Keck School of Medicine of USC

BIOC 581: Toolbox for Biochemistry and Molecular Biology

Units: 4
Term—Day—Time: Fall 2020, T, Th 6 pm – 8 pm, Pacific Standard Time
Location: Online via Zoom
Course Coordinator: Pragna Patel. Ph.D., M.Ed.
Office: XX
Office Hours: By appointment
Contact Info: pragna@usc.edu
Phone: XX
All instructor email addresses are provided below. Students are encouraged to contact them with questions by email; they may expect a response within 48 hours.
Teaching Assistant: TBA
Contact Info: TBA

Course Description

Welcome to BIOC 581! I designed this interactive course from the ground-up in 2016 for three reasons. Firstly, I believe that knowing the principles underlying the methods used in molecular biology, biochemistry and cell biology will provide a strong foundation for experimentation to any student who wants to pursue research. Secondly, I believe that the ability to read a scientific research article can be taught and thus, after learning about the range of methods, it should be possible for students with some guidance to read a paper – not just read it and believe everything the authors say – but to know how to analyze the data on their own and draw their own conclusion. Thirdly, it is never too early to develop scientific writing skills: to practice describing experimental results and their interpretation, to identify controls, and to conceive alternate controls as well as alternate methods to approach a research question. Thus, the goals of BIOC 581 are to help you acquire these critical skills that will be of value throughout your research career no matter the subject. I really enjoy directing and teaching in this course because I get to interact with students throughout the course during the many group exercises that are focused on application of the factual content to real-world laboratory experiments. Having just completed my Master's degree in Education with an emphasis in Learning Design and Technology, I am passionate about experimenting with new tools and approaches to improve students' learning experience and hope you will join me on my adventures.

While this course is open to any MS or PhD student at USC, it is required of all first-year students in the Master's degree program in the Department of Biochemistry and Molecular Medicine. The latter students as well as any other MS or Ph.D. students who embark on a focused thesis project

should be well-prepared with the theoretical knowledge required for experiments and also develop intellectual independence by the end of the course.

Learning Objectives

Upon completion of the course, students should be able to:

1. Utilize databases and simple bioinformatic tools to retrieve, analyze or manipulate nucleotide or amino acid sequence and derive the expected result with 100% accuracy.

2. Explain the principles underlying the methods, equipment and reagents commonly used in biochemistry and molecular biology research.

3. Analyze and interpret the results of a real or hypothetical experiment conducted using molecular biology or biochemistry methods, without error or omission.

4. Given a molecular biology or biochemistry research goal, propose experimental strategy/strategies (including the use of appropriate equipment and/or techniques) to achieve it successfully.

5. Identify the research questions and interpret the experimental data in a research article without being influenced by the author's analysis.

6. Propose alternate approaches to those used in a publication for solving a research question in order to achieve a similar or more informative result.

7. Summarize key concepts of the Introduction, the results and conclusion sections or the entire research article by constructing a concept map.

Prerequisite(s): There are no prerequisite course requirements.
Co-Requisite (s): There are no co-requisite course requirements.
Concurrent Enrollment: Students in the MS program in Biochemistry and Molecular Medicine will be taking BIOC 511 concurrently.
Recommended Preparation: Students will be expected to have a fundamental knowledge of DNA, RNA and protein equivalent to an undergraduate molecular biology course.

Course Notes

General Class structure

1. Before each class, students will be required to view papers/videos that provide basic background on the class topic, followed by a short (3-5 questions) online quiz addressing

basic information from the papers/videos. The quiz will be auto-graded or hand-graded and the grade fed directly into the Blackboard gradebook.

2. Classes will begin with a short introductory lecture, followed by a short period of group work to answer a question (or questions) central to the day's topic. The question(s) will be provided to the students prior to the introductory lecture, to help them focus during the introductory lecture. Student work will be assessed by cold-calling students or group representatives.
3. A longer lecture will provide further details and examples of the day's topic. The lecture will proceed for ~30 mins followed by a 20 min period of group work that will involve solving a problem or interpreting data. The lecture will resume for an additional 30 min and a second period of group work 20 min as before will close the class. Students will be broken into groups (3 to 4 students/group) and as stated, given cases/problems to address. Each student will submit the solved problem on paper or on Blackboard and it will be graded for completion (completed/not completed) and will serve as a means of recording attendance/participation. Student groups will be set by the instructor and changed periodically (every four lectures). Group representatives may be called upon to explain their group's response, as time allows.

