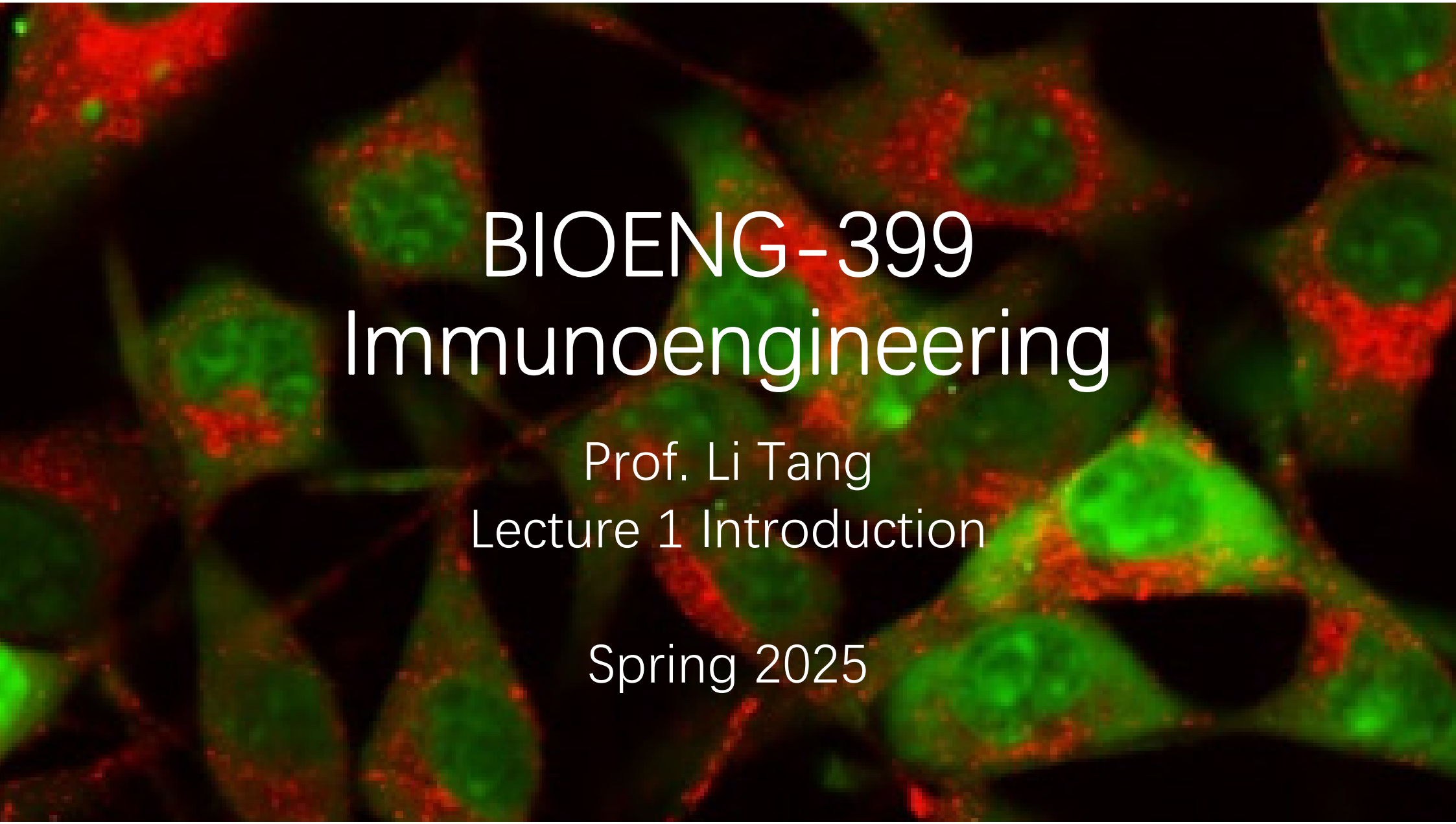


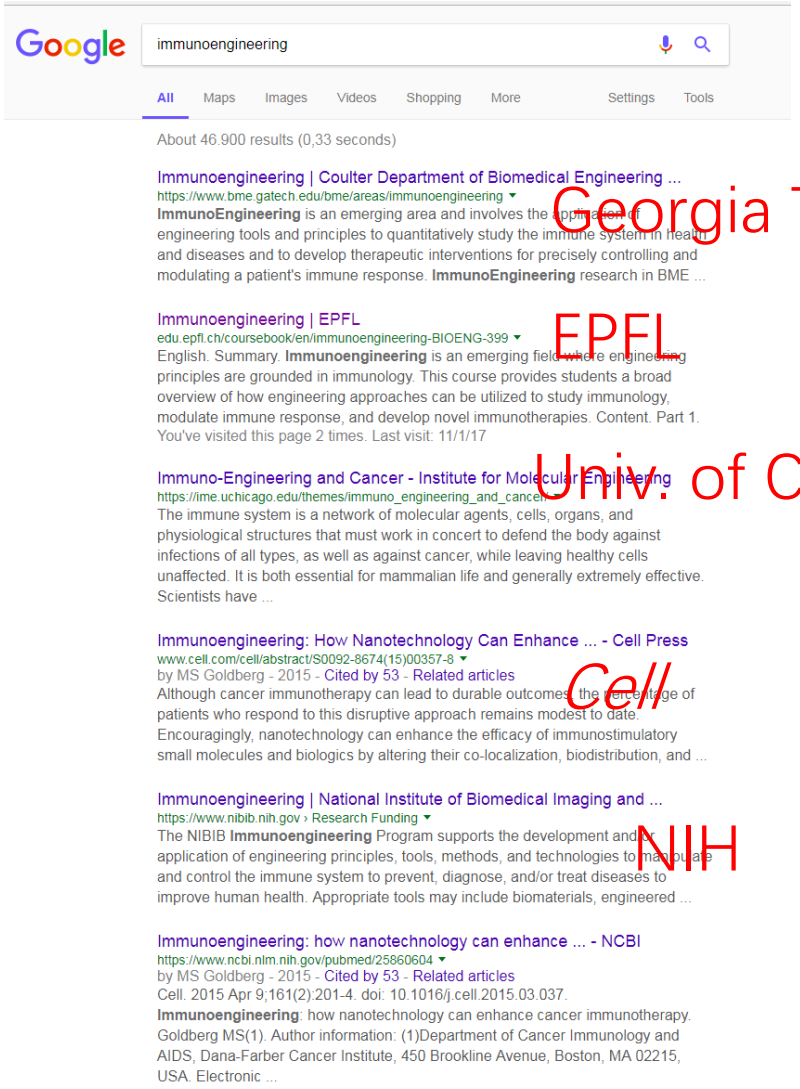
BIOENG-399 Immunoengineering

Prof. Li Tang

Lecture 1 Introduction

Spring 2025

Why do we need this course?



Yes, teaching a course on **Immunoengineering** at the university level is highly important, especially given the increasing role of engineering approaches in immunology and medicine. Here's why:

1. Bridging Engineering and Immunology

Immunoengineering integrates principles of bioengineering, synthetic biology, and materials science with immunology. This interdisciplinary approach is essential for training the next generation of scientists and engineers who can design novel immunotherapies, vaccines, and diagnostics.

2. Growing Demand in Industry & Research

With advances in **CAR-T cell therapy, monoclonal antibodies, cytokine engineering, and biomaterials for immune modulation**, industries are actively seeking professionals who understand both engineering and immunology. A course in **Immunoengineering** prepares students for careers in biotech, pharma, and academia.

3. Cutting-Edge Biomedical Applications

Students will learn how to:

- Engineer immune cells for cancer therapy
- Design biomaterials for vaccine delivery
- Develop computational models for immune system responses
- Apply nanotechnology in immunotherapy

4. Enhancing Problem-Solving Skills

The field is filled with open-ended challenges—how to improve immune responses, reduce autoimmune reactions, or develop personalized immunotherapies. Teaching Immunoengineering cultivates **critical thinking and innovation**.

5. Preparing for the Future of Medicine

Immunotherapy is revolutionizing medicine. As next-generation therapies become

What do we want to learn from this course?

Exposure to real research world is the key theme of this class!

What are the basic principles of immunoengineering?

What are some of the cutting-edge research on-going in the field?

How to identify unmet biomedical needs and look for solutions?

How to connect the knowledge/techniques from distinct fields?

How to do research/problem-solving in academia or industry?

