, with a major in

bioengineering and a minor in neurobiology. My past research ranges from modelling COVID-19 household transmission in epidemiology, combining quantitative detection with sequencing to analyze complex clinical and environmental samples, and looking at the connection between the gut microbiome and Parkinson's disease. I would love to chat more about research, classwork, or anything else! Feel free to find me at office hours Wednesdays after class (4:30-5:30 PM) in STLC!

## COURSE OVERVIEW

### Course Description

This course will examine the basic concepts of biotechnology and the instrumentation and techniques used in the manipulation of nucleic acids (DNA and RNA). Students will learn how biotechnology's tools and techniques are being used to help identify and fight disease, with a special emphasis on tools that help detect viral infections such as COVID-19. This course will also examine the ethical and privacy issues associated with biotechnology such as genetic testing, vaccine distributions and gene therapy.
**Prerequisites:** General Biology & Chemistry
**Recommended:** AP/IB Biology & Chemistry

### Land Acknowledgement

Stanford occupies the territory of the Muwekma Ohlone Tribe. These lands continue to be of great importance to the Ohlone people. This land acknowledgement serves to recognize that each of us continues to benefit from the use and occupation of this land. I offer gratitude for the pedagogy and learning that takes place and hope that we can strive to act against injustice, act with memory, and consider Indigenous and multiply marginalized perspectives.

### Learning Objectives

Our goals for the course are to get you excited about science and biotechnology and provide you with a framework to better understand how biotechnology is developed, implemented, and improved over time. We will use case studies, including COVID-19, to exemplify the core principles of the course. Ultimately, we seek to create a learning community where we can all learn synergistically together. We empower you to bring your questions, curiosity, and whole selves to class and engage with the course material and assignments using a critical lens informed by your lived experiences.

*By the end of this course, you will be able to:*

- Define biotechnology and demonstrate understanding of how biotechnology is being applied to detect and treat disease.
- Describe key concepts in cell biology, biochemistry, and genetics and their significance in biotechnology research and therapeutic development.
- Understand the structure and dynamics of DNA and RNA, and how they are manipulated in biotechnology applications.
- Explain what a virus is, how it replicates, and how vaccines work to fight them.

- Discuss and debate the bioethical issues and societal impacts involved in different biotechnology applications.
- Describe how biotechnology products are conceived, executed, and commercialized
- Demonstrate the ability to apply your knowledge in developing a disease-specific project through structured group work.

### Section Description

This course will include one weekly discussion section. There will be three times offered on Wednesday and Thursdays. Attendance is required at the weekly section time you commit to at the beginning of the quarter. You will not be allowed to attend another section. The goal of section is to provide a space to explore concepts introduced during class at a deeper level and provide structured opportunities to scaffold the learning process throughout the quarter. *Sections are meant to support your learning, not add more to your plate!* Each section will be led by the teaching assistant. As a project-based course, this class will involve developing ideas over time with several assignments spaced throughout the quarter. To this end, sections will serve as an opportunity to build the skills you need to build and deliver your projects.

## COURSE EXPECTATIONS

### Contacting the Teaching Team

Given the number of students enrolled in this course, we will be using the Canvas Discussion platform, which is integrated into our course Canvas page, for all course-related questions. *Email should only be used for personal communication with the teaching team*, for example to set up a one-on-one meeting outside of office hours, discuss an accommodation request, etc. Canvas Discussion allows other students to benefit from questions that are posted, streamlining the question and answer process for both students and the teaching team. *If you email a question to the teaching team that is better suited for posting to Canvas Discussion, they will send you an email asking you to re-submit your question using Canvas Discussion.* Canvas Discussion has functionality that supports anonymous posts (your name will not be visible to other students or the teaching team) and private posts (only visible to you and the teaching team)—we encourage you to utilize these features as needed. If you know the answer to another student's question, you can also post a response on Canvas Discussion, encouraging community engagement and support. We recommend that you search for questions on Canvas Discussion to see if another student has already asked the same question before you create a new post.

