Chulalongkorn School of Integrated Innovation

What can biotechnology bring us?

Innovation for health & beyond

*Dr Sebastien BERTIN-MAGHIT, PhD*

1. **Course Number**
2. **Course Credit** 3 Credits
3. **Course Title** Biotechnology Innovations for Health & Beyond
4. **Faculty / Department** School of Integrated Innovation

Chulalongkorn University

1. **Semester** Second Semester
2. **Academic Year** 2024-2025
3. **Instructor / Academic Staff** Dr Sebastien BERTIN-MAGHIT
4. **Condition** None

**(Prerequisite, Corequisite, Concurrent)**

1. **Status (Required/Elective)** Elective
2. **Curriculum** Bachelor of Arts and Science in Integrated Innovation

(International Program)

1. **Degree** Undergraduate, \_\_\_\_Year
2. **Hours / Week** 3 Hours
3. **Course Description**

This course aims at exploring how biotechnologies, especially latest innovations, can help us find solutions to our societies’ challenges, not only in health but also in other fields.

The idea of this course is for students to be proactive and do some research themselves, discuss in class and understand better the science behind the biotech breakthrough with the help of the instructor.

The course instructor has selected few topics where biotechnologies have brought or may bring innovative solutions. In each class, students will be asked to do some research on these topics, find information on the innovative solutions involving and present the results of their research in front of the class to trigger an open discussion and some brainstorming. Students should also get some questions about the technologies they identified, and the instructor will explain the science and go deeper for students to understand the ins and outs of the innovative biotechnologies identified by the students.

This course is not about students undergoing lectures but rather about students identifying something of interest and getting deeper explanation about that topic from the lecturer.

Students should learn about biotechnology in a more interactive way, they will learn what they chose to learn through the initial research they conducted.

This course is built on a bottom-up consideration rather than top-down lectures.

1. **Course Outline**
   1. **Learning Objectives / Behavioural Objectives**

By the end of this course, students should be able to:

1. Understand some fundamental of life sciences and of biotechnology.
2. Know some recent breakthroughs in health but also beyond health that were based on biotechnology.
3. Critically analyse new techniques derived from biotechnologies.
4. Use some biotechnologies to design solutions to some current society’s challenges.

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| **Learning/Behavioral Objectives** | | | | |
| **No.** | **Behavioural Objectives** | **Learning Outcomes** | **Teaching Methods/Developments** | **Evaluation Methods** |
| 1. | Being knowledgeable about and understanding biotechnologies | 1.1 Possessing well-rounded knowledge  5.1 Having an inquiry mind | 1. Lecture  2. Debate  6. Case study | 1. Written exam  7. Assignment evaluation  12. Collaborative reflection evaluation |
| 2. | Being curious about current biotechnology advances | 5.1 Having an inquiring mind  5.2 knowing how to learn | 2. Debate  6. Case study  19. Research based | 4. Behavioural observation  7. Assignment evaluation  8. Report/Project evaluation |
| 3. | Being a critical thinker | 3.1 Being able to think critically  2.1 Being moral and ethical | 1. Lecture  2. Debate  4. Deductive reasoning | 4. Behavioural observation  7. Assignment evaluation  8. Report/Project evaluation |
| 4. | Being able to identify/create solutions using technical and ethical knowledge | 2.1 Being moral and ethical  3.2 Being able to thing creatively  3.3 Having skills in problem solving | 2. Debate  6. Case study  20. Problem-based | 1. Written exam  7. Assignment evaluation  8. Report/Project evaluation  11. Critical/Presentation evaluation |