Introducing Teachers

Lecturer: Prof. Li Tang

Laboratory of Biomaterials for Immunoengineering
Lab website: https://tang-lab.epfl.ch/
li.tang@epfl.ch

Guest Lecturer : Dr. Miguel Garcia

Director, EPFL Flow Cytometry Core Facility (FCCF)
Lab website: https://fccf.epfl.ch/
miguel.garcia@epfl.ch

Guest Lecturer: Dr. Mathias Wenes

Post Doctoral Researcher – UNIGE (Wenes Mathias – Agora)
Head of immunotherapy - MPC Therapeutics (Welcome to MPC Therapeutics)
mathias.wenes@unige.ch

Guest Lecturer: Dr. van (Vanya) Loroch

CEO, NOVOCHIZOL SA (https://www.novochizol.ch/)
yl@novochizol.ch

Miguel Garcia

Mathias Wenes

Yvan (Vanya) Loroch

Introducing Teachers

Teaching Assistants (TAs)

Arianna Dorschel	arianna.dorschel@epfl.ch
Emile Dorchies	emile.dorchies@epfl.ch
Ellen Dagher	ellen.dagher@epfl.ch
Jiayi Tan	jiayi.tan@epfl.ch

How do we communicate after classes?

Moodle and emails

Office hours:

-TAs are available during exercises
-Prof. Tang and TAs are also available by appointments.

Moodle

All the logistic documents including lecture notes, relevant papers, etc will be uploaded in Moodle

https://moodle.epfl.ch/

Basic Facts

Life Sciences Engineering (Biotechnology minor)

Bachelor semester 6/Master semester 2/4

Semester: Fall

Credits 4

Lecture: 2 Hour(s) per week x 14 weeks

Exercises: 2 Hour(s) per week x 14 weeks

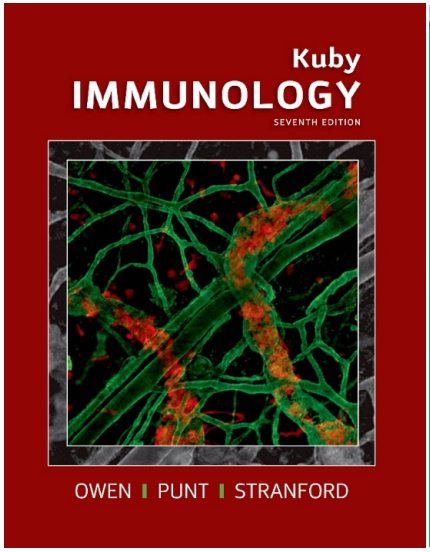
Required courses:

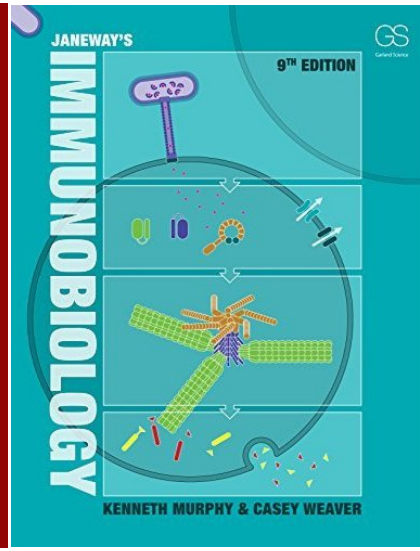
- BIO-310 Immunology (Lemaitre Bruno, Suter David Michael) *or an equivalent*
- https://edu.epfl.ch/coursebook/en/immunology-BIO-310
- MOOC is available (in French): https://www.epfl.ch/labs/lemaitrelab/enseignement-introduction-a-limmunologie-moocs/

