NANYANG TECHNOLOGICAL UNIVERSITY
SINGAPORE

COURSE CONTENT

Academic Year	2024/2025	**Semester**	1
Course Coordinator	Prof. Duan Hongwei / Assoc Prof. Lim Sierin		
Course Code	BG4215		
Course Title	Biomedical Nanotechnology		
Pre-requisites	Nil		
No of AUs	3		
Contact Hours	Lectures: 39 hrs		
Proposal Date	14 October 2017		

Course Aims

This course aims to develop your understanding of micro/nanotechnology for applications in biomedical field including nanomedicine, medical diagnostics, pathways to molecular manufacturing, molecular transport, and nanosensors for medical applications. The knowledge will prepare you for the potential further training in biomedical research, and development in bioengineering/medical industry.

Intended Learning Outcomes (LO)

By the end of this lesson, you should be able to:

1. describe the principles of nanotechnology
2. state the contents of biomedical engineering
3. identify the challenges of current technologies for a specific biological or medical problem
4. analyze these challenges
5. overcome these challenges with nanotechnologies
6. present convincingly on the nanotechnologies you have developed.

Course Content

Inorganic nanostructures; Organic nanostructures; Diagnostic nanotechnology; therapeutic nanomedicine; nanotechnology in the diagnosis and treatment of selected diseases.

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attribute	Weighting (Total 100%)	Team/ Individual	Assessment rubrics
1. Final Examination (2hrs; Closed Book)	LO 1 – 6	SLO a, b, c, d, e	50%	Individual	Refer to appendix 2
2. Continuous Assessment: Quiz	LO 1 -5	SLO a, b, c, d	20%	Individual	Refer to appendix 2
3. Project and Presentation	LO 1 - 6	SLO a, b, c, d, i, j, k	30%	Team	Refer to appendix 2 and 3
		Total	100%		

Reading and References

- Nanobiotechnology: Concepts, Applications and Perspectives (Wiley-VCH Verlag GmbH, Print ISBN: 9783527306589).
- Nanobiotechnology II: More Concepts and Applications (Wiley-VCH Verlag GmbH, ISBN10: 3527316736).
- Additional reading:
    - Selected review articles and other peer-reviewed publications on biomedical applications of nanotechnology.

Course Policies and Student Responsibilities

CA: Absentees must be supported by a medical certificate or other valid official documents.
No make-up will be entertained.

Group project: No make-up.

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

Course Instructors

Instructor(s)	Office Location	Phone	Email
Duan Hongwei	N1.3-B3-12	65141019	hduan@ntu.edu.sg
Sierin Lim	N1.3-B3-11	63168966	slim@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities LN = Lecture Notes RW = Responseware	Lecturer
1	Introduction to nanotechnology	1, 2	LN, RW	DHW
2	Inorganic nanostructures	1, 2, 5	LN, RW	DHW
3	Organic nanostructures	1, 2, 5	LN, RW	SL
4	Introduction to selected human diseases	2, 3, 4	LN, RW	SL
5	Diagnostic nanotechnology	2, 3, 4, 5	LN, RW	DHW
6	Therapeutic nanotechnology	2, 3, 4, 5	LN, RW	SL
7	Overview of lecture 1-6	1-5	LN, RW	DHW & SL
	(Recess)			
8	CA – 2h Discussion and Q&A – 1h	1-5	Quiz papers	DHW & SL

9	Lab session (1)	1-5	Small group lab session	DHW, SL
10	Lab session (1)	1-6	Small group lab session	DHW, SL
11	Lab session (2)	1-6	Small group lab session	DHW, SL
12	Lab session (2)	1-6	Small group lab session	DHW, SL
13	Group presentation	1-6	Presentation	DHW & SL

Project and presentation

Students will form a group of 4 to conduct a lab project on either the preparation of lateral flow assay test strip or cytotoxicity assay. After the lab session, the groups will make a presentation to cover the background, results discussion, and potential technical improvement on the techniques. In addition, the groups should submit a written report on the lab session. Students will be evaluated based on laboratory performance, presentation, and written report.

Lateral flow immunoassays (LFIAs) also known as immunochromatographic assays or strip tests, are simple paper-based devices intended to quickly detect the target analyte in a liquid sample without the need for specialized and costly equipment. LFIAs have attracted great interest due to their friendly user formats, short assay times, little interferences, low costs, and being easy by operated by non-specialized personnel. This technology has been employed to develop a wide range of assays for clinical, veterinary, agricultural, food industry and environmental applications. For example, the home pregnancy test is a most widely used LFIAs that detects a certain hormone. LFIAs tests also have played a critical role in COVID-19 testing as they have the benefit of delivering a result in 5-30 minutes. Refer to the lab manual for the technical details.

Cytotoxicity assay. With the development of nanotechnology, myriad nanomaterials have been synthesized. However, the extent of their effects on human health are not fully understood. Among the synthetic nanomaterials, nanoparticles account for the largest segment. Nanoparticles have found applications in biomedicine as drug carrier, therapeutics, bioimaging, and diagnostics. For these biomedical applications, the safety of nanoparticles must be assessed. Conventional methods include in-vitro and in-vivo cytotoxicity, immunogenicity, and sensitivity assay. The objective of this lab module is to provide students with basic knowledge and practical skills for examining the toxicity of nanoparticles using in vitro method. The students will also apply statistical analysis and data presentation.

