

# Introduction to the Molecular Basis of Cancer (BIO 50S)

Tues/Thurs 4:00 – 5:30 pm PST | 3 units | McMurtry Art Building 350

## TEACHING TEAM

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### Lecturer/Instructor

Jae Chung, PhD | [chungjae@stanford.edu](mailto:chungjae@stanford.edu) | Pronouns: he/him

**How to reach me? Meet by appointment (email to schedule)**

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 "Dr. Chung" or "Dr. Jae" during class and in writing.

### Head Teaching Assistant

Helen Zhang, MS | [helen18@stanford.edu](mailto:helen18@stanford.edu) | Pronouns: she/her

**How to reach me? Office Hours: Tuesdays from 5:30-6:15 PM at McMurtry Art 350**

I will be hosting office hours every week throughout the quarter and am happy to meet by appointment (email to schedule). If you're not sure what office hours can be used for, feel free to check out this brief [article](#) by the Cardinal Compass. I'm more than happy to discuss anything from questions you might have in the course, to coming up with a plan for success if you feel like you're struggling, to discussing interdisciplinary approaches in cancer—and everything in between! This time is for *you*. You are welcome to call me by my first name during class and in writing.

### Teaching Assistants

Yasmeen AlSaif | [yalsaif@stanford.edu](mailto:yalsaif@stanford.edu) | Pronouns: she/her

**How to reach me? Office Hours: Mondays from 3:00-4:00 PM on [Zoom](#)**  
(Password: 644432)

I will host virtual office hours every week throughout the quarter and am happy to meet by appointment (email to schedule as well!). My undergraduate major was Biology (Biochemistry & Biophysics track) and I'm now coterminating in Biology (drug discovery and development focus), so I'm happy to discuss research in those areas. I also am available for advice on being pre-med at Stanford and applying to jobs with a life sciences background. You are welcome to call me by my first name during class and in writing. Excited to meet you all!

Chris Neimeth | [cneimeth@stanford.edu](mailto:cneimeth@stanford.edu) | Pronouns: he/him

**How to reach me? Office Hours: Thursdays from 5:30-6:15 PM at McMurtry Art 350**

I will host office hours every week throughout the quarter, and am also free to meet by appointment (email me to schedule). I am more than happy to discuss course

logistics, as well as any science or career-based questions you may have! I am also happy to talk about balancing athletics and STEM as I did both while studying bioengineering during my undergrad. You are welcome to call me by my first name during class and in writing.

## **COURSE OVERVIEW**

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### **Course Description**

This course will examine the biological processes that are disrupted in cancer, such as DNA repair, cell cycle control and signaling pathways. Students will learn the molecular mechanisms by which tumors gain and maintain a growth advantage and of potential therapeutic targets. This course will also explore the science behind cancer prevention, diagnosis, and treatments.

**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**

The objective of this course is to explore the principles of cancer biology and identify the main cellular and molecular mechanisms underlying the initiation and progression of cancer. The complexities of the causes and cells that give rise to this disease have stressed the need for a better understanding of the basic biology of cancer. Additionally, advancements in basic and biomedical research and medicine have led to more effective treatments, enhanced detection methods, and better prevention strategies.

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

- Describe the original six hallmarks that rationalize the complexities of cancer.
- Identify the main cellular and molecular mechanisms leading to the initiation and progression of cancer growth.
- Define the role of oncogenes, tumor suppressors, and mutations in cancer
- Discuss the cellular signaling pathways that are deregulated in tumors cells compared to normal cells
- Define the main factors contributing to metastatic growth
- Delineate general cancer prevention and detection strategies
- Demonstrate core knowledge of cellular targets and molecular mechanisms of traditional and novel cancer therapies
- Demonstrate the ability to apply your knowledge in developing a cancer-specific project through structured group work.

## Section Description

This course will include one weekly discussion section. There will be three times offered on Wednesdays. 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

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### 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!

- 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 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. For tips on how to uphold the honor code in an online learning environment, read [these recommendations](#). 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**

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### **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 (actively engaging with your group for in-class activities) 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 cancer 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.
  - **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
≥ 94.0	A	69.9 - 67.0	D+
93.9 - 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, as described above, 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**

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### **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

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### Our Goal

The main deliverable for this course will be a project about a particular cancer of your choice. As a project-based course, the goal of the assignments for this class are to help you develop your own ideas, explore a cancer type 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 that having more flexibility can bring more uncertainty, so we have scaffolded the project development process through the course and section content and the assignments interspersed throughout the quarter.

