

BISC 406L: Biotechnology

4 Units

Fall 2023

Lecture:

Tu and Th 9:00-9:50 a.m.

Lab:

Th 10:00-1:00 p.m. (usually we will begin lab at 9:00 a.m. and start lecture after)

Room: ZHS 472

Instructors:

Christa Bancroft, Ph.D.

Office: ZHS 470

Office Hours: By appointment

Contact Info:

Email: cbancrof@usc.edu (best choice). Subject line should state: "BISC 406"

Phone number: 213-740-5553

Laboratory Director: Celeste Chong-Cerrillo, Ph.D.

Office: ZHS 450

Office Hours: By appointment or open door policy

Contact Info: chongcer@usc.edu. Subject line should state: "BISC 406"

Laboratory Instructor:

Office:

Office Hours:

Contact Info:

Course Description

BISC406L is the capstone course for the BS in Biological Sciences with Emphasis in Biotechnology. It is also the capstone course and the Minor in Biology and Business offered by the Dornsife College of Letters, Arts and Sciences and the Marshall School of Business. The course will focus on the impact of the biotechnology revolution on health care in this age of molecular medicine. Topics to be covered include: (1) Recombinant DNA technology from plasmids to genomes; (2) CRISPR applications including genome editing; (3) Modern DNA sequencing technologies; (4) Genomics and Proteomics; (5) Manipulating Prokaryotic and Eukaryotic gene expression; (6) Molecular Diagnostics and Therapeutics; (7) Vaccines and Gene Therapy; (8) Genetic Engineering of Plants and Animals and; (9) Biotechnology regulation. We will address the ethical, legal and social implications of advances in biotechnology and will discuss governmental regulation of food, drugs and biotechnology itself. The laboratory exercises will focus on synthetic biology and other techniques, which have played a fundamental role in the "new" biotechnology revolution.

Learning Objectives

Explain the difference between historical biotechnology and modern biotechnology.
Know how to synthesize genes and to build plasmids, chromosomes, and genomes.

Have an understanding of how CRISPR/Cas systems work and can be utilized in diverse ways for human benefit, including as therapies.

Develop knowledge of the history of DNA sequencing technologies, especially modern short and long read approaches and their applications.

Provide examples on how to use microbes and mammalian cells for the production of pharmaceutical products.

Explain the concept and application of monoclonal antibody technology and the development of vaccines.

Explain the general principles of using DNA technology to generate transgenic plants, animals and microbes.

Provide examples of current applications of biotechnology and advances in different areas: medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic science.

Discuss ethical implications of biotechnology research and development.

Design an experiment with step-by-step instructions to address a research problem.

Demonstrate proficiency of technical skills in a variety of biotechnology methods.

Explain relevant background content, interpret data and critically evaluate conclusions of a scientific research paper. Effectively communicate the information to peers in a classroom setting during discussions and presentations.

Prerequisite: BISC 320L

Recommended Preparation: BISC 313 or BISC 325

Course Notes

Lectures: The lecture slides will be posted on the course Blackboard internet site as .ppt and .pdf files (<https://blackboard.usc.edu>). All course materials, information, announcements and grades will be posted on Blackboard until the end of the semester.

Class lecture periods will either be lectures given by the instructor (labeled Lect. on syllabus calendar) or discussions of reading assignments by students (labeled Disc. in bold red on syllabus calendar). Participation in these discussions is an important part of the course. A TENTATIVE reading list is given in the course syllabus below the topic calendar. If we deviate from this version of the reading list, a new, dated version of this syllabus will be posted on Blackboard. You should be prepared to discuss reading assignments on the days specified as discussions. Questions will be assigned ahead of time that each student will answer and discuss during the discussion period.

It is important to attend all of the lectures during the course and to take good notes for study. Prior to attending each lecture, it is important to have read the appropriate papers. However, many of the lectures will contain new and additional information that is not in those readings. Examinations will be based on information in lecture slides, communicated during lecture, discussed during class discussions and presented in assigned readings. In studying for examinations, complete and accurate lecture and discussion notes are of prime importance.