Pedagogical techniques

The following practices will be followed throughout the course to enhance student learning experience:

- Active learning strategy of requiring two problem-solving sessions in groups after ~30 mins of the lecture to promote student engagement, information retention, knowledge construction and peer-networking
- Posting of pre-class exercises and of an associated short assignment that is graded to help students gain basic background information to assist their understanding of the lecture
- Posting slide decks on Blackboard two days before the lecture so students can familiarize themselves with content
- Instructors intentionally recalling information from relevant previous lectures to assist students in gaining practice with the information
- Live demonstrations of instrumentation used when possible for mass spectrometry and video demonstrations for flow cytometry and transgenic mice/knockout mice production
- Instruction in critical analysis of empirical research articles to develop critical thinking skills
- Use of an app for formative assessment during the lectures
- Provision of video-captures of each lecture and when possible, the notes for each slide deck after the lecture to enable review of the lecture content if necessary
- Shuffling of student groups after every four lectures to facilitate peer-networking and to alter social learning dynamics

- Rotation of student group seating by the TA in every session and identification of students by tent cards and name tags to enable an instructor to call on a specific student

Communication

Students should feel comfortable asking questions and giving the course coordinator feedback on the course. If they have questions or comments, they should not hesitate to bring them up after class or during posted office hours. They could also email her at pragna@usc.edu. She will respond to all emails within 48 hours.

Technological Proficiency and Hardware/Software Required

Students will need a laptop computer or tablet with internet access to use Blackboard in the classroom. They will also need a smartphone to respond to queries in class. If a loaner laptop is needed, it may be obtained from the USC Computing Center Laptop Loaner Program (details can be seen at https://itservices.usc.edu/spaces/laptoploaner/).

Required Materials

1) There is no textbook for the course.
2) Articles that students are required to read for some lectures will be posted in PDF format on Blackboard. Links to online videos that students are required to watch will be posted on Blackboard prior to and/or after the lecture.

Optional Materials (Placed on reserve at Norris Medical Library for in-library use)

1) Short Protocols in Molecular Biology (2 volume set) 5th Edition, F. Ausubel et al. Editors. Wiley Press. Call No. QH 506 S559 2002 v.1
2) Molecular Cloning: A Laboratory Manual (Fourth Edition): Three-volume set by Michael R. Green, Joseph Sambrook. Cold Spring Harbor Press. Call No. QH 442.2 G797m 2012

Detailed Description and Assessment of Assignments

A) Pre-class assignments: Students will be expected to read the assigned topics or watch a video(s) before the actual class to enhance comprehension of the material in class. They will take a short quiz in Blackboard and will earn full points for completion of the assignment by the posted deadline. Assignments submitted after the deadline will result in a 10% deduction of points for each day they are late. Additional homework assignments may also be given at the discretion of the lecturers.

B) In-class participation: Typically, two problem-solving exercises will be assigned during class and students will work in groups and submit the responses individually to the instructor on paper or on Blackboard. Full credit will be earned for thoughtful completion and submission of the exercise by the posted deadline.

C) Exams: There will be a total of three exams. Each of the exams will test understanding of topics covered in the course. These exams will be partly open-computer and partly closed-book written exams given at a scheduled time/date. Exam formats will include a few multiple-choice questions, and short-answer questions; most of the exam questions will follow the format of the group exercises where they will be required to analyze and interpret data.

D) In-class individual graded assignment: This in-class graded assignment will be toward the end of the semester before the final exam and will test a student's ability to apply the method taught in the course on how to read a paper critically and will require a working knowledge of all the methods learnt in the course. It is aligned with the learning objective #5 that states*: Identify the research questions and interpret the experimental data in a research article.* The students will be given a worked example of the quiz so that they are clear about what is expected of them.

E) Final Project: Students will be given a semester-long group assignment that they can do at their pace where they will be given the name of five genes. Each student group will select one gene and identify articles where at least six of the Methods were used to answer questions such as the "What is the research question being asked?", "Why did they use Method X?" and "What other method could they have used instead of Method X?" This assignment will be due just before the final exam. Eighty percent of the final grade will be the grade for the submitted group assignment. In addition, an individual grade will be given for a reflection statement from each student about the student's learning experience during the Final Project. The average of the individual grades will be used towards 20% of the final grade.

In addition, repeat exams or assignments may be given if the instructor perceives that students have not demonstrated mastery in particular areas.

Items A and B are essential participation grades and designed primarily for learning, not assessment or evaluation. Item E likewise is designed to allow a student to complete at their own pace working in a small group. It encourages students to develop a curiosity about different journals and different fields that use the methods covered in the course and is intended to stimulate students to listen to each lecture with an ear for application.

