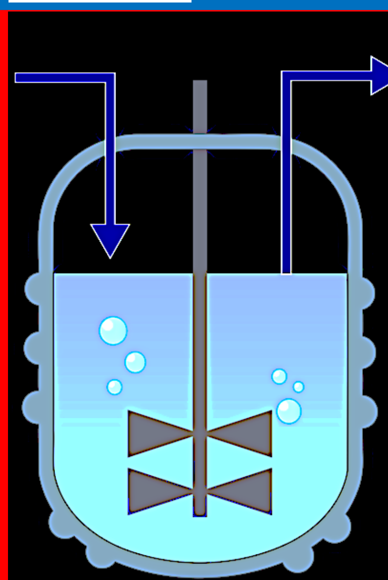
Chemical-Biological Engineering Laboratory 10.28
Fall 2017
Fundamental Concepts and Applications in Energy and Biotechnology

<u>**Your**</u> <u>**Future**</u> Starts Now

WE WILL FOCUS ON:

- **Bioinformatics**
- **Combinatorial Chemistry**
- **Biochemical Engineering**
- **Mini- and Benchtop bioreactors**
- **Online analytical tools**



- **Digital & Hands-on Learning**
- **Industry expertise**
- **Professional communication skills**
- **Become a sought-after 10.28 graduate**

A course for juniors and seniors in the Schools of Science and Engineering

Lead Instructor: Dr. Jean-François Hamel

Communications Instructor: Mary Caulfield

Learn by Doing!

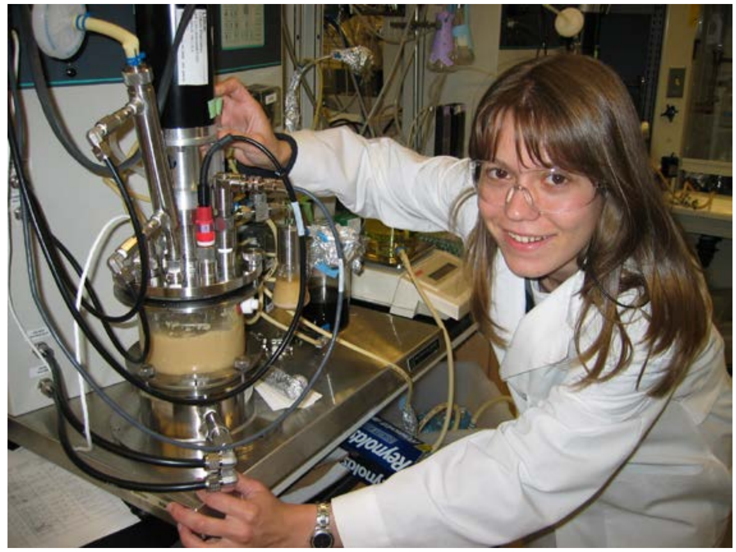
Live demonstration in 10.28 as the class learns bioreactor assembly, before going back to their benches to practice doing it themselves.

COURSE 10.28

Chemical-Biological Engineering Laboratory - *Fundamental Concepts and Applications in Energy and Biotechnology* is an introductory experimental and computational lab course which fulfills the requirements for 10, 10B, 7A and is an elective for the Energy Minor, while it gives you the opportunity to engage in the discovery process of tackling *real* research questions. Students from Courses 5, 6, 7 and 20 have also joined the class.

As a Science or Engineering major, you will learn how to solve technological problems and these skills have lead previous students to go into fields of study such as the development of clean energy resources, materials, pulp and paper manufacturing, pharmaceuticals, plastics, personal care products, synthetic fibers, food processing, waste treatment, pollution abatement, public health and biotechnology.

During the course, you will have the opportunity to discuss aspects of the field and your course with industry experts, including during on-site visits (the 2016 Class spent an afternoon with scientists and engineers at Shire Pharmaceuticals – see page 6).



