Course Syllabus: Special Topics - CRISPR and Genome Editing

Course Information
Course number: BMEN6396
Title: CRISPR and Genome Editing
Time: Friday 10am-12:45pm
Semester: Fall 2025
Location: GR 4.208

Instructor Information
Instructor: Leonidas Bleris
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Office hours: MS Teams (by email)
Office location: NSERL 4.708

Course Description
Genome editing has evolved from early engineered nucleases such as **zinc finger proteins** and **TALENs**, which provided programmable but complex means of targeting DNA, to the transformative **CRISPR-Cas systems**, which offer unprecedented simplicity and versatility. CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) originates from microbial adaptive immunity and, when repurposed in eukaryotes, has revolutionized agriculture, biomanufacturing, and human health. This course traces that trajectory: beginning with zinc fingers and TALENs, then advancing to CRISPR locus architecture; Cas9/Cas12/Cas13 mechanisms; guide RNA design; DNA repair pathways (NHEJ/HDR); and emerging modalities such as base and prime editing. Additional modules cover delivery strategies (plasmid, RNP, viral), off-target prediction/measurement, pooled functional genomics, and ethical/regulatory challenges. Students will design end-to-end genome editing experiments, analyze sequencing and phenotypic data, and prepare a project proposal that applies editing technologies to real-world problems.

Learning Outcomes
- Explain CRISPR adaptive immunity and major Cas families.
- Design gRNAs and choose editing modalities (knock-out, knock-in, base/prime).
- Select delivery methods matched to cell type and application.
- Predict and evaluate off-target risk; interpret editing outcomes.
- Plan and analyze pooled screens; summarize results clearly.
- Discuss ethical, safety, and regulatory considerations.

Textbook: Notes/Slides/Papers

Topics
1. Introduction to Molecular and Cell Biology – DNA, RNA, proteins, gene expression, and repair pathways
2. History of Genome Editing Tools – zinc finger nucleases, TALENs, and the rise of CRISPR systems
3. CRISPR Biology: gRNAs and Cas Proteins – mechanisms of Cas9, Cas12, Cas13, and emerging variants
4. Design and Bioinformatics Tools – guide RNA selection, off-target prediction, and computational resources
5. CRISPR-Based Genome Editing – knockouts, knock-ins, and homology-directed repair
6. Base, Prime, and RNA Editing – cytidine and adenine base editors, prime editing systems, and ADAR-mediated RNA editing
7. CRISPR Libraries and Functional Screening – pooled screens, phenotypic assays, and data analysis
8. CRISPR in Human Health – applications in genetic diseases, immunotherapy, and regenerative medicine
9. CRISPR Beyond Editing – diagnostics, sensors, and in vitro technologies
10. Ethics, Safety, and Policy – responsible innovation, biosafety, regulation, and societal impact
11. Team Projects and Presentations – design and propose a genome editing experiment or application

Grading Policy: Grades will be based on the project reports, homework, exams, and online presentations.

Classroom Conduct Requirements Related to Public Health Measures
UT Dallas will follow the public health and safety guidelines put forth by the Centers for Disease Control and Prevention (CDC), the Texas Department of State Health Services (DSHS), and local public health agencies that are in effect at that time during the Fall 2021 semester to the extent allowed by state governance. Texas Governor Greg Abbott's Executive Order GA-38 prohibits us from mandating vaccines and face coverings for UT Dallas employees, students, and members of the public on campus. However, we strongly encourage all Comets to get vaccinated and wear face coverings as recommended by the CDC. Check the Comets United: Latest Updates webpage for the latest guidance on the University's public health measures. Comets are expected to carry out Student Safety protocols in adherence to the Comet Commitment. Unvaccinated Comets will be expected to complete the Required Daily Health Screening. Those students who do not comply will be referred to the Office of Community Standards and Conduct for disciplinary action under the Student Code of Conduct – UTSP5003.

Class Attendance
The University's attendance policy requirement is that individual faculty set their course attendance requirements. Regular and punctual class attendance is expected. Students who fail to attend class regularly are inviting scholastic difficulty. In some courses, instructors may have special attendance requirements; these should be made known to students during the first week of classes. Faculty have the discretion to set an attendance policy for their in-person meetings, but the absences due to COVID-19 cannot be counted against a quarantined student.

Class Participation
Regular class participation is expected. Students who fail to participate in class regularly are inviting scholastic difficulty. A portion of the grade for this course is directly tied to your participation in this class. It also includes engaging in group or other activities during class that solicit your feedback on homework assignments, readings, or materials covered in the lectures (and/or labs). Class participation is documented by faculty. Successful participation is defined as consistently adhering to University requirements, as presented in this syllabus. Failure to comply with these University requirements is a violation of the Student Code of Conduct.

Class Recordings
Students are expected to follow appropriate University policies and maintain the security of passwords used to access recorded lectures. Unless the Office of Student AccessAbility has approved the student to record the instruction, students are expressly prohibited from recording any part of this course. Recordings may not be published, reproduced, or shared with those not in the class, or uploaded to other online environments except to implement an approved Office of Student AccessAbility accommodation. Failure to comply with these University requirements is a violation of the Student Code of Conduct.

NOTE: if the instructor records any part of the course, then the instructor will need to add the following syllabus statement:
The instructor may record meetings of this course. These recordings will be made available to all students registered for this class if the intent is to supplement the classroom experience. If the instructor or a UTD school/department/office plans any other uses for the recordings, consent of the students identifiable in the recordings is required prior to such use unless an exception is allowed by law.

Academic Support Resources
The information contained in the following link lists the University's academic support resources for all students. Please see http://go.utdallas.edu/academic-support-resources.

UT Dallas Syllabus Policies and Procedures
The information contained in the following link constitutes the University's policies and procedures segment of the course syllabus. Please review the catalog sections regarding the credit/no credit or pass/fail grading option and withdrawal from class. Please go to http://go.utdallas.edu/syllabus-policies for these policies.

The descriptions and timelines contained in this syllabus are subject to change at the discretion of the Professor.