# Engineering Life: Synthetic Biology and Innovations for Human Health

Fall 2025/26

**Course Information**
*Course number: BIEN1610*
*No. of Credits: 3.0*
*Credit hours: 2 hours 40 mins per week/13 weeks*
*Meeting times: Mon. 12:00PM - 13:20PM; Wed. 12:00PM - 13:20PM*
*Classroom location: LT-D*

**Instructor Information**
**Prof. Yong Lai**
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## Course Description

This course offers an introductory overview of synthetic biology and its innovations for human health, encompassing both technical and business aspects, tailored for undergraduate students. It is suitable for those intrigued by the cutting-edge technologies driving the emerging biopharmaceutical industry and interested in the transformation of synthetic biology. This course begins by exploring the timeline of biotechnology's emergence and development, delving into the discovery of groundbreaking pharmaceuticals in human history and the evolution of synthetic biology. It provides students with a framework for critical thinking while exploring the current landscape of synthetic biology. The course covers key milestones, explains foundational scientific concepts, and highlights the transformative impact of synthetic biology on human health. Through case studies, students gain insights into the opportunities and limitations in current and future technological advancements. Additionally, the course features guest lectures by experts from the industry and investment sector, offering valuable perspectives on course-related topics.

The course is divided into four main parts. **Part I** talks about the roots and history of synthetic biology. The technological development of some classical biotechnology products is highlighted, in the context of the opportunities captured by the companies that are considered biopharmaceutical giants nowadays in the world. **Part II** categorizes the human body into immune, metabolic, and digestive systems, outlining strategies for developing targeted therapies using advanced synthetic biology approaches. **Part III** discusses the enabling technologies and foundational strategies that drive progress in synthetic biology and targeted therapies. **Part IV** discusses the key elements for building synthetic biology ecosystems by guest lectures, with emphasis on the increasingly significant role of universities in technology transfer, and provides a glimpse of the biotechnology landscape in Hong Kong and the Greater Bay Area.

We look forward to meeting you this semester!

**Intended Learning Outcomes (ILOs)**

By the end of this course, students will be able to…

1. Explain the basic technical concepts, scientific and engineering principles in medical synthetic biology.
2. Describe the opportunities and challenges facing the synthetic biology industry.
3. Analyze the potential and impact of synthetic biology on human health and bioeconomy.
4. Identify the key components that contribute to commercially relevant synthetic biology.
5. Develop the ability to work in a team with complementary strengths.
6. Communicate technical ideas clearly and effectively to diverse audiences.
7. Evaluate personal interests in synthetic biology and the broader biotech industry through reflection on the course project.

## Course materials

**The following e-books can be accessed via the library by HKUST students**:
-Synthetic Biology - A Primer, Geoff Baldwin, Travis Bayer, et al. Imperial College Press. 2015
-New frontiers and applications of synthetic biology, Singh, Vijai. London : Academic Press, 2022
[*Comments from instructor: This text offers several important areas of synthetic biology which allow you to read and understand easily.*]
-Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs by Rodney J.Y. Ho, Milo Gibaldi, Wiley-Liss, c2013
[*Comments from instructor: This text provides more in-depth knowledge about many topics of medical biotechnology that we are covering in this course*].
-The Biotech Age: the business of biotech and how to profit from it, by Richard W. Oliver, McGraw-Hill, c2003

## Assessments

Summative assessments are used to facilitate your understanding of synthetic biology and its real-world therapeutic applications. We use quizzes, group projects, and final examination outlined below to assess your learning against the ILOs.

| | Time | Notes | Percent of final grade | Purpose |
|---|---|---|---|---|
| **Quizzes** | Sep 29 and Oct 27 | Closed-book; 30 min for each quiz | 20% | Assesses ILO 1 |
| **Class project**[1] | Sep 29-Nov 03 | Midterm project plan[2] | 10% | Assesses ILO 1-7 |
| | Nov 03-Nov 17 | Final project poster | 10% | |
| | Nov 24 and 26 | Poster[3] presentation | 10% | |
| **Final exam** | TBD | Open book examination | 45% | Assesses ILO 1-3 |

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| **Class participation** | | Submit notes for at least three of the four guest lectures[4] | 5% | Assesses ILO 1-4 |

[1]Class project: the iPeer system will be used for intra-group peer evaluation to ensure fairness in grading your project.
[2]Midterm project plan**:** 6-page PPT slides
[3]Poster: A0 size = 841 x 1189 mm = 33.1 x 46.8 inches
[4]Each note should be at least 200 words. You need to submit your notes by the end of the day, no later than 12:00 AM.

**Course Expectations and Policies**

● Attendance
Students are expected to attend each class in person.

● Class participation
Be open to learning from each other; Respect your classmates who hold different opinions and beliefs. All members of this class are expected to contribute to a **respectful**, **welcoming**, and **inclusive** environment for every other member of the class.

● Late assignments
All course assignments must be submitted no later than the due date unless a new due date is established by the instructor. Late assignments will be deducted (5% of the grade of the assignment).

● Academic integrity and honesty
https://registry.hkust.edu.hk/resource-library/academic-integrity
Possible sanctions include receiving a failing grade on the assignment or quiz. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has ZERO tolerance of academic misconduct.

● We encourage students to use generative AI.

## Course outline

| | Time | Topics | Notes |
|---|---|---|---|
| Week 1 | Sep 01 | Course introduction | |
| | Sep 03 | Innovation in biotechnology and medicine | |
| Week 2 | Sep 08 | Brief history of synthetic biology | |
| | Sep 10 | Basics of Synthetic Biology I: DNA, RNA, and proteins | |
| Week 3 | Sep 15 | Basics of Synthetic Biology II: genetic information flow | |
| | Sep 17 | Recombinant DNA-The story of Genentech [Human Metabolism] | |
| Week 4 | Sep 22 | **Library workshop***: How to find and evaluate biotech-related business information? (**Ms. Eunice WONG**, HKUST library) | Library E-Learning Classroom B |
| | Sep 24 | | |
| Week 5 | Sep 29 | Immunotherapy of cancer: engineering antibody and immune cells [Human Immune System] | Quiz 1 |
| Week 6 | Oct 06 | Vaccine development: mRNA vaccine [Human Immune System] | |
| | Oct 08 | **Invited guest speaker** (**Prof. Terence Wong**, CBE, HKUST, Founder and Chairman of PhoMedics): AI and Bio-imaging | |
| Week 7 | Oct 13 | Bugs as Drugs: therapeutic microbes [Human Digestive System] | |

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| | Oct 15 | Artificial control over biological systems | |
| Week 8 | Oct 20 | Rational design of genetic parts, devices, and circuits | |
| | Oct 22 | **Invited guest speaker** (**Dr. Ka Chin Wong**, CEO of SPES Tech): Smart Protein Engineering Solution Technology | |
| Week 9 | Oct 27 | Genomic advancements: DNA read, write, and assembly | Quiz 2 |
| Week 10 | Nov 03 | Biotech Venture Capital | Project plan submission |
| | Nov 05 | Development of a business plan for a virtual synthetic biology start-up (our course TAs) | |
| Week 11 | Nov 10 | The Genome editing Revolution I | |
| | Nov 12 | **Invited guest speaker** (**Ms. Jennifer Che**, US patent attorney, President and managing director of Eagle IP Limited) | |
| Week 12 | Nov 17 | The Genome editing Revolution II | Poster submission for printing |
| | Nov 19 | **Invited guest speaker** (**Dr. Mingyu Xue**, VP of Matrix Partners China): Biotech investment | |
| Week 13 | Nov 24 | Poster presentation (6:30 PM-8:30 PM) | Library LG4 Multi-function room |
| | Nov 26 | | |

*Library workshop: please scan your HKUST card (twice) to take attendance.
- including 4 sessions of **35-min** Library Workshop on Sep 22 Monday and 24 Wednesday 12:00-13:20 PM in Library Classroom B and 1 session of **45-min** Library Workshop outside of class time (TBD).

## Important Dates

- Library Workshop – **Sep 22** or **Sep 24, 2025** (**no class on these two dates**)
- Team Forming of class project (5 people per group) – **Sep 29, 2025**
- Project Plan Due Date – **Nov 03, 2025**
- Poster submission Due date – **Nov 17, 2025**