Grading Breakdown

Grades will be recorded in the Blackboard gradebook.

Assignment	% of Grade
Exams • Exam 1 (15%) (mid-term) • Exam 2 (15%) (mid-term) • Exam 3 (15%) (final)	45
In-class assignment (paper analysis)	15
Group exercises (in class work)	15
Pre-class assignments	5
Final Project • Final paper (16%) • Average of Individual grade (4%)	20
Total	**100**

Grading Scale

Final grade will be based upon the following percentages:

Default threshold*	Grade
93%	**A**
90%	**A-**
87%	**B+**
83%	**B**
80%	**B-**
77%	**C+**
73%	**C**
70%	**C-**
60%	**D**
<60%	**F**

* **Default threshold** *is the minimum score needed for the corresponding letter grade.*

Course-specific Policies

Assignment Completion and Submission Policy
Before class, students will be required to view papers/videos that provide basic background on the class topic, followed by a short (3-5 question) online quiz addressing basic information from the papers/videos that will be graded. In-class assignments must be completed by working collaboratively in groups rather than individually and can be done on paper and submitted as such or uploaded as a Word document on Blackboard and will be used to determine the class participation grade.

Grading Timeline
All graded work will be returned no later than two weeks from the exam date or submission deadline.

Late work
If the submission deadline for a pre-class or group assignment is missed, the assignment may be submitted up to one day late. A 10% grade deduction will be applied to all late assignments.

Up to two of the lowest pre-class and up to two of the lowest group assignment scores will be dropped during the final grade calculation.

Technology in the classroom
Students can use personal electronic devices (laptops, cell phones) **only** for academic purposes directly related to the class.

Expectations on Student engagement
Students are expected to act in a professional manner, meeting deadlines, solving problems, responding to questions from instructors voluntarily or when called upon, cooperating with classmates, and generally contributing in a positive way to the class. Working in the real world often means searching for solutions in a group context. Teamwork, listening, empathy, enthusiasm, emotional maturity, and consideration of other people's concerns are all essential to success. Please bring these qualities and values with you to class. It is as important to 'practice' these interpersonal skills as it is to learn new intellectual content.

Students are expected to provide feedback to instructors. This can be done informally during the semester through the course director or TA. It must be done formally by responding to surveys conducted where student anonymity is maintained to ensure that necessary changes may be made to the instructional material, presentation or assessments.

Academic integrity

A grade of zero will be applied to submitted work that does not comply with the USC standards of academic conduct. Such work may not be resubmitted for a new grade.

Attendance

Students are expected to attend all class sessions, on time, for the entire course of the class. If any student misses an in-class assignment, he/she will not be allowed to make up those points.

Course evaluation

Two surveys will gather student opinions about the course: the mid-semester evaluation and the standard USC course evaluation survey at the end of the semester. Your opinion is valued and can make a difference in how this course is conducted; please give your honest and constructive recommendations.

Course Schedule: A Weekly Breakdown

BIOC 581_2020_Course Schedule Tuesdays and Thursdays, 6 - 8 pm					
Session	**Day**	**Month**	**Date**	**Topic**	**Lecturer**
1	Tuesday	August	18	Overview of databases and resources available for Mol Biol. Hands-on exercises with NCBI databases; Literature databases: Pubmed vs Google Scholar; OMIM, Web of Science.	Patel
2	Thursday	August	20	DNA Manipulation, Amplification, and Detection: Enzymes to modify, label amplify or quantify nucleic acids; Polymerase chain reaction (PCR) and applications incldg. hybrid PCR, quantitative PCR, real time PCR, digital PCR; PCR-based mutagenesis methods	Patel
3	Tuesday	August	25	DNA Cloning I: Applications of cloning, vectors, transformation methods, plasmid purification systems, traditional cloning methods	Patel
4	Thursday	August	27	DNA Cloning II: Applications of advanced cloning and mutagenesis; Gateway & PIPE, sequence, and ligation-independent cloning, Gibson cloning, Type IIs cloning; site-directed/insertion/deletion mutagenesis	Patel
5	Tuesday	September	1	cDNA and Genomic Libraries: Construction and handling of cDNA libraries; whole genome libraries, targeted strategies such as exome and regional capture, circulating cell-free genomic libraries	Patel
6	Thursday	September	3	First-Generation Sequencing and Global Gene Expression: Introduction to Maxam-Gilbert, Sanger and automated Sanger sequencing; microarray analysis	Allayee
7	Tuesday	September	8	DNA Variation Detection: Technology approaches for detection of single nucleotide and structural variants; determination of allele-specific expression using coding variants	Allayee
8	Thursday	September	10	Next-generation sequencing platforms: Principles and comparison of the different sequencing technologies and their applications	Campo
optional	Friday	September	11	Review session	Patel/ TA