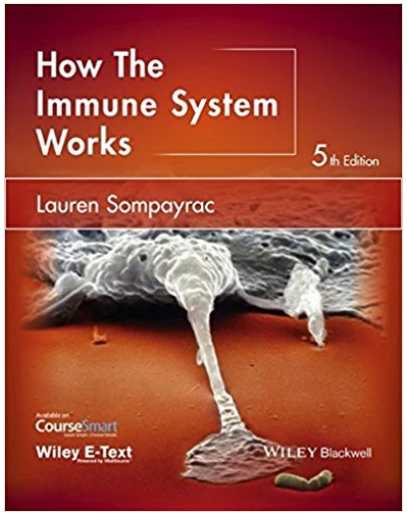
Textbook

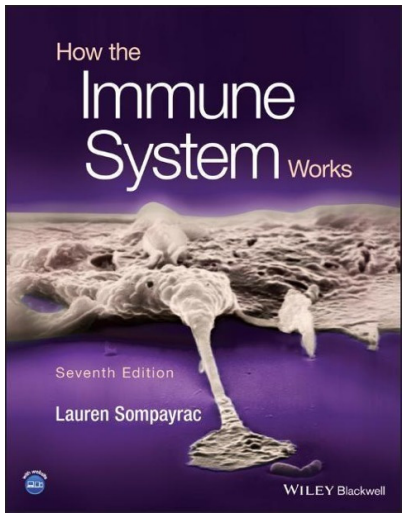
There is no required textbook

- an immunology textbook could be a useful reference
- For example: **Kuby Immunology**, **Janeway's Immunobiology** (newest or older editions)
- A short, inexpensive primer: Lauren Sompayrac's '**How the Immune System Works**' (any edition): highly recommended for students with little previous exposure to immunology
- All available in EPFL library









Course Schedule

Lectures (L)	**CE1106**	**Friday 8h15-10h00**
Exercises (E)	CE1106	Friday 10h15-12h00

Date	Class	Content/Activity	Teacher(s)
21-Feb	**L1**	**Introduction**	**LT**
		none	
28-Feb	**L2**	**The Emerging Field of Immunoengineering**	**LT**
	E1	review and exercise	**TAs**
7-Mar	**L3**	**Cancer and Cancer Immunotherapy**	**LT**
	E2	review and exercise	**TAs**
14-Mar	**L4**	**Introduction to Flow Cytometry**	**Dr. Miguel Garcia**
	E3	review and exercise	**TAs**
21-Mar	**L5**	**Overview of Drug Delivery**	**LT**
	E4	EPFL Flow Cytometry Core Facility (FCCF)	**TAs**
28-Mar	**L6**	**Material Engineering in Cancer Immunotherapy**	**LT**
	E5	EPFL Flow Cytometry Core Facility (FCCF)	**TAs**
4-Apr	**L7**	**Immune Cell Engineering**	**LT**
	E6	review and exercise	**TAs**
11-Apr	**L8**	**Metabolic Engineering and Immunity**	**Dr. Mathias Wenes**
	E7	review and exercise	**TAs**
18-Apr		Good Friday	
25-Apr		Easter	
2-May	**L9**	**An Overview of Vaccine**	**LT**
	E8	Tang lab visit	**TAs**
9-May	**L10**	**Design of Immunogenic Vaccines I**	**LT**
	E9	Tang lab visit	**TAs**
16-May	**L11**	**Design of Immunogenic Vaccines II**	**LT**
	E10	review and exercise	**TAs**
23-May	**L12**	**Considerations in Drug Disc.&Devel.**	**Dr. Yvan Loroch**
	E11	review and exercise	**TAs**
30-May	**L13**	**Special Vaccines**	**LT**
	E12	review of the whole course	**TAs**
Final Exam: time/place to be accnounced by email and Moodle			
Lectures (L)	lectures by Tang: 10		
	guest lectures: 3		
Exercises (E)	review and exercise: 8		
	lab visit: 4		

Overview of the course – Exercises

Review and exercise

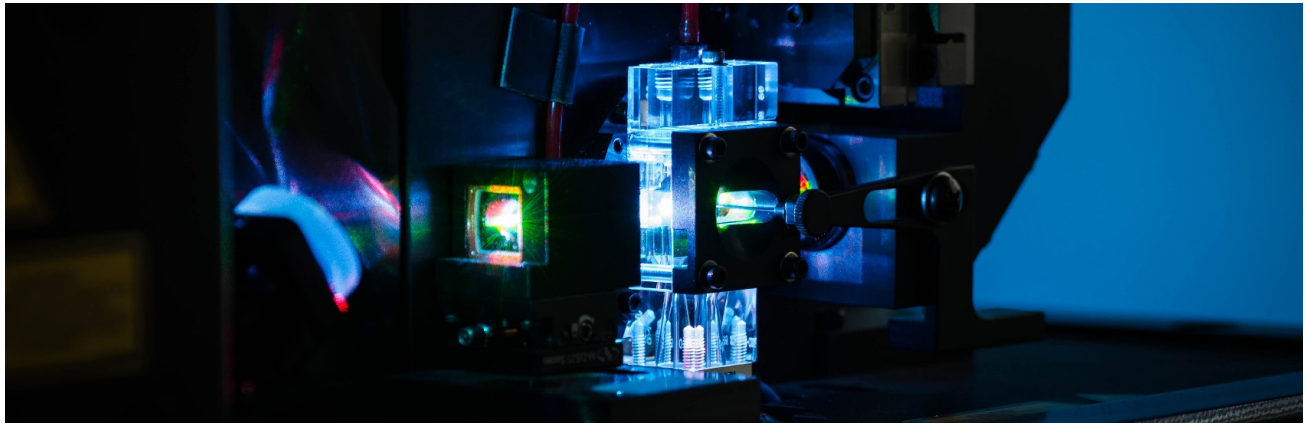
- Lead by TAs
- Recapitulate the previous lectures
- Address questions regarding the research papers mentioned in the lectures (prepare your questions)
- Practice with questions (use smart phone, laptop, or clicker available from library)

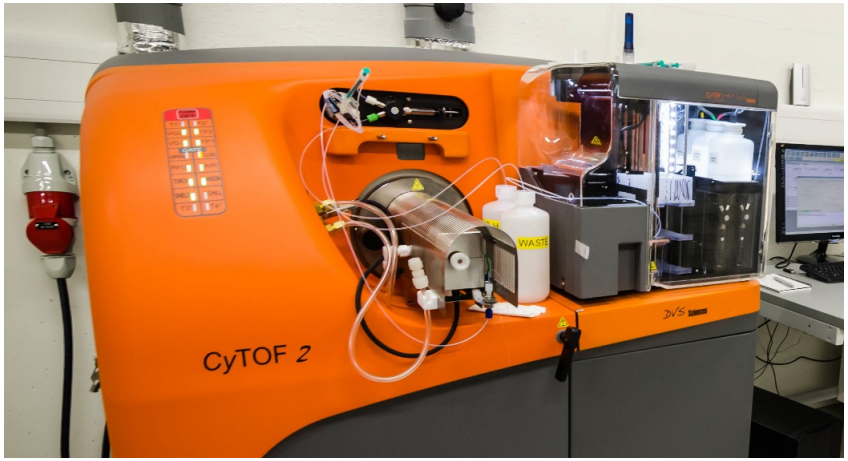
Overview of the course – Exercises

Lab visit

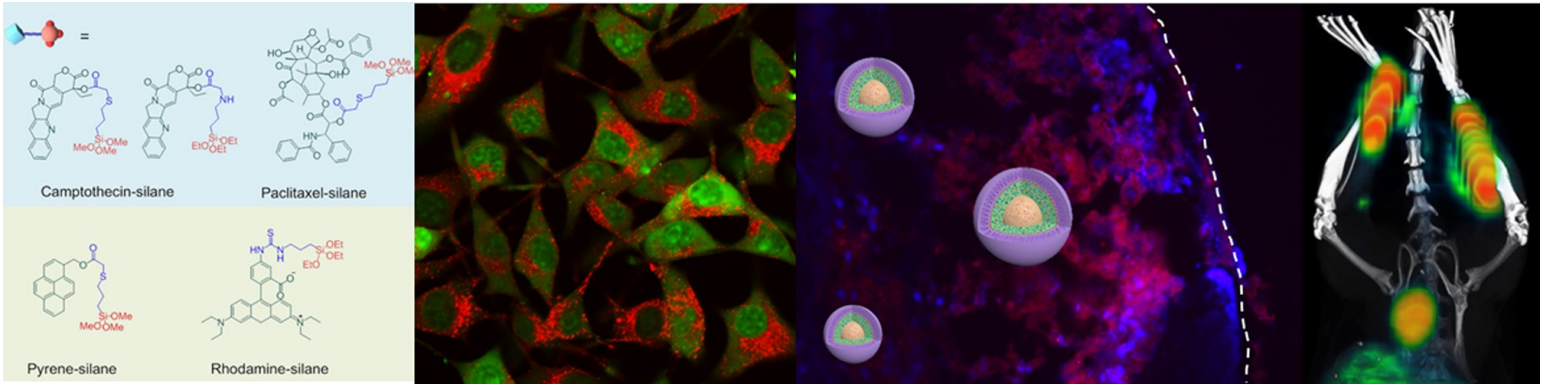
- Choose a day from 2
- Sign up by doodle: the TAs will email the doodle link one week ahead of time
- ~max 20 students/group for each visit (first come first serve)