Team members set up their fluidized-bed reactor in the continuous mode (called “perfusion”) during a process for IgG production

A student studies an industrial yeast yielding antibody fragments, in the fed-batch bioreactor

In this course, research questions are generated by faculty, but approaches and methods for working on them, are chosen by you and your team as you engage in real research. Every term is a little different from the last; coursework is selected based in part on the real needs of companies. Here’s what some former students have to say about the course:

Amanda Lewis, Scientist II Bristol-Myers Squibb (MA) says*:*

> *"The biotechnology industry is looking for smart and innovative problem solvers with hands-on, relevant laboratory experience. MIT's 10.28 course gives students exposure to concepts, equipment, and problems that are directly relevant to industry. In particular, the opportunity to operate cell culture bioreactors is unique and directly applicable to many jobs. For those interested in a career in biotechnology, I highly recommend the 10.28 course."*

Mariah Hoover, Shell (TX):

> *In her internship right after 10.28 she said: "Kitty and I are out here at Clorox (Pleasanton, CA) and we just finished our 2nd of 3 power point presentations on the progress of our project and we're both thanking you SO much for 10.28 presentations. We had a serious leg up on the other students and felt comfortable in front of all the employees who came to our talk. It's an awesome skill to have out here!!"*

Sam Maurer, Scientist II at DuPont in Palo Alto (CA):

> *In his internship right after 10.28 with Bayer CropScience, he said: The job was laid-back and definitely a change from MIT classes and my UROP experience. Still, I've had the opportunity to get some extensive training in LC-MS and TOF chromatography, which I had never encountered before. I haven't directly applied any of the concepts that I learned in MIT classes, but I think that 10.28 was extremely helpful in teaching me how to quickly pick up new lab techniques and learn new instrumentation--there's so much equipment in the 10.28 lab and so many different modules that you need to learn things as quickly as possible in order to survive."*

Maxine Yang, now at Philips (MA):
In her internship with Eli Lilly, St. Louis after 10.28, she said: I developed a model for calculating the OUR that the 40-L pilot plant reactor could support, using the conservation of mass to model oxygen transfer. I estimated k_La of the sparger much the same way we did in 10.28--I took oxygen probe readings, and fit the model to the experimental data (although the model I developed is much more complex than what we used in 10.28)".

What will we do in the Lab?

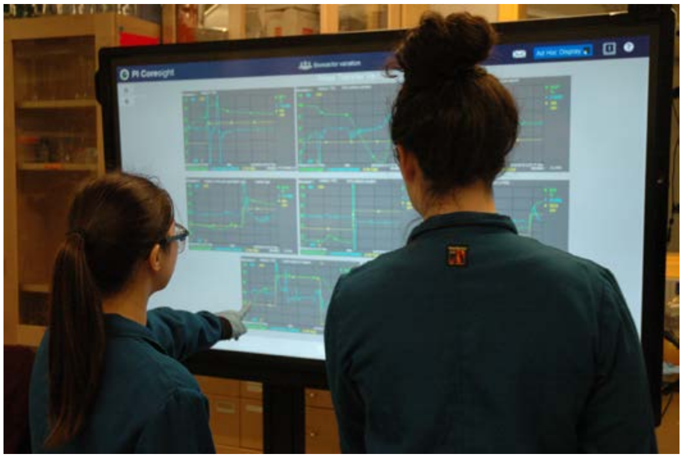
IN THE ONLINE ENVIRONMENT YOU WILL:

a) Learn concepts of chemical and biological engineering, relevant to the chemical, biopharmaceutical and energy fields
b) Develop communication skills for producing written and oral reports, individually (the Technical Analysis Paper or TAP) and as a team, peer-reviewing, and interviewing industry leaders
c) Monitor your learning experience weekly, thanks to built-in assessment tools
d) Control bioreactor experiments, run continuously for days, from home, using state-of-the-art software

A live bioreactor can be observed remotely with a smart phone. Being able to see real-time trends from the sensors (e.g., pH, dissolved oxygen, CO_2), is a useful feature for week-long continuous experiments. Do science from your dorm room!!

IN THE LABORATORY YOU WILL:

a) Apply your prior and 10.28 knowledge and experience to hands-on, meaningful, real-life research in both the energy and biotech fields
b) Put "principles into practice," using state-of-the-art equipment, including bioreactors and online mass spectrometry (for O_2 and CO_2 off gas) to study batch and continuous processes
c) Learn for concepts behind combinational chemistry, as part of a drug discovery experiment
d) Study process intensification with a microalgae platform that sequesters gas-warming CO_2 while bioenergy products omega-3 fatty acids and H_2 gas
e) Propose, with your team, specific experiment design, prior to each lab session
f) Shoot videos or take pictures to document complex laboratory procedures, in preparation for your written and oral reports
g) Analyze the real-time bioreactor-off gas data from all teams on a large monitor in the lab, all at once.



Students analyze the O_2 mass transfer trends from 8 bioreactors (1 bioreactor per team), seen simultaneously on a large monitor, in the lab.

A student gathers the glucose data from a robotic biochemical analyzer, which reads a 96-well plate in a few minutes.

Overall, you'll build your critical thinking and scientific reasoning skills as you analyze your data with peers and the course instructor. Additionally, your written and oral communication skills will increase as you present findings to team mates and at a formal presentation session at the end of the course. With guidance, you will choose your own experimental pathway.

Pre-Requisites

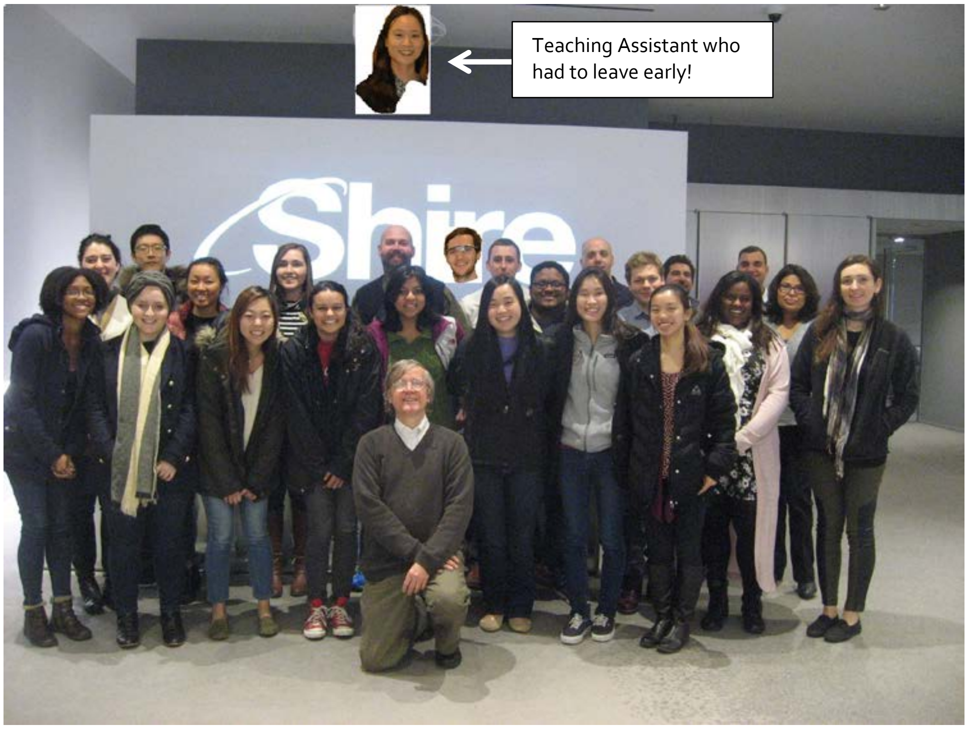
Biochemistry (e.g., 7.05, 5.07) or equivalent, and Introductory lab course (e.g., 5.310, 7.02) or equivalent.

Career Focus

Biotech, energy, consulting, traditional chemical and food companies and start-ups have benefited from 10.28 graduates.

Some students even use their final oral presentation when looking for summer internships and their first jobs.

Meeting with Shire Scientists & Engineers (Fall 2016)



Career Paths after the Lab?

- Hunt for new antibiotics to fight the challenge of drug-resistance
- Discover new clean energy technologies and fuels
- Consult for companies in the health care and chemical and biological process industries
- Discover new greener chemicals, that are less toxic and more sustainable
- Develop innovative sensors and better analytical tools
- Regulate pollution and direct industrial clean up
- Create new microelectronics, and biotechnology systems
- Develop new forms of pollution control
- Work on traditional fuels and chemicals

Want to be a part of this? Here's how!

Reserve your spot by pre-registering directly for 10.28 or, if you would like more information, please email Dr. J.-F. Hamel, at jhamel@mit.edu.