

A fluorescence microscopy image showing a dense population of cells. The cells exhibit bright green fluorescence, likely indicating the presence of a specific protein or marker. Interspersed among the green cells are some cells showing red fluorescence, possibly representing a different cell type or a different state. The background is dark, making the fluorescent cells stand out.

BIOENG-399

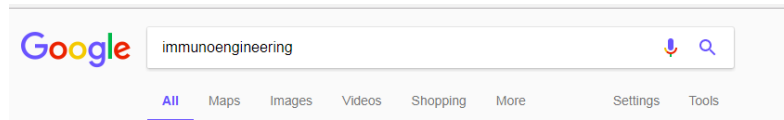
Immunoengineering

Prof. Li Tang

Lecture 1 Introduction

Spring 2025

Why do we need this course?



Immunoengineering | Coulter Department of Biomedical Engineering ...
<https://www.bme.gatech.edu/bme/areas/immunoengineering>
ImmunoEngineering is an emerging area and involves the application of engineering tools and principles to quantitatively study the immune system in health and diseases and to develop therapeutic interventions for precisely controlling and modulating a patient's immune response. **ImmunoEngineering** research in BME ...

Georgia Tech

Homepage – Immunoengineering and Regenerative Medicine | ETH ...
www.immunoereg.ethz.ch/
 Welcome to the Laboratory for **Immunoengineering** & Regenerative Medicine. The Laboratory for **Immunoengineering** & Regenerative Medicine aims to elucidate cellular alterations underlying various pathologies and consequently to develop novel, molecular treatment options, with a focus on controlling inflammation.

ETH

Immunoengineering | EPFL
<https://ime.epfl.ch/coursebook/en/immunoengineering-BIOENG-399>
 English. Summary **Immunoengineering** is an emerging field where engineering principles are grounded in immunology. This course provides students a broad overview of how engineering approaches can be utilized to study immunology, modulate immune response, and develop novel immunotherapies. Content. Part 1. You've visited this page 2 times. Last visit: 11/1/17

EPFL

585.651 - Immunoengineering | Johns Hopkins University Engineering ...
<https://ep.jhu.edu/programs-and-courses/585.651-immunoengineering>
Immunoengineering is a quickly growing field where engineering principles are used to better understand the dynamics of the immune system and enhance the efficacy of current immunotherapeutics. This course will provide relevant background in our understanding of various immune responses including to pathogens, ...

Johns Hopkins

Immuno-Engineering and Cancer - Institute for Molecular Engineering
https://ime.uchicago.edu/themes/immuno_engineering_and_cancer
 The immune system is a network of molecular agents, cells, organs, and physiological structures that must work in concert to defend the body against infections of all types, as well as against cancer, while leaving healthy cells unaffected. It is both essential for mammalian life and generally extremely effective. Scientists have ...

Univ. of Chicago

ImmunoEngineering | Bloomberg-Kimmel Institute for Cancer ...
<https://www.hopkinsmedicine.org/kimmel...for.../immunoengineering.html>
 The **Immunoengineering** Program at the Bloomberg-Kimmel Institute for Cancer Immunotherapy has emerged as a link between the fields of biomedical engineering and immunotherapy. Led by Jennifer Elisseeff, Ph.D., director of the Translational Tissue Engineering Center, the program's work stems from discoveries ...

Immunoengineering: How Nanotechnology Can Enhance ... - Cell Press
[www.cell.com/cell/abstract/S0092-8674\(15\)00357-8](http://www.cell.com/cell/abstract/S0092-8674(15)00357-8)
 by MS Goldberg - 2015 - Cited by 53 - Related articles
 Although cancer immunotherapy can lead to durable outcomes, the percentage of patients who respond to this disruptive approach remains modest to date. Encouragingly, nanotechnology can enhance the efficacy of immunostimulatory small molecules and biologics by altering their co-localization, biodistribution, and ...

Cell

[PDF] Immunoengineering - MIT Department of Biological Engineering
be.mit.edu/sites/default/files/documents/immunoengineering.pdf
 Aug 15, 2016 - Updated August 15, 2016. **Immunoengineering**. Faculty: Michael Birnbaum, Arup Chakraborty, Darrell Irvine, Doug Lauffenburger, Timothy Lu, Ram. Sasisekharan, Dane Wittrup. Faculty contact: Michael Birnbaum (mbirnb@mit.edu). Description: What vaccine best exploits the evolutionary weaknesses of a ...

MIT

Immunoengineering | National Institute of Biomedical Imaging and ...
<https://www.nibib.nih.gov/ResearchFunding>
 The NIBIB **Immunoengineering** Program supports the development and/or application of engineering principles, tools, methods, and technologies to manipulate and control the immune system to prevent, diagnose, and/or treat diseases to improve human health. Appropriate tools may include biomaterials, engineered ...

NIH

Searches related to immunoengineering

immunoengineering definition
 immunoengineering mit

Nature

Eindhoven University...



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](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](https://fccf.epfl.ch/miguel.garcia@epfl.ch)

Guest Lecturer: Dr. Mathias Wenes

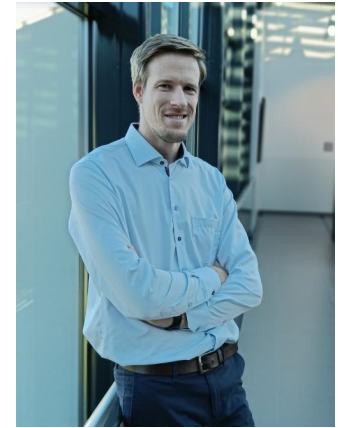
Post Doctoral Researcher – UNIGE ([Wenes Mathias – Agora](#))
Head of immunotherapy - MPC Therapeutics ([Welcome to MPC Therapeutics](#))
mathias.wenes@unige.ch

Guest Lecturer: Dr. van (Vanya) Lorocho

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



Miguel Garcia



Mathias Wenes



Yvan (Vanya) Lorocho

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

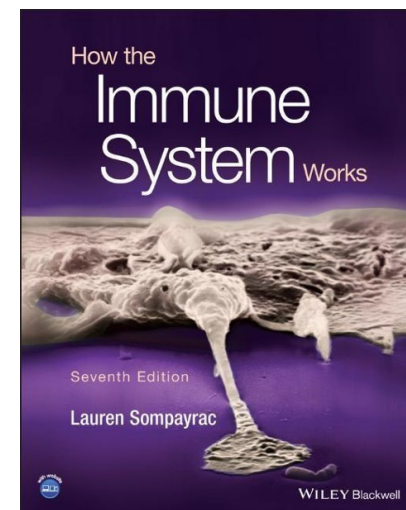
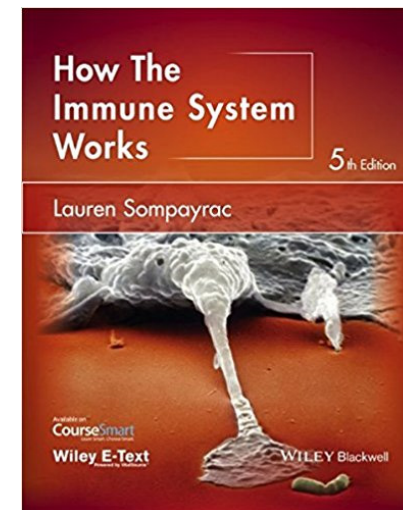
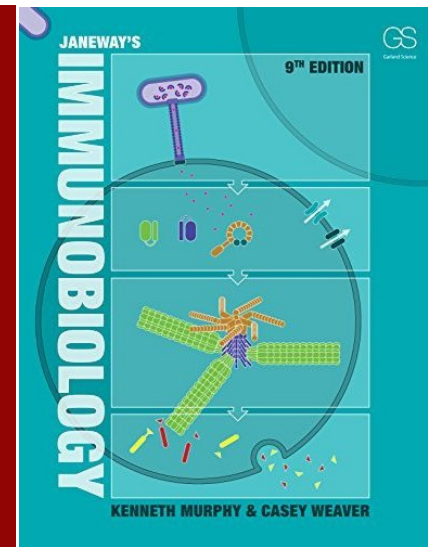
Required courses:

- 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 announced 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

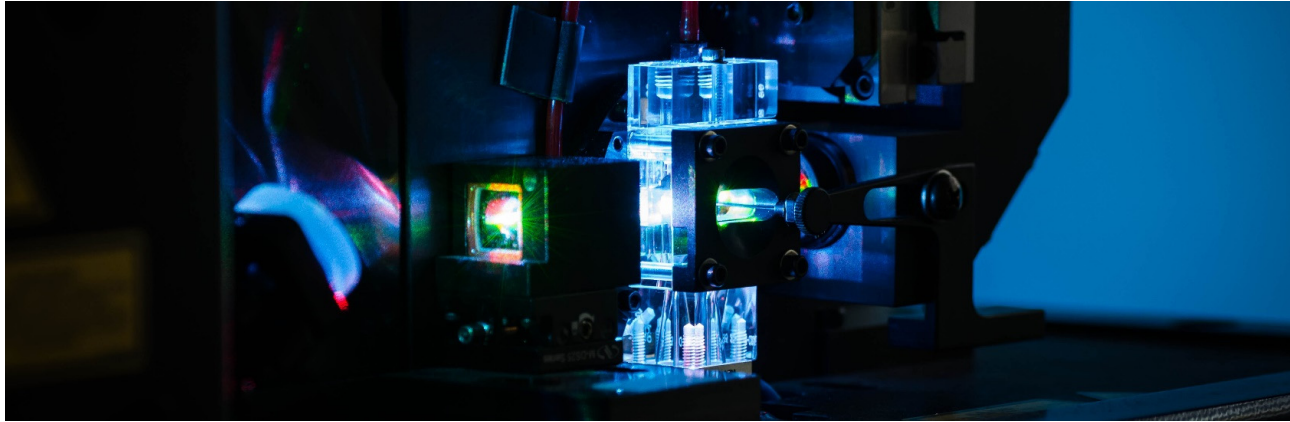
- Lead by TAs
- Recapitulate the previous lectures
- Address questions regarding the research papers mentioned in the lectures (prepare your questions)
- Practice with questions (use smart phone, laptop, or clicker available from library)

Overview of the course – Exercises

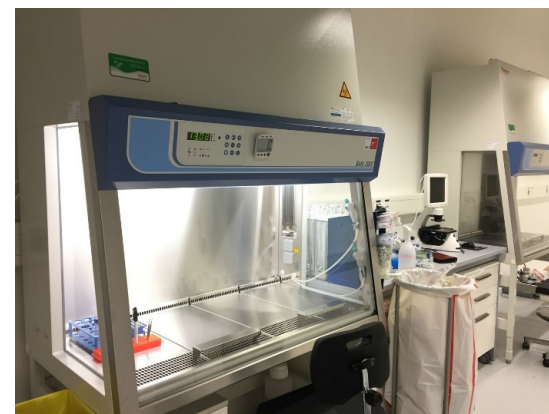
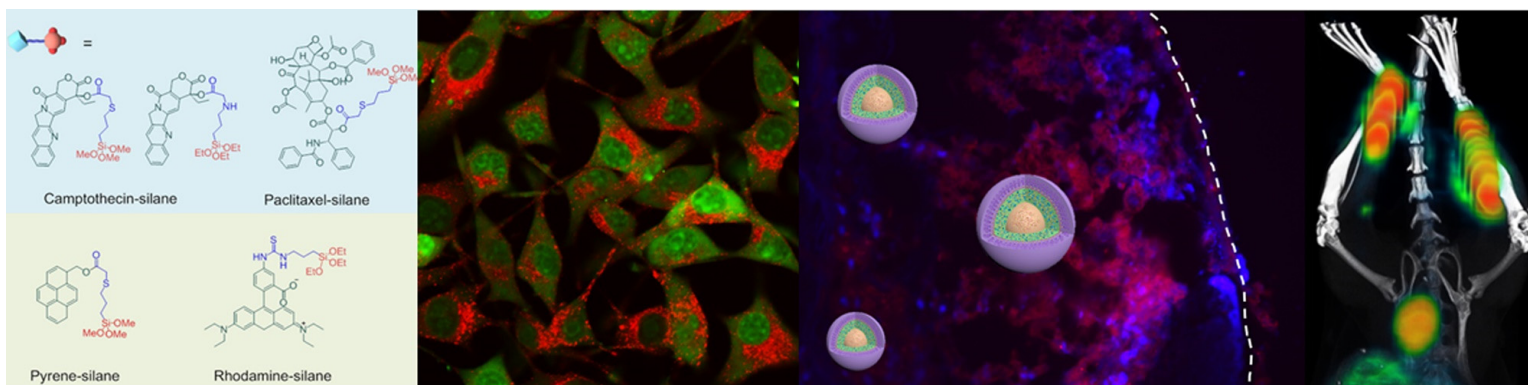
Lab visit

- 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

Scientific essay: 30%

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

- 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](#)

9446 Accesses | **66** Citations | **230** Altmetric | [Metrics](#)

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

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[A backpack revs up T-cell activity](#)

Thomas Shum & Helen E Heslop

[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](#)

745 Accesses | **1** Citations | **8** Altmetric | [Metrics](#)

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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Li Tang, Yiran Zheng[...] Darrell J Irvine

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News & Views

News & Views | 12 February 2020

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 range of sugars

Unlike many sugar-transporting proteins, a transporter in one species of malaria parasite can import several types of sugar equally effectively, aiding the parasite's survival. The structure of the 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 bridged by ligands to form extended network structures. An analysis reveals a surprising ordering of voids found in their crystal lattices.

Adam Jaffe & Jeffrey R. Long

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