Appendix 1: The EAB (Engineering Accreditation Board) Accreditation SLOs (Student Learning Outcomes)

a) Engineering knowledge: Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems

b) Problem Analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c) Design/development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

d) Investigation: Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e) Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations

f) The engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g) Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.

h) Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i) Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.

j) Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k) Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l) Life-long Learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Appendix 2: Assessment Criteria

Criteria	Unsatisfactory	Borderline	Satisfactory	Very good	Exemplary
Essential knowledge Understand the principles of nanotechnology	Lack understanding of the principles of nanotechnology and unable to relate the structure of nanomaterials to their properties	Partially understand the principles of nanotechnology and able to partially relate the structures of nanomaterials to their properties	Understand some principles of nanotechnology and able to relate some structures of nanomaterials to their properties	Understand most principles of nanotechnology and able to relate most structure and property correlations of nanomaterials	Comprehensive understanding of the principles of nanotechnology and able to fully correlate the structure and properties of nanomaterials
Application Applying nanotechnology to solve medical problems	Unable to apply the principles of nanotechnology to solve any problem in biomedical field	Can apply the principles of nanotechnology to solve some problems in biomedical field	Can apply the principles of nanotechnology to solve some problems in biomedical field independently	Can apply the principles of nanotechnology to solve some problems in biomedical field independently while providing suggestions to other problems that can't be addressed by nanotechnology	Can apply the principles of nanotechnology to solve some problems in biomedical field independently while providing solutions to other problems
Analysis	Unable to identify and characterize the structure and properties of nanomaterials to address diagnosis and treatment of major human diseases	Able to characterize the structures and properties of some nanomaterials but unable to identify nanomaterials for the diagnosis and treatment of major human diseases	Able to identify and characterize the structures and properties of most nanomaterials for diagnosis and treatment of some major human diseases	Able to correlate the structures and properties of most nanomaterials and select nanomaterials for diagnosis and treatment of major human diseases	Comprehensive understanding of the correlation of structures and properties of all relevant nanomaterials and able to design nanomaterials for diagnosis and treatment of major human diseases
Presentation of Solutions	Unable to summarize a reported design of biomedical nanotechnology and present it	Able to partially summarize and present a reported design of biomedical nanotechnology	Able to summarize and present most of a reported design of biomedical nanotechnology	Able to fully summarize and present a reported design of biomedical nanotechnology	Able to fully summarize and present a reported design of biomedical nanotechnology and identify its limitation

Appendix 3: Assessment Criteria for Peer Evaluation

Each student in the group is required to rate the contribution of other group members. All evaluations are held in confidence so no student will know how other group members rate his/her contribution. You are to evaluate other group members fairly and objectively, bearing in mind the implications for the other members' grades (explained below). It is absolutely essential for you to submit your peer evaluation form to get marks. To factor peer evaluations into the marks for your homework assignment, the following computation will be used:

- If, on average, a student receives a rating of 9 or more, that student receives 100% of the group's grade.
- If, on average, a student receives a rating of less than 9, that student receives a specific percentage of the group's grade to be determined by the formulae below:

An average rating of 8 to < 9 = 90% + (average rating obtained - 8)*10
An average rating of 7 to < 8 = 80% + (average rating obtained - 7)*10
An average rating of 6 to < 7 = 70% + (average rating obtained - 6)*10
An average rating of 5 to < 6 = 60% + (average rating obtained - 5)*10
An average rating of 4 to < 5 = 50% + (average rating obtained - 4)*10
An average rating of 3 to < 4 = 40% + (average rating obtained - 3)*10
An average rating of < 3 will be investigated by your instructor and the student may receive 0-40% of group grades.

Example 1:
Assume the overall group assignment is 30 marks, and out of 30 your group got 30 marks. A student with an average rating of 9.10 gets 100% of 30 marks, i.e., 30 marks. An average rating of 6.29 means that a student gets 72.9% (or 70%+(6.29-6)*10) of 30 marks, i.e., 21.87 marks.

Example 2:
Assume the overall group assignment is 30 marks, and out of 30 your group got 20 marks. A student with an average rating of 9.10 gets 100% of 20 marks, i.e., 20 marks. An average rating of 6.29 means that a student gets 72.9% (or 70%+(6.29-6)*10) of 20 marks, i.e., 14.58 marks.

Your instructor reserves the right to review the student ratings for questionable circumstances, which include, but are not limited to, acts of discrimination or malice.

Peer Evaluation Form for Lab Project and Presentation

Each team member should complete a peer rating form. This form will provide an evaluation of each team member and will be kept in strict confidence. In the space below, please fill in the names of your group members and record your peer rating for each of the standards below. You may rate your peers on a scale from 1 to 5 (see below). Please total your score for each member at the end of each column. Your total score for each member can be a minimum of 5 and a maximum of 25. Feel free to write other comments below. The final peer evaluation score will be rescaled to 10 for the calculation of the marks of the lab project and presentation as stated above.

1 = Unacceptable
2 = Poor
3 = Average
4 = Good
5 = Excellent

Your Name:

Standards	NAME 1	NAME 2	NAME 3	NAME 4
	Rating	Rating	Rating	Rating
Willingness to complete the assigned tasks and responsibilities				
Ability to meet deadlines, attend group meetings and be on time				
Cooperation with other team members				
Quality of the individual's work				
Individual's overall contribution the discussion and assignments.				
TOTAL SCORE OUT OF 25				

Comments: