Academic Year	2023/24	**Semester**	2
Course Coordinator	Phan Anh Tuan		
Course Code	PH3603		
Course Title	Biophysics		
Pre-requisites	PH2103 Thermal Physics (for PHY) OR PH1801 Foundations of Physics I and CM2041 Physical and Biophysical Chemistry 1 (for CHEM) OR PH1011 Physics and CM2041 Physical and Biophysical Chemistry 1 (for CHEM) OR PH1012 Physics A and and CM2041 Physical and Biophysical Chemistry 1 (for CHEM)		
Mutually exclusive	Nil		
No of AUs	3 AUs		
Contact Hours	Total 50 contact hours per semester (26 lecture hours + 12 tutorial hours + 12 lab hours)		
Proposal Date	6 November 2023		

Course Aims

This course serves as an introduction to "How physics approaches living matter". It aims to provide a framework for understanding biophysics and physical models of biological systems. You will build foundational knowledge in key topics of molecular biophysics and structural biology. Through this course, you will be introduced to the working principles of common biophysical methods used to investigate the structure and dynamics of biomolecules as well as novel methods for manipulation and analysis in biophysics.

Intended Learning Outcomes (ILO)

By the end of this course, you will be able to:

1. explain the fundamental principles of key topics in biophysics, such as the structure and behaviour of biopolymers, motors and cells.
2. describe the operation principles and the techniques for analysing biophysical properties of biological systems.
3. work in a team to propose a research project investigating a specific question in biophysics.
4. present a research work in oral and written form.

Course Content

The course consists of the following topics:

- Introduction to Biophysics
- Chemical bonds
- Structure of biomolecules
- Structure calculation and computer simulation
- Thermodynamics and kinetics of molecular interactions
- Single-molecule biophysics

- Physics and Medicine

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Weighting	Team / Individual	Assessment Rubrics
1. Labs	LO 2-4	20%	Team (5%) and individual (15%)	Appendix 1
2. Mid-term tests	LO 1-2	40%	Individual	Appendix 2
3. Research projects	LO 1-4	40%	Team (20%) and individual (20%)	Appendix 3A & 3B
Total		100%		

Formative feedback

The classes will be designed to have many opportunities for discussions and debates during lectures, tutorials, students' presentations of research projects. You will be able to participate in debates on proposed research ideas and the analysis of your experimental results. You will have some hands-on experiences in the lab to develop an educated sense about biomolecules and how biophysical techniques can be used to provide information about the molecules. The instructor can organize viva sessions for your lab work.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lectures	During the lectures fundamental principles of key topics in biophysics will be introduced along with applications of biophysical techniques in studying biological systems. Time will be allocated for your presentations of research ideas.
Tutorials	You will practice solving various problems and participate in debates on proposed research ideas and the analysis of your experimental results.
Labs	You will have hands on experience in the lab to develop an educated sense about biomolecules and how biophysical techniques can be used to provide information about the molecules. You can answer research questions by using your own experimental measurements.

Reading and References

a. Physical Biology of the Cell, 2nd ed, Rob Phillips, Jane Kondev, Julie Theriot, Garland Science, 978-0815341635, 2013
b. Biological Physics (Updated Edition), 1st ed, Philip Nelson, W.H. Freeman and Company, 978-0716798972, 2007
c. Molecular Biology of the Cell, 5th ed, Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Garland Science, 978-0815341055, 2007

NOTE: The above listing comprises the foundational readings for the course and more up-to-date relevant readings will be provided when they become available.

Course Policies and Student Responsibilities

Absence Due to Medical or Other Reasons

If you are sick and unable to attend your class, you have to:

1. Send an email to the instructor regarding the absence.
2. Submit the Medical Certificate* to administrator.

* The medical certificate mentioned above should be issued in Singapore by a medical practitioner registered with the Singapore Medical Association.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information.

On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning.

Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Phan Anh Tuan (Prof)	SPMS-PAP-05-04	6514 1915	PhanTuan@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1-2	Introduction to Biophysics	LO 1	References (a), (b), (c)
3	Chemical bonds	LO 1	References (a), (b) and Lecture Notes
4-6	Structure of biomolecules	LO 1-4	References (a), (b) and Lecture Notes
7	Structure calculation and computer simulation	LO 1-2	References (a), (b) and Lecture Notes
8-9	Thermodynamics and kinetics of molecular interactions	LO 1-4	References (a), (b) and Lecture Notes
10-11	Single-molecule biophysics	LO 1-4	References (a), (b) and Lecture Notes)
12-13	Physics and Medicine	LO 1-2	References (a), (b) and Lecture Notes

Appendix 1: Assessment criteria for labs

The assessment of the lab component will be done though lab report, viva and presentation in the class.

Performance Level	Criteria
Excellent	Demonstrates excellent understanding of the techniques used in the lab. Capable of doing the experiments. Able to write a clear report and make good oral presentation about the experiment performed. Able to answer to most questions about the experiment.
Good	Demonstrates good understanding of the techniques used in the lab. Capable of doing the experiments. Able to write a clear report and make good oral presentation about the experiment performed. Has trouble in answering some questions about the experiment.
Satisfactory	Demonstrates average understanding of the techniques used. Capable of doing the experiments. Cannot answer to many questions about the experiment.
Poor	Demonstrates below average grasp of the concepts behind the techniques used.
Extremely Poor	Does not know the principles behind the techniques used.

Appendix 2: Assessment criteria for mid-term tests

Mid-term assessment is done through closed-book written tests.

Performance Level	**Criteria**
Excellent	Demonstrates excellent understanding of the biophysical concepts and biophysical techniques covered in the class. Capable of analysing biological processes not covered in the class and proposing biophysical experiments for investigating these processes.
Good	Demonstrates good understanding of the main concepts and techniques discussed in the class. Has partial success in applying these in new situations.
Satisfactory	Demonstrates reasonable understanding of the main concepts and techniques discussed in the class. Has trouble in applying these in new situations.
Poor	Demonstrates below average grasp of the concepts discussed in the class. Unable to applying these in unfamiliar situations.
Extremely Poor	Has no idea of the concepts discussed in the class.

Appendix 3A: Assessment criteria for research projects (Team Component 20%)

The assessment of research projects will be done through the presentation of research proposal (literature review, research question, proposed research and experimental design), performed research, written paper and presentation of results.

Please note that by default, everyone in the team will receive the same score for the team components. However, team scores for particular students may vary in cases where there is evidence of insufficient contribution to the team.

Performance Level	**Criteria**
Excellent	Demonstrates excellent understanding of the biophysical concepts behind the research project. Demonstrates the ability to review literature (read research papers and summarize the hypothesis, experiments and key findings). Is able to formulate research question and propose experimental design. Able to work in a group. Demonstrates active participation in the work of the group. Demonstrates the techniques used in the lab. Capable of doing the experiments. Able to write a clear report and make good oral presentation about the experiment performed. Able to answer to most questions about the experiment.
Good	Demonstrates good understanding of the problems at hand. Able to formulate research question and propose experimental design. Has trouble in answering some questions about the experiment.
Satisfactory	Demonstrates partial understanding of the problems at hand. Able to apply some techniques discussed in class only in direct way. Has trouble in answering many questions about the experiment.

Poor	Demonstrates minimal understanding of the problems at hand. Not sure how it can be solved.
Extremely Poor	Has little idea about the problems to be solved.

Appendix 3B: Assessment criteria for research projects (Individual Contribution Component 20%)
You will be assessed orally on your understanding of your group's project research. In addition, you will be asked to declare your individual contribution to the project.

Performance Level	**Criteria**
Excellent	Able to answer to most questions about the experiment. Contributed more than your fair share of work and was vital in supporting others in the group.
Good	Has trouble in answering some questions about the experiment. Contributed your fair share of work, and supported others in the group.
Satisfactory	Has trouble in answering many questions about the experiment. Contributed your fair share of work, but did not provide adequate support to the others in the group.
Poor	Not sure how it can be solved. Contributed less than your fair share of work, and did not support the others in the group.
Extremely Poor	Has little idea about the problems to be solved. Did not contribute or support the others in the group.