Lecture and Discussion Absences:

Attendance at all lecture and discussion sections is expected. If you must miss a discussion due to illness or valid USC travel, please present Dr. Bancroft with evidence of the reason for absence and you will be allowed to make-up the discussion assignment within 1 week of the missed lecture period.

Exams:

In case the midterm exam must be missed for legitimate reasons, discuss the situation with the course instructor **prior** to the exam, if possible. If the midterm is missed for an emergency or for a valid health reason (with written documentation), the score of the final exam will be used to comprise your total point score for course exams.

Regrades:

In the event an error is made in the grading of your exam, written submittal a description of the error, using the regrade form posted on Blackboard, with the exam should be returned to Dr. Bancroft within a week after receiving your graded exam. After this time period, exams will not be regraded.

Email Communication:

To ensure privacy, only student's USC email accounts may be used for email communications. Students are responsible for understanding the content of email messages that the instructor sends to their USC accounts. Therefore, each student must check their USC email regularly and make sure their account is not over quota, so new messages can be received.

Required Readings and Supplementary Materials

There is no textbook for the course. All reading assignments will be posted on Blackboard in .pdf format for you to access.

Description and Assessment of Assignments

Midterm and Final Exams will include multiple choice, short answer and mathematical problems that can be done without a calculator.

Classroom discussion questions will be assigned to each lab partner group during the class meeting prior to the class discussion. Pairs will present relevant data and figures to answer the questions during class discussion time. Points will be awarded based on participation of each member and correctness of answer.

Final project report: Students will be expected to provide a single-spaced, 10-page paper describing the problem, methods to address the problem, and the potential range of outcomes for the proposed experiments. The paper should be written in Arial font with a font size of 12 and 1-inch margins on each side of the page. Primary literature should be used to reference salient points, and at least 25 papers should be referenced.

Student presentations will occur during the last four weeks of class. Presentation dates will be assigned at least 3 weeks ahead of the first scheduled presentation. Detailed information about this assignment is posted on Blackboard under Course Documents. During student presentations attendance is mandatory and all students are expected to listen attentively and ask questions of other groups. Missing another group's presentation without a valid excuse will result in a 5 pt. deduction from your own presentation score.

Laboratory work assignments are discussed in more detail in the laboratory manual.

Grading Breakdown

The course grade will be based upon 675 possible points:

Assignment	Points	% of Grade
Midterm Exam	150	22.2
Final Exam	150	22.2
Classroom Discussions	100	14.8
Student Presentations	75	11.1
Laboratory	200	29.6
TOTAL	675	100

Course letter grades:

Course final grades will be determined using the following scale. If necessary, course grades will be adjusted at the end of the semester such that the average will be the lowest "B-" for the class.

Letter grade	Corresponding numerical point range
A	93-100
A-	90-92.9
B+	86-89.9
B	83-85.9
B-	80-82.9
C+	76-79.9
C	73-75.9
C-	70-72.9
D+	67-69.9
D	63-66.9
D-	60-62.9
F	59.9 and below

Student Presentation Guidelines and Rubric

Will be posted to Blackboard website under Content and “Student Presentations”.

Grading Timeline

Grades for Midterm Exams will be posted within one calendar week following the exam date.