* 1. **Learning Contents**

Class Day & Time: TBD

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| **Session** | **Date** | **Module** |
| 1 |  | **New drugs #1**. Students will do some research on the recent new drugs and vaccines for cancer, infectious diseases, neurodegenerative diseases. The instructor will orient the discussions from the 1st biologics in the early 2000’s to the latest therapeutic antibodies and the new RNA vaccines. We may also analyse the recent new drugs treating metabolism impairments fighting the pandemics of obesity and the associated conditions such as diabetes, high blood pressure etc. |
| 2 |  | **New drugs #2**. Continuation of class #1  2 sessions will be used for that wide topic. |
| 3 |  | **Gene therapy**. Students will be asked to identify some current gene therapy and analyse how they work and their current limitations. This will be the opportunity to learn about genetics, what genes are, how they work, how they are transmitted from generations to generations, how they can be the cause of diseases, and how they can be edited. |
| 4 |  | **Cell therapy.** Students will do some research on the latest approved cell therapy products. This session will be used to learn about how cells works and how we can use them to treat some conditions/diseases. We will also learn about the current medications, discuss some ethics considerations when using human cells for therapy. |
| 5 |  | **Microbiome therapy.** Microbiome has been a topic of interest in recent years, it is now proven that gut microbiome is deeply linked with the immune system and the nervous system and thus has an impact on mood, neuro-health and immunity. Students will be asked to do some research in that field. The instructor will introduce microbiomes (gut, skin…) and how they can interact with other systems, how they are part of our health and wellbeing, and how they could be used for medical applications. |
| 6 |  | **Repairing the body #1.** From stem cells to organoids, tissue engineering, secretome, bioprinting… We will learn the recent discoveries in the field of repairing tissues and growing new organs. Students will also be questioned about the ethics of replacing organs and potentially reaching immortality. |
| 7 |  | **Repairing the body #2.** This session will focus more on the robotics aspects and digital tech/AI involvement of repairing the body.  2 sessions will be use for that wide topic. |
| **Midterm Examination: YES** | | |
| 8 |  | **Protein engineering, the revolution of AI**. Using a few case studies (Adaptyv Bio, Alpha-fold…) students will learn about the current revolution using AI to better understand proteins, their folding and functions and the new hopes of creating artificial proteins with a controlled functions that could be used in the therapeutic field. This will be the opportunity for students to learn about protein natural manufacturing, protein engineering, recombinant protein, and future man-designed proteins. |
| 9 |  | **Bio-agro-technology #1.** How can biotech help us with better and more sustainable agriculture? We will conduct research and learn about GMOs in agriculture, how can biotech help men getting better production yield, crops that resist to pest without using potentially hazardous pesticides, or how we can produce food with better health benefits. |
| 10 |  | **Bio-agro-technology #2.**This 2nd session on the topic will focus on the integration of bio-agro-technology with AI and robotics to get easier farming, limiting hard, health-impacting labour. We will also discuss the topic of laboratory-grown food, especially meat. |
| 11 |  | **Innovations to tackle Food security and Water scarcity.** Students will learn what is the current status of development of sustainable agricultural practices, water management, recombinant plants crops and seeds, crop yields to address problem of food and security (agriculture shift for the future, rice resistant to salt for floods, etc….). |
| 12 |  | **Epigenetic-based medicine.** Students will do some research about epigenetics and the impact of this new understandings on health. Can we use epigenetics factors to treat some diseases? Can we use epigenetic factors to better adapt to our fast-changing environment? Can we use epigenetic factors to fight some current pandemics that are highly linked with our modern living conditions? We will think about fast-growing diseases such as obesity, diabetes, high blood pressure… |
| 13 |  | **Biomaterials.** Students will look for new more sustainable material obtained through biotechnologies. Can we produce new plant-based materials: plastic, leather etc.? Could they replace a major part of materials currently resulting from the transformation of fossil-based material? What would they bring in terms of sustainability? Would they offer similar characteristics as current materials or would they present more limitations? |
| 14 |  | **Bio-fuels and bio-lubricants.** Similar to the previous session, this class will focus more on replacement of oil-based fuels and lubricants with interesting new discoveries in the field. |
| 15 |  | **Course summary & critical thinking**. Wrap-up on the different biotechnologies studied in the course and brainstorming sessions on the ***ethics*** in the field. Biotechnologies are using, and potentially modifying living organisms, is that ethical to do so? When to draw a line? Should new policies to frame those technologies be implemented? Should we always use existing technologies? E.g. Thailand population is decreasing, it is a concern for the economy, through biotechnology we could in few years “create” more babies, should we do this or not? If the technology allows us to modify our genome to become resistant to certain infections, should we do it? |
| **Final Examination: YES** | | |

* 1. **Teaching Methods**

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| * Lectures and discussions | 20% |
| * Presentations and discussions | 40% |
| * Brainstorming and discussion of case studies so students learn to analyse and solve problems | 40% |

* 1. **Media**

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| * PowerPoint media (by students and instructor) |  |
| * Electronics and website media |  |
| * Scientific paper |  |
| * Press papers |  |

* 1. **Assignment through Network System**

Assigning and Submitting Method: MS Teams / Email / In Class

Learning Management System: MS Teams

* 1. **Evaluation**

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| * Assessment of academic knowledge | 25% |
| * Assessment of literature research | 25% |
| * Assessment of the assigned tasks | 25% |
| * Class participation | 25% |

* 1. **Reading List**

Research Articles / Academic Articles (if any) will be identified or communicated during classes.

Electronic Media / Websites (if any) will be identified or communicated during classes.

1. **Teacher Evaluation**

Through CUCAS system

1. **Instructor**

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| **Name** | **Contact number** | **Email** |
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