9	Tuesday	September	15	Genomic Profiling Methods: Functional assays using NGS: ChIP-seq, Whole genome Bisulfite-seq, ATAC-seq, and RNA-seq	Bell
10	Thursday	September	17	Exam 1	Patel
11	Tuesday	September	22	Transfection and stable cell line production: approaches for the introduction of DNA into mammalian cells (CaCl2, lipofection, electroporation and lentivirus-mediated); various selection methods including G418, hygromycin & puromycin, single clone isolation	Frenkel
12	Thursday	September	24	RNA Interference: RNA interference (RNAi) mechanisms and tools, technical considerations in using RNAi	Frenkel
13	Tuesday	September	29	Transgenic and Knock-out mice: constructs, generation of founders, breeding basics, Cre-lox applications	Maxson
14	Thursday	October	1	Genome editing: Zinc-finger technology, TALEN, CRISPR/Cas9 systems	Cannon/Rogers
15	Tuesday	October	6	Physical Biochemistry Methods: pH, dialysis and filtration, spectrophotometry (absorbance spectroscopy, fluorescence spectroscopy, fluorescence transfer, circular dichroism), centrifugation	Siemer
16	Thursday	October	8	Protein Purification: Strategies for protein purification, basic principles of purification (solubilization, centrifugation, differential precipitation, column chromatography). Protein quantification and stabilization.	Comai
optional	Friday	October	9	Review session	Patel/ TA
17	Tuesday	October	13	Analysis of Proteins and Detection of Protein-Protein Interactions: Electrophoresis, isoelectric focusing, 2D gels, immunoblotting, immunoprecipitation, protein motifs, and domains. Methods to detect protein-protein interactions: co-immunoprecipitation, in vitro pull-down assays and yeast two-hybrid system. Protein expression systems (E. coli, yeast, insect and mammalian cells), epitope/affinity tags (6x His, GST, HA, myc).	Comai
18	Thursday	October	15	Exam II	Patel
19	Tuesday	October	20	Application of the methods learnt in the course/data analysis in research papers: Part I	Patel
20	Thursday	October	22	Microscopy: Light, Fluorescence, confocal microscopy; principles and applications	Lansford
21	Tuesday	October	27	Flow cytometry: Introduction to the technique of flow cytometry and cell sorting, detecting fluorescent cells through expressed antigens and endogenous fluorescent molecules	TBD
22	Thursday	October	29	Visualizing DNA, RNA and Proteins: in situ hybridization (ISH), fluorescence ISH, immunohistochemical detection methods; colored fluorescence protein reporters; fluorescence resonance energy transfer (FRET)	Frey
23	Tuesday	November	3	Mass Spectrometry - Basic Principles: instruments and analytical methods; principles of identification of analytes	Katz

				and analysis of data. Specific examples with peptides and post-translational modifications (PTMs). Protein identification, MS-based quantification	
24	Thursday	November	5	Application of the methods learnt in the course/data analysis in research papers: Part II	Patel
25	Tuesday	November	10	In-class assignment: Analysis of a paper using the techniques learnt in class (counts towards class grade)	Patel
26	Thursday	November	12	Group work: Final Project (work in class; get feedback as needed)	Patel
27	Thursday	November	18	Final exam	Patel

Statement on Academic Conduct and Support Systems

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

Support Systems:
Student Counseling Services (SCS) – (213) 740-7711 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. engemannshc.usc.edu/counseling

National Suicide Prevention Lifeline – 1 (800) 273-8255
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) – (213) 740-4900 – 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender-based harm. engemannshc.usc.edu/rsvp

Sexual Assault Resource Center
For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: sarc.usc.edu

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086
Works with faculty, staff, visitors, applicants, and students around issues of protected class. equity.usc.edu

Bias Assessment Response and Support
Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. studentaffairs.usc.edu/bias-assessment-response-support

The Office of Disability Services and Programs
Provides certification for students with disabilities and helps arrange relevant accommodations. dsp.usc.edu

Student Support and Advocacy – (213) 821-4710
Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. studentaffairs.usc.edu/ssa

Diversity at USC
Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. diversity.usc.edu

USC Emergency Information
Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. emergency.usc.edu

USC Department of Public Safety – UPC: (213) 740-4321 – HSC: (323) 442-1000 – 24-hour emergency or to report a crime.
Provides overall safety to USC community. dps.usc.edu