Course Schedule:

Bancroft lecture/discussion: black

Student presentations: blue

Wk	Type	Date	Lecture Topic	Reading
1	Lect.	Aug 22	Intro to Biotechnology	1 and 1a
	Disc.	Aug 24	Cloning and synthesizing DNA molecules	2
2	Disc.	Aug 29	Assembling DNA molecules into chromosomes and genomes	3
	Disc.	Aug 31	Bacterial genome synthesis and transplantation	4 and 5
3	Disc.	Sept 5	Eukaryotic chromosome synthesis and transplantation	6 and 7
	Disc.	Sept 7	CRISPR/Cas technology and applications	8
4	Disc.	Sept 12	CRISPR-based diagnostics	9
	Disc.	Sept 14	CRISPR therapies in humans	10 and 11
5	Disc.	Sept 19	CRISPR therapy clinical trials	12
	Disc.	Sept 21	DNA sequencing technologies	13
6	Disc.	Sept 26	Telomere-to-telomere genome sequences	14
	Disc.	Sept 28	Single cell sequencing	15
7	Lect.	Oct 3	Plant Biotechnology	16

	Disc.	Oct 5	Plant Biotechnology	17
8		Oct 10	Midterm Exam	
		Oct 12	Fall Break, no classes	
9	Lect.	Oct 17	Immunology	18
	Disc.	Oct 19	Vaccine Development	19 and 20
10	Disc.	Oct 24	Cancer Vaccines	21
	Disc.	Oct 26	Techniques in Diagnostics	22
11	Lect.	Oct 31	Drug Development	23
	Disc.	Nov 2	Monoclonal Antibodies as Drugs	24
12	Disc.	Nov 7	Tissue Engineering	25
	Disc.	Nov 9	Animal Engineering	26 and 27
13	Disc.	Nov 14	Microbial Engineering	28
		Nov 16	Student Presentations	
14		Nov 21	Student Presentations	
		Nov 23	Thanksgiving Break, no classes	
15		Nov 28	Student Presentations	
		Nov 30	Student Presentations	
17		Dec. 7	FINAL EXAM: 11 a.m. to 12 p.m. (60 min.)	

Readings:

- Clark, D. P., and N. J. Pazdernik. 2015. Basics of Biotechnology. In Clark, D. P., and N. J. Pazdernik. (Authors), Biotechnology: Applying the genetic revolution, p. 1-32. Elsevier Academic Press, San Diego, CA.
- 1a. <https://www.labiotech.eu/in-depth/history-biotechnology-genentech/>
- Lu, Y. 2021. The gene synthesis revolution. New York Times November 24, 2021.
- Coradini, A. L. V., C. B. Hull, I. M. Ehrenreich. 2020. Building genomes to understand biology. Nature Communications 11, 6177.
- Hutchison, 3rd, C. A. et al. 2016. Design and synthesis of a minimal bacterial genome. Science 351, aad6253.
- Fredens, J. et al. 2019. Total synthesis of Escherichia coli with a recoded genome. Nature 569, 514-518.
- Dymond, J. S. et al. 2011. Synthetic chromosome arms function in yeast and generate phenotypic diversity by design. Nature 477, 471-476.
- Richardson, S. M. et al. 2017. Design of a synthetic yeast genome. Science 355, 1040-1044.
- Komor, A.C. et al. 2017. CRISPR-Based Technologies for the Manipulation of Eukaryotic Genomes. Cell 168(1-2): 20-36.
- Kaminski, M.M. et al. 2021. CRISPR-based diagnostics. Nature Biomedical Engineering 5: 643-656.
- Cong, L. et al. 2013. Multiplex Genome Engineering Using CRISPR/Cas Systems. Science 339(6121): 819-823.
- Mali, P. et al. 2013. RNA-Guided Human Genome Engineering via Cas9. Science 339(6121): 823-826.
- Frangoul, H. et al. 2021. CRISPR-Cas9 Gene Editing for Sickle Cell Disease and β -Thalassemia. New England Journal of Medicine 384: 252-260.
- Slatko, B.E. et al. 2018. Overview of Next Generation Sequencing Technologies. Current Protocols in Molecular Biology 122: e59.