### Attendance Policy

As a synchronous course, attendance is expected and **required** for all classes and discussion sections. We also expect you all to arrive on time for our sessions together as a show of respect to each other. The teaching team will also uphold the same standards for ourselves! We encourage you to prioritize attending sessions because the content builds each week and missing one session can make it challenging to catch up, particularly since the assignments for this course are project and team-based.

*Please make sure to email your section TA to let them know you will be missing class ahead of time if possible! This will prevent penalties to your grade!*

- Each lecture missed will lower your final course grade by 3%.
- Each discussion section missed will lower your final course grade by 2%.
- You must attend the discussion section that you are assigned. Since your project group will be in the section that you are assigned, you cannot attend another discussion section.
- *Our general approach to making up for an absence (to prevent lowering of your grade) will be having you reach out to your project team members (team assignments will be announced Week 1) to ask them to fill you in on what you missed during class.* If you have any lingering questions, you can then reach out to your section TA to get your questions answered.

### The Honor Code

It is expected that everyone in the class, including the teaching team, will follow Stanford's Honor Code in all matters relating to this course. You are encouraged to virtually meet and exchange ideas with your classmates and work with your team to complete all group assignments. However, you are not permitted to copy or plagiarize any existing content. For all individual assignments for the course, you are expected to submit work that reflects your own understanding of the course material. Compromising your academic integrity may lead to serious consequences, including, but not limited to, one or more of the following: failure of the assignment, failure of the course, disciplinary probation, suspension from the university, or dismissal from the university. We are all responsible for understanding the University's Honor Code policy and must make proper use of citations of sources for writing papers, creating, presenting, and performing our work, taking examinations, and doing research. If you have any questions, please contact the teaching team.

### Course Privacy Statement & Recording Policy

As noted in the University's recording and broadcasting courses policy, students may not audio or video record class meetings without permission from the teaching team (and guest speakers, when applicable). If the instructor grants permission, or if the teaching team posts videos themselves, students may keep recordings only for personal use and may not post recordings on the internet, or otherwise distribute them. These policies protect the privacy rights of instructors and students, and the intellectual property and other rights of the university. Students who need sessions recorded for academic accommodation should contact the Office of Accessible Education. *Unless sessions need to be recorded for accommodation purposes, we are not planning to record class sessions. This is because class sessions will involve minimal didactic content, and we will primarily focus on discussions and interactive activities.*

## GRADING

### Our Approach

Your final grades will be based on the following:

- **Pre-Class Assignments (25%)**: Starting week 2, we will assign pre-class readings and/or videos that are designed to help build foundational knowledge that will be necessary for the class sessions. An assignment will accompany these readings and videos to help you reflect and think deeply about the material that we will cover in class.

- **Participation (15%):** Participation is a critical component of this course. Our time in class is the opportunity to actively engage with the material we are exploring. I encourage you to be active in every class session. This participation grade serves as a way to credit you with the effort and work you are putting into the class in and out of the classroom. However, I understand that we all have different levels of comfort regarding speaking in class. Participation will thus be counted as speaking to the whole group (e.g. responding to questions from the instructor or TA and asking questions in class), in smaller groups (e.g. actively engaging with your group for in-class activities or participating in office hours) and in-class activities which may involve writing. Students will be expected to participate in some way at least once every week in lecture and every week in discussion section.

- **Project Assignments (60%):** The main deliverable for this course will be a project about a particular disease of your choice. You will develop a case study about this disease throughout the quarter working in teams of 3-4 students. The goal of this project is to provide a hands-on opportunity to take ownership of a topic and practice applying what you learn in class to a disease of interest to you. The majority of your project assignments will be a group grade.
    - **Weekly Project Assignments (30%):** There will be weekly project assignments starting in Week 1 to provide you with structure and guidance as you develop your final project. The weekly assignments from Weeks 1 to 7 will constitute 30% of your final grade.
    - **Final Project Assignment (30%):** During Week 8, you will submit your final project, presentation materials to showcase your deliverable, and your final reflection. These three materials will make up the remaining 30% of your final grade.

