

Immunoengineering

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Description: What vaccine best exploits the evolutionary weaknesses of a virus or a tumor's mutations? What is the intratumoral exposure history of intravenously injected antibodies? How does deregulated signaling tip the balance from healthy homeostasis to autoimmune disease? Can native T cell tropism overcome physical barriers to macromolecular drug delivery? How does our antibody repertoire respond to therapy or disease? How might innate and adaptive immunotherapies best be combined? How does lymphatic transport actively regulate adaptive immunity? Can injectable biomaterials program and effective anti-tumor immune response? A common thread through these varied topics is the engagement of biological, chemical, and materials engineers at the forefront. At their disposal in an analytical toolkit honed to solve problems in the petrochemical and materials industries, which share the presence of complex reaction networks, and convective and diffusive molecular transport. Powerful synthetic capabilities have also been crafted: binding proteins can be engineered with effectively arbitrary specificity and affinity, and multifunctional nanoparticles and gels have been designed to interact in highly specific fashions with cells and tissues. Fearless pursuit of knowledge and solutions across disciplinary boundaries characterizes this nascent discipline of immune engineering, synergizing with immunologist and clinicians to put immunotherapy into practice.

Guide for class selection:

While these courses can be taken in any order, students should consider starting the concentration with 20.230 (co-listed as 7.23), which provides a comprehensive background in immunology helpful for contextualizing the other courses. Additionally, 20.365 is strongly recommended as the 'keystone' course for the concentration as it focuses on applying engineering approaches to immunology. As these courses are both given in the spring, it is suggested that students interested in this concentration take 20.230 in Junior year followed by 20.365 in Senior year. If necessary for course scheduling, students may consider simultaneously taking 20.230 and 20.365, but should consult the instructors about the potential benefits and drawbacks of doing so.

Restricted Electives

20.230 Immunology (co-listed with 7.23) (U)

Prereq: 7.06 (7.06 can be considered as a co-req with permission of instructor)

7.26 Molecular Basis of Infectious Disease (U)

Prereq: 7.06

7.371 Biological and Engineering Principles Underlying Novel Biotherapeutics (U)

Prereq: 7.06

7.45 The Hallmarks of Cancer (U)

Prereq: None Coreq: 7.06

10.495 Molecular Design and Bioprocess Development of Immunotherapies (U)

Prereq: 7.06 or permission of instructor

20.365 Engineering the Immune System in Cancer and Beyond (U)

Prereq: 20.110 or permission of instructor

20.373 Foundations of Cell Therapy Manufacturing (NEW)

Prereq: none

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