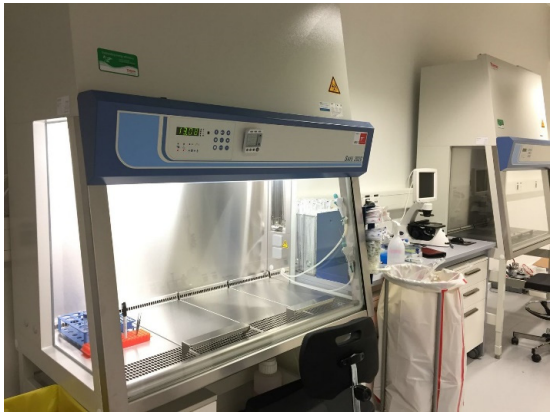
EPFL Flow Cytometry Core Facility (FCCF)





Laboratory of Biomaterials for Immunoengineering (LBI)





Assessment method

Average:	5.09
Median:	5.00

Scientific essay: 30%

Final written exam: 70%

- Exam format: single and multiple choice questions, questions/brief answers (examples will be shared before the exam)
- Exam questions will be similar as the questions in Exercises
- ONLY the contents on lecture notes will be covered in the final exam (you don't have to search and read each cited papers in the lecture; but you are encouraged to do so if you are interested)
- Detailed experimental information that is not required will be labeled in lecture slides
- Questions on guest lectures will be light
- Lab visits are not included in the final exam

Assessment method

- **What is the difference between review papers vs. original research papers?**

Scientific essay: 30%

- Choose any topic related to immunoengineering (discuss your topics with TAs during exercise session)
- Read related, recent papers in this topic (search in Web of Science, Pubmed, Google Scholar, etc):
  - **BA at least 1 review article and 1 research article**
  - **MA at least 1 review article and 2 related research article (compare and discuss the 2 papers); and propose an idea with some justification**
- Write a **2-page (BA) or 3-page (MA)** scientific essay ("views" or "perspective") to summarize this topic (state-of-the-art, outstanding challenges, your own perspective); summarize and comment on the research of the papers you read
- Grading criteria: choice of topic, understanding of the topic, comprehensiveness, vision
- Detailed guidelines and examples (template, criteria) are uploaded in Moodle
- **ChatGPT or other AI tools are forbidden**

Article | Published: 09 July 2018

Enhancing T cell therapy through TCR-signaling-responsive nanoparticle drug delivery

Li Tang, Yiran Zheng, Mariane Bandeira Melo, Llian Mabardi, Ana P Castaño, Yu-Qing Xie, Na Li, Sagar B Kudchodkar, Hing C Wong, Emily K Jeng, Marcela V Maus & Darrell J Irvine

Nature Biotechnology **36**, 707–716(2018) | Cite this article

Abstract

Adoptive cell therapy (ACT) with antigen-specific T cells has shown remarkable clinical success; however, approaches to safely and effectively augment T cell function, especially in solid tumors, remain great interest. Here we describe a strategy to 'backpack' large quantities of supporting protein drugs on T cells by using protein

Nature Biotechnology

MENU nature biotechnology

News & Views | Published: 06 August 2018

A backpack revs up T-cell activity

Thomas Shum & Helen E Heslop

Nature Biotechnology **36**, 702–703(2018) | Cite this article

Cytokine backpacks improve T-cell efficacy in the tumor microenvironment.

Turning a T cell infused into a cancer patient into a large population of tumor-killing T cells requires just the right combination of events. The T cell must recognize a tumor antigen on an antigen-presenting cell, its costimulatory receptors must be engaged, and it must encounter cytokines required for proliferation and sustained tumoricidal activity.

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Quantum cascade laser lives on the edge

Devices known as quantum cascade lasers produce useful terahertz radiation, but are typically highly sensitive to fabrication defects. This limitation has now been overcome using a property called topological robustness.

Sunil Mittal & Edo Waks

News & Views | 29 January 2020

Protein structure reveals how a malaria parasite imports a wide r of sugars

Unlike many sugar-transporting proteins, a transporter in one species of malaria parasite import several types of sugar equally effectively, aiding the parasite's survival. The struct protein reveals the reason for its versatility.

Thorsten Althoff & Jeff Abramson

News & Views | 12 February 2020

Ordered absences observed in porous framework materials

Prussian blue analogues are archetypes of coordination solids, in which metal ions are bri ligands to form extended network structures. An analysis reveals a surprising ordering of found in their crystal lattices.

Adam Jaffe & Jeffrey R. Long

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