## Grading Schematic

| Point Range (%) | Letter Grade | Point Range (%) | Letter Grade |
|---|---|---|---|
| ≥ 93.0 | A | 69.9 - 67.0 | D+ |
| 92.9 - 90.0 | A- | 66.9 - 63.0 | D |
| 89.9 - 87.0 | B+ | 62.9 - 60.0 | D- |
| 86.9 - 83.0 | B | <60.0 | NP |

| | | | |
|---|---|---|---|
| 82.9 - 80.0 | B- | | If you are taking the course for credit, you must score ≥ 70.0 to receive credit. |
| 79.9 - 77.0 | C+ | | |
| 76.9 - 73.0 | C | | |
| 72.9 - 70.0 | C- | | |

### Late Policy

The quarter system is fast-paced, particularly during the summer session when we have only 8 weeks instead of the typical 10 weeks. As a result, it can be hard to catch up if you fall behind, especially since the assignments for this course build on each other. As such, *we highly recommend doing your best to submit assignments on time to support your own learning process in this course!* That being said, our goal is not to be punitive. As such, there will be no formal deduction of points for late submissions. However, *you (and your team for any group assignments) will be required to meet with the teaching team to discuss how to get back on track to support your learning progress*. These discussions are meant to be supportive, not punitive, but will be crucial to ensure a productive learning experience for you and your teammates, if applicable. Review more details about our course late policy here.

## RESOURCES & ACCOMMODATIONS

### Academic Support

Learning is challenging, particularly during the current times. The university offers a variety of academic resources that can support your learning during this course in the summer. We recommend exploring the options available to students over the summer, which are all *free of charge*, at the following webpage for the Summer Academic Resource Center (SARC).

### Students with Documented Disabilities

Students who may need an academic accommodation based on the impact of a disability should initiate the request with the Office of Accessible Education (OAE). Professional staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty dated in the current quarter in which the request is made. Students should contact the OAE as soon as possible since timely notice is needed to coordinate accommodations. Students should e-mail their OAE letter to the instructor in the first 2-3 weeks of the quarter or as soon as it is issued since timely notice is needed to coordinate accommodations. Once you email us your letter, we will be in touch with you to let you know how we plan to accommodate you and hope to partner with you in this process to ensure that your needs are met.

### First Generation & Low-Income (FLI) Students

In this course, we seek to create an engaging learning environment for students from all backgrounds. All course materials will be provided to you free of charge through the

course Canvas page. If you have any concerns about affording specific items relevant to your learning in this course, please reach out to the teaching team and we will work with you to identify the appropriate University resources to support your needs.

### Student Athletes

If you anticipate being absent from class due to an athletic performance, we suggest you have your coach email us at the very beginning of the quarter so we can make appropriate arrangements based on when you will be away. If you have any concerns balancing coursework and your athletic commitments, please reach out to the teaching team! We can come up with a plan together to help you balance your commitments.

### Student Resources for Health & Wellbeing

Being a student can be stressful. Mental health issues, including significant stress, mood changes, excessive worry, or problems eating or sleeping can interfere with reaching your optimal academic engagement. Sources of such symptoms might be related to your coursework in this course—if so, please contact one of us on the teaching team. However, these symptoms can also be the consequence of personal struggle, loss, or crisis, which can also affect your well-being in the classroom. Stanford provides health and well-being resources to support students during summer session. To view resources available to you, visit the following webpage for more information about options, including Vaden Health Center, Counseling and Psychological Services (CAPS), and the Confidential Support Team (CST). *Please feel free to also reach out to the teaching team for support in connecting with these resources—we are here to help!*

## ASSIGNMENTS

### Our Goal

As a project-based course, the goal of the assignments for this class are to help you develop your own ideas, explore a biotechnology topic more deeply, and develop your own curiosity and excitement for science. To this end, we have built flexibility into each assignment and encourage you to identify what would be most interesting and exciting to you. We know with more flexibility can come more uncertainty, so we have scaffolded the project development process through the course/section content and the assignments interspersed throughout the quarter.