### Project Description

You will work in a team of 3-4 students throughout the entire quarter. The project goal is to learn how to work in a group efficiently, search and read scientific literature, and present your group findings in a scientific poster format.

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

- **Week 1:** You will form a team with 3-4 other students during the first week of section and this will be the group that you will work together with throughout the quarter. You and your team will decide on the top 3 cancer types that most interests you. Each team will be assigned one cancer type to focus on for the quarter for all assignments and the ultimate end-quarter project by Friday of Week 1. You will also review examples of scientific posters to help you understand what will be expected of you for the final poster project.  
(Assignment: **Reviewing Poster Examples & Ranking Cancer Types**)
- **Week 2:** You will confirm the cancer type you and your team will study with your TA. Your team will focus on hallmark #1 and the cell of origin for your cancer type. You will work as a team to submit an assignment about the cancer type your group chose. The assignment should include the following information with proper citations:
  - What cell type does the cancer arise from? (Cell of origin for the cancer type)
  - What part of the body does it generally affect? (Location of the cell type)
  - What is the normal function of the cell type?

- Does the cell proliferate under homeostasis? Does the cell proliferate under other conditions (such as injury)?
- Are there any growth suppressor mutations? What is it? How do these genes operate in normal cells? What happens to this operation when the genes are mutated? (Hallmark 1: Evading Growth Suppressors)
- Are there any treatments for the growth suppressor mutation? (Hallmark 1: Evading Growth Suppressors)

(Assignment: Cancer Cell of Origin and Growth Suppressor Evasion & Poster Introduction)

- **Week 3:** You will examine your cancer type further through literature reviews and research. Your team will focus on hallmark #2 and the symptoms of your cancer type. You will work as a team to submit an assignment about the cancer type your group chose. The assignment should include the following information with proper citations.
  - Describe the symptoms of your cancer type:
    - What are the first signs of your cancer type?
    - What part(s) of the body do symptoms arise?
    - Do the symptoms show up earlier or later when the cancer has progressed?
  - Are there any growth signaling pathways used by the cell? (Hallmark 2: Proliferative Signaling)
  - Are there any growth signaling pathway-related mutations? What is it? How does it affect the normal cell? (Hallmark 2: Proliferative Signaling)
  - Are there any treatments for the growth signaling pathway-related mutation? (Hallmark 2: Proliferative signaling)

(Assignment: Cancer Symptoms and Sustaining Proliferative Signaling & Poster Draft)

- **Week 4:** You will examine your cancer type further through literature reviews and research. Your team will focus on hallmark #3 and the possible causes of your cancer type. You will work as a team to submit an assignment about the cancer type your group chose. The assignment should include the following information with proper citations:
  - Are there environmental or health factors that can cause your cancer type?
  - What is the most common age group of those who are affected by your cancer type?
  - How many people are likely to be diagnosed with your cancer type each year? What populations (e.g. ethnic, socioeconomic, body type, immunocompromised, etc...) are at a greater predisposition to be diagnosed with your cancer type?
  - How rare or common is your cancer type?
  - Can your cancer type be inherited?



- Are there any mutations related to cell death? What is it? How do these genes operate in normal cells? What happens to this operation when the genes are mutated? (Hallmark 3: Resisting Cell Death)
- Are there any treatments for the cell-death related mutation? (Hallmark 3: Resisting Cell Death)

**(Assignment: Cancer Causes and Resisting Cell Death & Poster Draft)**

- **Week 5:** You will examine your cancer type further through literature reviews and research. Your team will focus on hallmark #4 and how your cancer type is diagnosed. You will work as a team to submit an assignment and a diagram that outlines how your cancer type develops and progresses. The assignment should include the following information with proper citations:
  - How is your cancer type diagnosed? What kinds of tests and examinations are performed?
    - If your cancer type is diagnosed with medical imaging, what type of imaging is used? (MRI, CAT, PET, X-ray, ultrasound, etc...)
    - Does the diagnosis involve biopsies or histologies?
  - Based on what you've learned in class, summarize how your cancer type cells enable replicative immortality. Are there any additional mutations/factors that drive your cancer type? (Hallmark 4: Enabling Replicative Immortality)

**(Assignment: Cancer Diagnosis, Diagram of Cancer, & Poster Draft)**

- **Week 6:** You will examine your cancer type further through literature reviews and research. Your team will focus on hallmarks #5 and #6 and how your cancer type is treated. You will work as a team to submit an assignment about your cancer type. The assignment should include the following information with proper citations:
  - How is your cancer type treated? (e.g. surgery, medications, chemotherapy, radiation therapy, nutrition, lifestyle choices, etc...)
  - What does the angiogenic process look like for your cancer type? Are there any prevention methods to stop the angiogenic process? (Hallmark 5: Inducing Angiogenesis)
  - How does your cancer type invade other parts of the body and metastasize? Are there any prevention methods to stop metastasis? (Hallmark 6: Activating Invasion and Metastasis)

**(Assignment: Cancer Treatment, Angiogenesis and Metastasis & Poster Draft #1)**

- **Week 7:** You will examine your cancer type further through literature reviews and research. Cancer prevention is action taken to lower the risk of getting cancer. This can include maintaining a healthy lifestyle, avoiding exposure to known cancer-causing substances, and taking medicines or vaccines that can prevent cancer from developing. Your team will research how you can reduce the risk of getting your cancer type through preventative measures. You will work as a team to submit an assignment about your cancer type. The assignment should include the following information with proper citations:
  - What are at least 5 ways to reduce your risk of getting your cancer type?

- How do these preventative measures work to prevent cancer (e.g. how does smoking put you at greater risk for lung cancer and how would cutting back help prevent cancer?)

(Assignment: Cancer Prevention & Poster Draft #2)

- **Week 8:** During the last week of the quarter, you will deliver a short poster presentation (more details will be announced in class) showcasing your knowledge of your cancer type 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. You will be assigned as an evaluator for another group's poster presentation.

(Assignment: Project Showcase & Poster Evaluation)

## COURSE SCHEDULE

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### Legend:

Blue	Class Sessions
Green	Assignment Deadlines*
Red	Discussion Sections
Orange	Review Sessions

*\*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 Thursday beforehand (e.g. the Week 2 module will unlock Thurs. 6/23 at 7:00pm).

Week	Date	Topic
1	June 21	Welcome! Syllabus Overview Introduction: The Hallmarks of Cancer
	June 22	Introduction to Posters and Syllabus Review (Recording)
2	June 28	The Cell Cycle Hallmark #1: Evading Growth Suppressors
	June 29	Cancer Cell of Origin Cell Cycle Review
	June 30	DNA Mutations Tumor Suppressors and Oncogenes Hallmark #1: Evading Growth Suppressors Hallmark #2: Sustaining Proliferative Signaling
	July 1	Decide on Poster Format Assignment: Cancer Cell of Origin & Hallmark #1
	July 2	Review Session #1
3	July 5	Signaling Pathways Hallmark #2: Sustaining Proliferative Signaling
	July 6	Signaling Pathways Review Poster Draft Working Session
	July 7	Cell Death and Apoptosis Hallmark #3: Resisting Cell Death

	July 9	Review Session #2
	July 10	Assignment: Cancer Symptoms & Hallmark #2 Poster Update
4	July 12	The p53 and Rb Cell Cycle Hallmark #3: Resisting Cell Death
	July 13	p53/pRb Review Poster Draft Working Session
	July 14	Cellular Senescence and Telomerase Hallmark #4: Enabling Replicative Immortality
	July 17	Assignment: Cancer Causes & Hallmark #3 Poster Update
5	July 19	Bridging Hallmarks #1-4 Cancer Diagnosis and the Debate Around Screening
	July 20	Replicative Senescence Review Poster Draft Working Session
	July 21	Cancer Vascularization Hallmark #5: Inducing Angiogenesis
	July 23	Review Session #3
	July 26	Assignment: Cancer Diagnosis & Hallmark #4 Poster Update
6	July 28	Hypoxia in Cancer Hallmark #5: Inducing Angiogenesis
	July 29	Angiogenesis Review Poster Draft Working Session
	July 30	Invasion-Metastasis Cascade Hallmark #6: Activating Invasion and Metastasis
	July 31	Assignment: Cancer Treatments & Hallmarks #5 & #6 Polished Poster Draft #1 Due
7	August 2	Cancer Stem Cells Hallmark #6: Activating Invasion and Metastasis
	August 3	Poster Draft Working Session
	August 4	Beyond the 6 Hallmarks: New Dimensions
	<b>August 5</b>	<b>POSTER DRAFT #2 DUE</b>

	August 5	Review Session #4 (Individual TA Sessions)
	August 7	Assignment: Cancer Prevention
8	August 9 ( <b>Class time extended until 6:00 PM</b> )	Innovations in Cancer Diagnostics, Therapeutics, and Treatments Project Showcase: Presentations
	August 11 ( <b>Class time extended until 6:00 PM</b> )	Project Showcase: Presentations
	August 11	<b>POSTER EVALUATION DUE AFTER CLASS</b>