

University of Colorado, Boulder
Dept. of Chemical & Biological Engineering
CHEN 5838 Module 2: **The science and engineering behind the COVID-19 mRNA vaccines.** Spring 2022
Course Syllabus

Schedule

Lecture MW Mar 7 - Apr 27 3pm-4:35pm [Jennie Smoly Caruthers Biotec B115](#)

Office Hours Thurs 11-12 E1B32. *These office hours are nominally reserved for those giving presentations in the following week. I will have expanded office hours in the future.*

Course Instructor: Dr. Tim Whitehead
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Course catalog: This 2-credit module will be taught in the last 7 weeks of Spring 2022 (Monday March 7th - Wednesday Apr 27th). *You've taken the vaccine, now learn about the vaccine.* This course covers the science and engineering of mRNA biotechnology specifically in the context of the COVID-19 mRNA vaccines developed by Pfizer and Moderna.

About This Course

There are four parts to this course. The course will begin on general concepts in vaccinology and basic immunology, followed by presentation of pre-clinical and clinical results of the COVID-19 mRNA vaccines. Next, the discovery and development of mRNA technology will be covered, including key biochemistry and protein engineering advances. The third part of the course covers the vaccine process development led by biological and biochemical engineers, including high cell density fermentations, plasmid DNA purification, in vitro transcription, lipid formulations, supply chain management, and quality control. The final week of the course will cover the intellectual property landscape and the future prospects for mRNA biotechnologies.

Required COVID statement

As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policy on [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the "Accommodation for Disabilities" statement on this syllabus.

Required Text

There is no required text for this course.

Supplementary Texts

During the course we will utilize additional material from the following textbooks in lecture and assessments:

Janeway's Immunobiology 7th edition. ISBN: 0-8153-4123-7

Additionally, we will include dozens of primary literature research and review articles; all

relevant texts will be posted on Canvas.

Learning Objectives. Students completing this course should have and/or know:

1. Qualitatively describe general concepts in vaccinology and basic immunology.
2. Biochemistry behind mRNA technology.
3. Sequence-function relationships for diverse viral glycoproteins.
4. Protein engineering concepts on stability of viral glycoproteins.
5. Vaccine process development for mRNA vaccines, including high cell density fermentations, plasmid DNA purification, in vitro transcription, lipid formulations, supply chain management, and quality control.
6. A working knowledge of mRNA biotechnologies beyond the specific vaccination use.

Point Distribution for the Course Grade (late assignments NOT accepted)

50%	Oral Presentations
10%	Interim Research Paper
40%	Final Research Paper

Assessments. There are two main assessments for this course.

1. **Oral presentations.** Each student will give two oral presentations over the course of the semester. Each oral presentation will describe a seminal paper in the field (that I give you ahead of time) & include some details. Each of these presentations is expected to be 15-18 minutes in length, including questions.
2. **Research Paper.** Students have a choice for final research paper. The first choice would be to develop an independent research idea and to prepare an NSF (10 page) or NIH (6 page) research proposal on this topic. The **interim report** would be a 1 page research summary due the week of April 18th. The alternative choice is to present a critical review on a *narrow* topic covered during this semester (expecting 50-60 references using a *Current Opinion in....* format) with recent cutting edge research. The **interim report** would be a professionally prepared scientific abstract (250-300 words) and a rough outline of the main text. Since many of the narrow topics have been covered in recent and current reviews in the primary literature, I strongly recommend this second option only for undergraduates.

Active Shooter Situation

In the unlikely event we become involved in an active-shooter situation, we will follow the following strategies:

Step 1: Figure out whether we heard gunfire, where it is, and how many shooters.

Step 2: Get out – move quickly and get out if not safe. Leave your belongings!

Step 3: Call Out – call 911 with as much information as possible.

Step 4: Hide Out and Keep Out (Secure-in-Place) – Lock or barricade the doors to the classroom/lab.

Step 5: Spread Out – If we have to secure-in-place in A104, do not huddle together.

Step 6: Take Out – if necessary we may have to take out the active shooter. CHOOSE TO SURVIVE.

Accommodation for Disabilities

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition or injury, see [Temporary Medical Conditions](#) under the Students tab on the Disability Services website.

Classroom Behavior

Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on [classroom behavior](#) and the [Student Code of Conduct](#).

Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the [Honor Code Office website](#).

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

The University of Colorado Boulder (CU Boulder) is committed to fostering a positive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct, intimate partner abuse (including dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#).

Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, **students are responsible for alerting professor within the first two weeks for any potential conflicts with the course schedule.**

See the [campus policy regarding religious observances](#) for full details.

Tentative Course Outline. The topics and schedule in the syllabus are subject to change based on the expertise of the guest lecturers.

Week	Lectures	Lecture Content	Assignments Due
Mar 7 th	1-2	How do vaccines work? <i>Basics of Immunology</i> & clinical results for mRNA vaccines.	--
Mar 14 th	3-4	The mRNA technology behind mRNA vaccines	Oral presentations #1-4
Mar 21 st	--	SPRING BREAK	--
Mar 28 th	5-6	Immunogen design: viral glycoproteins and protein engineering	Oral presentations #5-8
Apr 4 th	7-8	Waning immunity and viral escape: how to hit a moving target, repeatedly	Oral presentations #9-12
Apr 11 th	9-10	Process Development I: Production of mRNA	Oral presentations #13-16
Apr 18 th	11-12	Process Development II: Scale-up & Quality Control	Interim Paper Due; Oral presentations #17-20
Apr 25 th	13-14	IP and Future Prospects for mRNA biotechnology	Oral presentations #21-24
May 2 nd	--	--	Final Paper Due 5 PM Mon May 2nd