### Project Description

The main deliverable for this course will be a project about a particular disease of your choice. You will develop a case study about this disease throughout the quarter working in teams of 3-4 students. **You will be assigned to teams based on your collective interest in particular diseases.** The goal of this project is to provide a hands-on opportunity to take ownership of a topic and practice applying what you learn in class to a disease of interest to you.

*The overall timeline for the project is as follows:*

- **Week 1:** Decide on a category of disease that you and your team will focus on for the quarter for all assignments and the ultimate end-quarter project.

Additionally, you will each record a brief (<5 min) video on Zoom introducing who you are, where you come from, your community, and what you are hoping to get out of the course. These videos will be made available to the whole class, so we can all get to know each other! The teaching team will provide an example during the first class when they introduce themselves.

(Assignment: Introduction Video & Ranking Section Time Preference)

- **Week 2:** You will decide with your group the specific disease that you will focus your project on based on the category that you selected in Week 1. You will work as a team to submit a brief proposal explaining why you think this disease would be a good fit for your group based on each of your interests. You will provide the teaching team with a summary of the disease and potential biotechnology innovations that have been recently developed, or are currently in development, to innovate the diagnostic or therapeutic process for the disease. You will also propose a preliminary plan for the topics you plan to focus on for examining the patient experience (Week 3), exploring a particular biotechnology innovation (Week 4), and developing a science communication project (Weeks 5-8). See below for more details for each component.

  (Assignment: Proposing a Specific Disease)

- **Week 3:** You will work with your team to explore the patient and clinician experience for the disease you selected in Week 2. The goal of this assignment is to better understand what it is like to live with the disease and what challenges/barriers patients and providers face to build a foundation of empathy and compassion for exploring potential biotechnological interventions. The form of this assignment is meant to encourage your team to explore your creativity and can take a number of different modalities, ranging from writing a short story to creating a video to conducting interviews, among other options.

  (Assignment: The Patient & Clinician Experience)

- **Week 4:** You will work with your team to explore a recent, or up and coming, biotechnology innovation for your particular disease. This innovation can address any part of the disease experience, from diagnosis to treatment to support, or anything else. The goal is to identify one innovation and explore it in more detail. You will summarize your findings, including a critical analysis of why you think this innovation addresses a particular need based on your patient experience assignment from Week 3. As with prior assignments, this assignment can take multiple forms, such as an infographic, online learning module, or video, among other options.

  (Assignment: Biotechnology Innovation)

- **Week 5:** For the rest of the quarter, you will work with your team to integrate the ideas you have explored through the Week 3 and 4 assignments into a science communication project. This project can take any form your group has identified as a good fit for the content you are hoping to convey; it can range from a podcast episode, online magazine, or video series, among other options. The goal of this project is to think about how to best convey the ideas you have learned about your chosen disease. Although the *content* you feature in this

project will be similar to the content you covered in your Week 3 and 4 assignments, the *form* will differ. The challenge will be identifying how you will incorporate both the patient experience and biotechnology innovation into one cohesive piece that tells a singular story to inform the public or specific audience about your chosen disease.

For the Week 5 assignment, you will work with your team to come up with a proposal for your science communication project, including what ideas you will cover in your project, what form your project will take, and what resources/support you will need to carry out your project.

(Assignment: Science Communication Proposal)

- **Week 6:** One of the goals of this course is to provide you with opportunities to implement feedback and reflect on your process to identify strategies for future growth. To this end, during Week 6 you and your group will submit a draft of your science communication project for feedback from both the teaching team and your peers (during Week 7). Although the assignment may be called a "draft," we encourage you to submit as complete a draft as possible! Doing so will allow for the most productive feedback to be provided to you during Week 7 for iterating your project.

  Additionally, each of you will submit your own 1-page process letter, addressed to the teaching team, (1) reflecting on your experience working on the project so far and (2) identifying areas of the project that you think would be most useful to receive feedback on. This is also an opportunity for you to share any challenges that you and/or your group have encountered in carrying out the project so that the teaching team can better support you.

