

BIOE 498/598 TC1: Technologies for Cancer Diagnosis and Therapy

Meeting time: Tuesdays and Thursdays, 2:00 – 3:20 PM

Location: Everitt Lab, 2310

Credit hours: 3 (498) or 4 (598)

CRN: 56513 (498) or 65893 (598)

Semester: Fall

Instructor Information

Name Professor Yang Liu

Contact Information liuy46@illinois.edu

Office Hours Tuesdays and Thursdays, 3:20 – 4:00 PM (in person), and by appointment

Office Location 4047 Beckman Institute

Teaching Assistant

Name Chathurya Devineni

Contact Information sd60@illinois.edu

Course Description

Technologies for Cancer Diagnosis and Therapy provides an introduction to how cancer is diagnosed and treated, focusing on fundamental concepts in cancer biology and bioengineering. One major goal is for students to become comfortable integrating principles from physics, chemistry, engineering, and biology related to current strategies for understanding, detecting, and treating cancer. A second major goal is for students to understand and assess innovative solutions to current challenges in the field, and to use this information to generate a research proposal in the format of an NIH R21, which will be written and reviewed through NIH-style study sections throughout the course term. The materials and content are designed for graduate students and senior undergraduate students from diverse majors.

This course has five components:

1. Fundamentals of cancer biology (brief)
2. Practices of clinical oncology
3. Therapeutic technologies
4. Diagnostic technologies
5. Proposal evaluation and development

There is a wide range of materials available for this class. Time in class will focus on key concepts, discussions, and projects. You should do the following **prior to each class** using the content on the course website:

1. Read any assigned materials.
2. Review the homework assignment.
3. For R21 study sections, read the proposal assigned to you in-depth and prepare for the discussion as described by the instructor.

Course Objectives

1. **Apply** terminology from cancer biology and clinical oncology.
2. **Identify** how cellular processes, tissue processes, and exogenous events lead to carcinogenesis.
3. **Evaluate and construct** cellular pathway maps related to carcinogenesis.
4. **Identify and analyze** diagnostic and therapeutic decision-making steps in clinical oncology.
5. **Analyze** mechanisms, strengths, and limitations of different classes of cancer therapies.
6. **Analyze** mechanisms, strengths, and limitations of different diagnostic technologies for cancer.
7. **Critically evaluate** research proposals and research reports related to cancer technologies in terms of significance, innovation, and approach.
8. **Conceptually design** technologies for cancer, formulated as an NIH R21 research proposal.

Course Format

- Two 80-min classes per week that mix lecture delivery with discussions. Discussion is a major component of the course.
- Four times during the semester, 80-min mock-NIH study sections will focus on critical evaluation of research proposals.
- Weekly, students are expected to spend ~3 hours in class and about 6 hours outside the class.

Recommended Prerequisites

- CHEM 232 or equivalent knowledge
- BIOE 206 or equivalent knowledge

Course Website

<https://canvas.illinois.edu/courses/49502>

Textbook and Reading Materials

No textbooks are required. We will use published scientific articles as the main sources of learning. The following reference texts are recommended for supplementary reading.

The Biology of Cancer, Robert A. Weinberg (**highly recommended**)

Third edition. New York: W. W. Norton & Company, 2023.

ISBN 9780393887655; ISBN 0393887650

(<https://wwnorton.com/books/9780393887655>)

Molecular Cytopathology, Yang, Bin and Jianyu Rao, eds. 1st ed. 2016. Cham: Springer International Publishing, 2016. Web. Accessible via Library Online Book (with University NetID and password):

https://i-share-uiu.primo.exlibrisgroup.com/permalink/01CARLI_UIU/1ubbi2j/alma99954914231505899

Biomarkers in Cancer Screening and Early Detection, Srivastava, Sudhir, ed. 1st ed. Hoboken, New Jersey: Wiley Blackwell, 2017. Accessible via Library Online Book (with University NetID and password):

https://i-share-uiu.primo.exlibrisgroup.com/permalink/01CARLI_UIU/gpjsoq/alma99955106446305899

Course Policies

- **Attendance:** Students are expected to attend every class with the exception of authorized absences or unavoidable emergencies. Roll will be compiled from written attendance logs (or Zoom chat comments) in the event that class periods are remote.
- **Course-related communications:** Course announcements will be sent via Canvas Announcements and Discussions; please check these regularly. For general course questions and information, first consult the syllabus. Use the Canvas Discussion forum for all communications related to class. In case of emergencies, email the instructor via email at liuy46@illinois.edu.

Approximate Course Schedule (Subject to changes)

Week	Date	Topics
Cancer Biology		
1	8/27	General introduction, the role of technology in cancer
	8/29	Overview of cancer (normal vs. cancer)
2	9/3	Virus/Oncogenes
	9/5	R21 proposal discussion (instructor's proposal)
3	9/10	Signaling pathways
	9/12	Cell cycle
4	9/17	Cell death
	9/19	Case studies on technologies to study signaling, cell cycles and death
5	9/24	Multi-step Tumorigenesis
	9/26	Cancer genome
6	10/1	Invasion and metastasis
	10/3	Tumor immunology
7	10/8	Case studies on technologies to study tumorigenesis, etc.
	10/10	R21 study section (students' proposals)
8	10/15	Mid-term Exam
Clinical Oncology (Diagnostics)		
	10/17	Clinical diagnosis (blood test, bodily fluids)
9	10/22	Surgical pathology and clinical workflow
	10/24	Cytopathology and clinical workflow
10	10/29	Molecular diagnostics (Genomics, IHC, FISH, etc)
	10/31	Process of biomarker discovery and validation
11	11/5	Case studies on cancer diagnostic technologies
	11/7	R21 study section (students' proposals)
Clinical Oncology (Therapeutics)		
12	11/12	Conventional cancer therapy 1
	11/14	Conventional cancer therapy 2
13	11/19	Therapeutic resistance
	11/21	Immunotherapy
14	11/26	Fall break
	11/28	Fall break
15	12/3	Cancer models for drug discovery and testing
	12/5	Case studies on technologies in personalized treatment
16	12/10	R21 study section (students' proposals)

