Online Synthetic Biology Courses

Course delivered by HKU iGEM 2020

Aim: The Online Synthetic Biology course is interdisciplinary course. We designed the course to start from the easiest part, then progressively increase the difficulty, so people without any scientific background could participate.

Our course is synbio-focused, and we will elaborate on the latest synthetic biology development from multiple perspectives. We sincerely students will acquire the skillset to design and complete an iGEM project hope that after the course.

Course outline:

Part 1 Basic Biology and Genetics and current research

- Introduction, Course Structure
- How does a organism work (genetics and epigenetics), and real life examples.
- What is DNA and what is protein
- From DNA to Protein, and different level of organization
- Developmental Genetics (pattern formation via gene signaling)
- How to add functionality to an organism, interesting examples. How to make bacteria/viruses our friend and cooperate.
- Current research and what are synbio used in real life (Perhaps go on filming a tour somewhere), iGEM and what constitutes a good synbio/iGEM research project

- Side module- bioethics, biosafety
- GMO and Human genome editing
- Side module- Online research tools and where to find paper and data
- Conducting an effective and efficient search. (And evaluating relevance)

Part 2 Parts, logic and gene circuit logic

- DNA parts, Cloning, piecing DNA together, vector, genome.
- Basic promoter, gene, terminator, enhancer etc. (Gene operon)
- Transcription factors, cells signaling (use human endocrine system as example)
- Basic Logic (And, Or, not etc.)
- Advanced logic (Multiple logic output)
- Constructing logic and memory in gene

Part 3 Complex circuit Design

- Gene Regulations
- Positive feedback, negative feedback loops
- Oscillators, toggle switches
- Metabolic burden
- Efficiency in gene networking (a simple comparison study)

Part 4 Mathematical modelling

- Python (Numpy), Matlab
- Kinetics, equilibrium
- Binding affinities (Hills) Etc.
- Proteomics modelling studies and DNA database alignment

Part 5 Tools in synthetic biology, Case/paper studies and comparison

- e.g. Different oscillators, unsynchronized v.s. quorum sensing synchronized version
- Comparison of different production project's pathway and efficiency.
- Tools: directed evolution, mutation studies, screening, metabolic engineering etc.
- Side module- entrepreneurship
- Depending on support I get, and platform, there will also be quiz and midterm.

Online/Offline Synthetic Biology Related Course

EdX by MIT
https://www.edx.org/course/principles-of-synthetic-biology
Corresponding publication: Principles of synthetic biology: a MOOC for an emerging field

Synbiobeta (one day)
https://synbiobeta.com/education/

Coursera by Manchester in Industrial Biotechnology (6 min)
https://www.coursera.org/lecture/industrial-biotech/introduction-to-synthetic-biology-visions-for-biotechnology-2-0-3kIJq?authMode=signup&isNewUser=true&redirectTo=%2Flecture%2Findustrial-biotech%2Fintroduction-to-synthetic-biology-visions-for-biotechnology-2-0-3kIJq
Course description:

1. Understand enzymatic function and catalysis
2. Explain the technologies and methodologies underpinning systems and synthetic biology
3. Explain the diversity of synthetic biology application and discuss the different ethical and regulatory/governance challenges involved in this research
4. Understand the principles and role of bioprocessing and biochemical engineering in industrial biotechnology
5. Have an informed discussion of the key enabling technologies underpinning research in industrial biotechnology
6. Give examples of industrial biotechnology products and processes and their application in healthcare, agriculture, fine chemicals, energy and the environment.

Course by MIT

- https://ocw.mit.edu/courses/biology/7-342-systems-and-synthetic-biology-how-the-cell-solves-problems-fall-2010/
- https://ocw.mit.edu/courses/find-by-topic/#cat=engineering&subcat=biologicalengineering&spec=syntheticbiology
- https://ocw.mit.edu/courses/biology/7-91j-foundations-of-computational-and-systems-biology-spring-2014/video-lectures/lecture-21-synthetic-biology-from-parts-to-modules-to-therapeutic-systems.-guest-lecture-ron-weiss/

Course description:

A millennial challenge in biology is to decipher how vast arrays of molecular interactions inside the cell work in concert to produce a cellular function. Systems biology, a new interdisciplinary field of science, brings together biologists and physicists to tackle this grand challenge through quantitative experiments and models. In this course, we will discuss the unifying principles that all organisms use to perform cellular functions. We will also discuss key challenges faced by a cell in both single and multi-cellular organisms. Finally, we will discuss how researchers in the field of synthetic biology are using the new knowledge gained from studying naturally-occurring biological systems to create artificial gene networks capable of performing new functions.

This course is one of many Advanced Undergraduate Seminars offered by the Biology Department at MIT. These seminars are tailored for students with an interest in using primary research literature to discuss and learn about current biological research in a highly interactive setting. Many instructors of the Advanced Undergraduate Seminars are postdoctoral scientists with a strong interest in teaching.

Coursera by Maryland
https://www.coursera.org/lecture/genes/synthetic-biology-8CrH2

Coursera by Johns Hopkins
https://www.coursera.org/learn/synbioethics

iBiology
https://www.ibiology.org/playlists/synthetic-biology/

University of Cambridge
https://www.synbio.cam.ac.uk/education

Overall
https://openwetware.org/wiki/Synthetic_Biology:Courses

Summer Course
https://academic.oup.com/synbio/article/3/1/ysy020/5210879?searchresult=1

MIT online course paper
https://academic.oup.com/synbio/article/4/1/ysz010/5487999

EMBL (offline)
https://www.embl.de/training/events/2019/SYN19-02/
Course description

The program consists of practicals with two daily lectures on some of the hottest topics in Bacterial SynBio, including:

1. Genome engineering (incl. CRISPR and MAGE)
2. Customizing synthetic sRNAs as tools to control gene expression
3. Engineering of synthetic C1-metabolism
4. In vitro gene expression implementation
5. Frugal screening of large biocatalyst libraries.

All students will engage in the corresponding activities. The practical will focus on bacteria, while the lectures will encompass a suite of topics in contemporary Synthetic Biology.