  (Assignment: Science Communication Draft & Process Letter)

- **Week 7:** An important part of science is giving and receiving feedback. We will practice this as a class by providing peer review to each other through the Week 7 assignment. Your group will review another group's project draft from Week 6 and provide feedback for improvement through either a written letter or a recorded video. The feedback you provide should be actionable and highlight both what is working about the project and what could be improved.

  (Assignment: Peer Review & Final Presentation Plan)

- **Week 8:** During the last week of the quarter, you will deliver a short presentation (more details will be announced in class) showcasing your science communication project to the rest of the class. This will be an opportunity for you to practice presenting, an important skill in science, while also learning from your peers and celebrating the work we have accomplished as a class! These presentations will occur during class time for Week 8.

  Additionally, you will submit a final reflection about what you have learned during the quarter through the course. This reflection can take the form of a written letter or a short recorded video addressed to the teaching team.

  (Assignment: Project Showcase & Final Reflection)

## COURSE SCHEDULE

**Legend:**

| | |
|---|---|
| **Blue** | **Class Sessions** |
| **Green** | **Assignment Deadlines*** |
| **Red** | **Discussion Sections** |
| **Orange** | **Biotech Innovation Highlight** (optional) |
| **Purple** | **Research Lab Tours** (optional) |

**All deadlines are 11:59pm PST on the dates designated below in the course schedule unless otherwise noted. All assignments should be submitted on Canvas!*

***Note:** All assignments will be posted to Canvas! The weekly modules will unlock the Wednesday beforehand (e.g. the Week 2 module will unlock Wednesday after class).*

| Week | Date | Topic |
|---|---|---|
| 1 | June 22 | Welcome!<br>Syllabus Overview<br>Science Communication Project Highlight |
| | June 23 | (23rd) Ranking Section Preferences *(due 11:59 pm PST)*<br>(24th) Introduction Video |
| | June 24 | Project Overview<br>What Is Biotechnology? |
| | June 24/25 | Building a Project Proposal |
| 2 | June 29 | Antibodies: Engineering and Discovery |
| | June 30 | Proposing a Specific Disease |
| | July 1 | Antibodies: Applications |
| | July 1/2 | Examining the Patient and Clinician Experience |
| 3 | July 6 | Diagnostics: DNA |
| | July7 | The Patient & Clinician Experience |
| | July 8 | Diagnostics: RNA |
| | July 8/9 | Biotech Innovation |
| | TBD | Biotech Highlight #1 |

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|---|---|---|
| 4 | July 13 | Therapeutics: DNA |
| | July 15 | Biotechnology Innovation |
| | July 16 | Therapeutics: RNA |
| | July 15/16 | Exploring Science Communication |
| 5 | July 20 | Introduction to Pathogens and Viral Diseases |
| | July 21 | Science Communication Proposal |
| | July 22 | Viral Diseases: Advances in Therapeutics and Vaccine Development |
| | July 22/23 | Reflecting on Process |
| | TBD | Biotech Highlight #2 |
| | TBD | Research Lab Tour |
| 6 | July 27 | Ethics: Gene Editing |
| | TBD | Gattaca Movie Night! |
| | July 29 | Science Communication Draft |
| | July 29 | Ethics: Selective Gene Editing<br>Process Letter |
| | July 29/30 | Presentation Skills 101 |
| 7 | August 3 | Emerging Biotech Innovations |
| | August 4 | Peer Review |
| | August 5 | Biotech to Market |
| | August 5/6 | Facilitated Work Time |
| | August 5/6 | Structured TA Office Hours for Science Comm. Project |
| | TBD | Biotech Highlight #3 |
| | TBD | Research Lab Tour |
| | **August 8** | **SCIENCE COMMUNICATION PROJECTS DUE!** |
| 8 | **August 9** | **PRESENTATION MATERIALS DUE!** |
| | August 10 | Project Showcase: Presentations |

| | | |
|---|---|---|
| | August 11 | Final Reflection |
| | August 12 | Project Showcase: Presentations |