14. Nurk, S. et al. 2022. The complete sequence of a human genome. *Science* 376(6588): 44-53.
15. Hwang, B. et al. 2018. Single-cell RNA sequencing technologies and bioinformatics pipelines. *Experimental and Molecular Medicine* 50: 1-14.
16. Clark, D. P., and N. J. Pazdernik. 2015. Transgenic plants and plant biotechnology. In Clark, D. P., and N. J. Pazdernik. (Authors), *Biotechnology: Applying the genetic revolution*, p. 397-424. Elsevier Academic Press, San Diego, CA.
17. Chen, JH. et al. 2020. Nuclear-encoded synthesis of the D1 subunit of photosystem II increases photosynthetic efficiency and crop yield. *Nature Plants* 6: 570-580.
18. Clark, D. P., and N. J. Pazdernik. 2015. Immune Technology. In Clark, D. P., and N. J. Pazdernik. (Authors), *Biotechnology: Applying the genetic revolution*, p. 181-217. Elsevier Academic Press, San Diego, CA.
19. Graham, B. 2020. Rapid COVID-19 Vaccine Development. *Science*. 368 (6494): 945-946.
20. Jackson, L. A. et al. 2020. An mRNA Vaccine against SARS-CoV-2 – Preliminary Report. *N Engl J Med*. 383: 1920-1931.
21. Hu, Z., et al. 2021. Personal neoantigen vaccines induce persistent memory T cell responses and epitope spreading in patients with melanoma. *Nature Medicine* 27: 515-525.
22. Gootenberg, J., et al. 2017. Nucleic acid detection with CRISPR-Cas13a/C2c2. *Science* 359 (6336):438-442.
23. Berg, J. M., J. L. Tymoczko, and L. Stryer. 2015. Drug development. In Berg, J. M., J. L. Tymoczko, and L. Stryer (Authors), *Biochemistry*, 8th ed., p. 1033-1056. W. H. Freeman and Company, New York.
24. Gasparo, R. D. et al. 2021. Bispecific IgG neutralizes SARS-CoV-2 variants and prevents escape in mice. *Nature*.
<https://doi-org.libproxy1.usc.edu/10.1038/s41586-021-03461-y>
25. Hofer, M. and Lutolf, M. 2021. Engineering Organoids. *Nat. Rev. Mater*
<https://doi.org/10.1038/s41578-021-00279-y>
26. Scudellari, M. 2019. Self-destructing mosquitoes and sterilized rodents: the promise of gene drives. *Nature* 571(7764): 160-162.
27. Faber, N. R. et al. 2021. Novel combination of CRISPR-based gene drives eliminates resistance and localises spread. *Sci. Rep.* 11: 3179.
<https://doi.org/10.1038/s41598-021-83239-4>.
28. Taketani, M. 2020. Genetic circuit design automation for the gut resident species *Bacteroides thetaiotaomicron*. *Nat Biotechnol* 38: 962-969.

Statement on Academic Conduct and Support Systems

Academic Integrity:

The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or “recycle” work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see [the student handbook](#) or the [Office of Academic Integrity’s website](#), and university policies on [Research and Scholarship Misconduct](#).

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University’s educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

[Counseling and Mental Health](#) - (213) 740-9355 - 24/7 on call

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

[988 Suicide and Crisis Lifeline](#) - 988 for both calls and text messages - 24/7 on call

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

[Relationship and Sexual Violence Prevention Services \(RSVP\)](#) - (213) 740-9355(WELL) - 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

[Office for Equity, Equal Opportunity, and Title IX \(EEO-TIX\)](#) - (213) 740-5086

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.

[Reporting Incidents of Bias or Harassment](#) - (213) 740-5086 or (213) 821-8298

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

[The Office of Student Accessibility Services \(OSAS\)](#) - (213) 740-0776

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

[USC Campus Support and Intervention](#) - (213) 740-0411

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

[Diversity, Equity and Inclusion](#) - (213) 740-2101

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

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) 442-1200 - 24/7 on call

Non-emergency assistance or information.

[Office of the Ombuds](#) - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

[Occupational Therapy Faculty Practice](#) - (323) 442-2850 or otfp@med.usc.edu

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.