Gradings

Category	Assignments	Percentage of Grade
Exams	Midterm (50%) and Final exams (50%)	30%
Homework and Short essays	Problem-solving and reflective writing prompts	20%
R21 proposals	Written proposal (30%) Presentation (30%) Revision proposal (20%) Written critiques of other proposals (20%)	40%
Class participation	Active participation of class discussion	10%

Academic Integrity

The university's policy on Academic Integrity can be found in the *Code of Policies and Regulations Applying to All Students* under Article One, Part IV which can be found at: <https://studentcode.illinois.edu/>.

The following policies support and reinforce that policy.

1. All students are expected to hold the highest standards of scientific and academic conduct. Any form of cheating on any graded work in this course is unacceptable and will be dealt with as outlined below, and in accordance with the University-wide standards in the *Code of Policies and Regulations Applying to All Students*.
2. It is a requirement that all graded work be entirely your own, and that anything you write using the words of other writers be correctly attributed. Some specific points follow:

Artificial intelligence text generation: Generative AI-based tools such as ChatGPT may be used in this course as desired by students, however, prompts related to content in this course in 2024 have been found to commonly yield contradictory and incomplete information. In addition, essay-style writings do not yield accurate citations and the citations are often fabricated. For R21 project submissions, all information must come from trusted sources as described in the project descriptions. **If fabricated citations are detected in submitted materials, significant grade deductions will occur.** If these tools are used in any submitted material in the class, this should be indicated in the submission together with a brief indication of how the tools were applied.

Plagiarism: On all assignments, exams, and presentations, all written and verbally communicated content must be your own words, formulated from your own understanding of the material, and not copied from any other material. If the work you submit resembles that of another work or that from another student/team (including work from previous offerings of this course or other courses), it may be concluded that it was not your original work. Turnitin reports will be used to determine the degree to which submitted materials resemble previously written work. If you use the *ideas and/or opinions* from another author or source, you must provide the appropriate citation. That is, you must, using APA format, place a parenthetical reference to the source that provided you this information.

Figures, schematics, and graphical content will be required for R21 proposals and related materials, including presentations. These materials may be acquired from the literature or other sources, however *the source must be cited in all cases*, and none of the describing information, including figure legends, may be copied directly. Instead, this information must be paraphrased in your own words.

Direct quotations: Direct quotations should not be used in your assignments; they should be used ONLY in the two cases below:

- A definition of a term. In this case, you must put the text in quotes and, using APA format, place a parenthetical reference to the source at the end of the quote.
- A profound statement made by an expert in the field. In this case, you must put the text in quotes and, using APA format, place a parenthetical reference to the source at the end of the quote.

3. Group work will be an important part of this class. Some specific points follow:

Group work: On all assignments and presentations, you must contribute demonstrably to the group's effort and not just have one or some individuals do all the work. Since group work cannot be monitored

directly, the appearance of your work is the only means to determine the contribution of each member to the team.

Failure to adhere to these standards may result in a grade of zero for the entire assignment, for all persons involved.

Diversity and Inclusivity

The Department of Bioengineering is committed to the creation of a diverse, anti-racist, and inclusive community. Our departmental and professional communities promote and benefit substantially from diversity of race, ethnicity and national origins, gender and gender identity, sexuality, disability status, class, age, and religious beliefs. The effectiveness of this course is dependent upon each of us to create an encouraging learning environment that encourages the open exchange of ideas while also ensuring equitable opportunities and respect for each individual. All individual involved in this class are expected to actively maintain an environment in which students, staff, and faculty can contribute without fear of personal ridicule or provocative language. If you witness or experience racism, discrimination, micro-aggressions, or other offensive behavior, you are encouraged to bring this to the attention of the course instructor. You can also report these behaviors to the Bias Assessment and Response Team (BART) at <https://bart.illinois.edu/>. Based on your report, BART members will follow up and reach out to students to make sure they have the support needed to be healthy and safe. If the reported behavior violates university policy, staff in the Office for Student Conflict Resolution may respond as well and will take appropriate action.

Disability Related Accommodations

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail disability@illinois.edu, or go to <https://www.disability.illinois.edu>. If you are concerned that you may have a disability-related condition that is impacting your academic progress, there are academic screening appointments available that can help diagnose

a previously undiagnosed disability. You may access these by visiting the DRES website and selecting "Request an Academic Screening" at the bottom of the page.

Family Educational Rights and Privacy Act

Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See <https://registrar.illinois.edu/academic-records/ferpa/> for more information on FERPA.

Religious Observances

Illinois law requires the University to reasonably accommodate its students' religious beliefs, observances, and practices in regard to admissions, class attendance, and the scheduling of examinations and work requirements. You should examine this syllabus at the beginning of the semester for potential conflicts between course deadlines and any of your religious observances. If a conflict exists, you should notify your instructor of the conflict and follow the procedure at <https://odos.illinois.edu/community-of-care/resources/students/religiousobservances/> to request appropriate accommodations. This should be completed in the first two weeks of classes.

Sexual Misconduct Reporting Obligation

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In response, an individual from the Title IX Office will provide information regarding rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options. A list of designated University employees who do not have this reporting responsibility and can maintain confidentiality as counselors, confidential advisors, and medical professionals can be found here: <https://wecare.illinois.edu/resources/students/#confidential>. Other information about resources and reporting is available here: <https://wecare.illinois.edu/>.