

COURSE CONTENT

Academic Year	2023/2024	Semester	2
Course Coordinator	Dr Luciana Lisa Lao		
Course Code	BG4309		
Course Title	Drug Delivery and Tissue Engineering		
Pre-requisites	NA		
No of AUs	3		
Contact Hours	Lectures: 26 hrs; Tutorials: 13 hrs		
Proposal Date	17 Sept 2019		

Course Aims

This prescribed elective course aims to deepen your understanding on two major biomedical applications of materials. The course will equip you with the basic principles of drug delivery and tissue engineering and the important roles played by biomaterials in these applications. It also presents engineering analyses of drug delivery along with biological and materials aspects of tissue engineering. All of this knowledge is essential for students who wish to specialize in medical materials or pursue a career in the fields of drug delivery or tissue engineering.

Intended Learning Outcomes (ILO)

By the end of the course, you should be able to:

1. Define drug delivery, controlled release and targeted delivery
2. Compare and contrast the advantages and limitations of various drug delivery routes
3. Illustrate the critical roles of polymers in drug delivery systems
4. Explain the mechanisms and roles of materials in diffusion-controlled systems, osmotic-controlled and degradation-controlled drug delivery systems
5. Distinguish zero-order release from first-order release kinetics
6. Estimate the drug release rate from diffusion-controlled, osmotic-controlled and degradation-controlled drug delivery system
7. Explain the mechanism and roles of materials in stimuli-responsive drug delivery systems
8. Explain the principles of passive and active targeting in targeted delivery
9. Define tissue engineering and its contribution in regenerative medicine
10. Describe the three main pillars that contribute to a successful tissue engineered product
11. Compare and contrast the advantages and limitation of various cell sources for tissue engineering applications
12. Analyze the major building blocks of extra-cellular matrix (ECM) and its functions as nature's scaffold
13. Explain the basic considerations in design and materials selection for biomaterial scaffolds
14. Describe various common scaffold fabrication methods
15. Recognize different environmental factors (bioreactors and signalling) that affect tissue engineering

Course Content

- Fundamentals of drug delivery
- Controlled and targeted delivery

- Principles of tissue engineering
- Biomaterial substrates for tissue engineering

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related EAB's Graduate Attributes	Weighting	Team/Individual	Assessment rubrics
1. Continuous Assessment 1 (CA1): Quiz	1 to 8	EAB SLO (a) Engineering knowledge (b) Problem analysis	20%	Individual	N.A.
2. Continuous Assessment 2 (CA2): Quiz	9 to 15	Same as above	20%	Individual	N.A.
3. Final Examination	1 to 15	Same as above	60%	Individual	N.A.
Total			100%		

Formative feedback

- CA questions are thoroughly discussed in the tutorial class;
- Feedback will be provided to the students on their approaches, common mistakes, and other general issues;
- Class average marks will be posted. Each of you will also be informed of your CA marks;
- You are encouraged to drop by coordinator's office during the consultation hours to browse through your papers and discuss any issues, if needed.
- A general feedback on your performance in final examination will also be provided after the release of final exam results.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Interactive Lectures	<p>Lectures notes are provided to students a few weeks in advance to encourage them to read up about the topics before the actual face-to-face lectures. During lectures, there are a lot of emphasis on the fundamental understanding of the structure and property relationships of various advanced biomaterials that lead to various applications in medicine. While lecture classes are conducted in a large group, you are encouraged to ask and raise your doubts while class is in progress or during the break.</p> <p>Lecturers also find the opportunities to test your learning by asking questions and walk around the class to gather your answers. The instant feedback works both ways as instructors are able to gauge your progress while you are able to assess your own level of understanding and correct any misconception.</p>

Face-to-face tutorials	Tutorials are conducted in a smaller class of 20 – 30 students. This allows more opportunities for discussions between you and the instructor. While some of the tutorial questions aim to check and reinforce your understanding on various concepts, many of the questions require students to think critically and apply their knowledge in solving engineering problems. During the tutorial discussions, you will be required to analyze why some drug formulations/tissue engineering products fail, select the most appropriate material for a particular drug delivery or tissue engineering application and predict the performance of a particular drug delivery system or tissue-engineering scaffold. All of these thought-provoking questions certainly provide you with opportunities to assess your ability to meet the intended learning outcomes of the course.
Use of Multimedia tools to teach abstract concepts and show real-world application	Multimedia tools such as videos, animations and apps are introduced to you during lectures/tutorial and out-of-contact hours too. The tools are selected exclusively for this course to help you better understand the contents especially some of the biological concepts introduced. In addition, some real-life application videos such as delivery or implantation procedure of drug formulations or tissue-engineered products are useful to show the actual surgical procedures to students.
Open consultations round the semester	You are welcome to consult the instructors whenever you face problems grasping the contents or when you wish clarify their concepts. This is an available helpline where you get the personalized attention in times of need.

Reading and References

- Treatise on Controlled Drug Delivery, A.Kydonieus, Editor. Marcel Dekker, 1992.
- Biomaterials Science, An Introduction to Materials in Medicine, B.D. Ratner, A.S. Hoffman, F.J. Schoen, J.E. Lemons, 3rd Edition, Academic Press, 2013
- Handbook of Pharmaceutical Controlled Release Technology, D.L. Wise, 1st Edition, CRC Press, 2000.
- Principles of Tissue Engineering, R.P.Lanza, R.Langer, J.Vacanti, Editors, 4th Edition, Academic Press, 2014.
- Biomaterials for Tissue Engineering Applications, J.A. Budrick, R.L.Mauck, Editors. Springer-Verlag, 2011.
- Bioreactor Systems for Tissue Engineering, T. Scheper, C. Kasper, M.Van-Griensven, R. Pörtner, Editors. Springer-Verlag, 2009.

Course Policies and Student Responsibilities

(1) CA

Absentees must be supported by a medical certificate or other valid official documents.

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	Office Location	Phone	Email
Dr Luciana Lisa Lao	N4.1-01-09	6592-3202	lllao@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Introduction to drug delivery fundamentals	1 – 2	Lecture (and notes) on topic 1
2	Diffusion-controlled drug delivery systems	3 – 6	Lecture (and notes) on topic 2, tutorial on topic 1
3	Osmotic-controlled drug delivery systems	3 – 6	Lecture (and notes) on topic 3
4	Degradation-controlled drug delivery systems	3 – 6	Lecture (and notes) on topic 4, tutorial on topics 2-3
5	Stimuli-responsive delivery system	3, 7	Lecture (and notes) on topic 5
6	Localized and targeted delivery	3, 8	Lecture (and notes) on topic 6, tutorial on topics 4-6
7	CA 1	1 – 8	CA quiz on topics 1 to 6
8	Recess week		
9	Principles of tissue engineering	9 – 10	Lecture (and notes) on topic 9
10	Classification and organization of cells and tissues	11	Lecture (and notes) on topic 10, tutorial on topic 9
11	The extracellular matrix (ECM) – Nature's scaffold	12	Lecture (and notes) on topic 11, tutorial on topic 10
12	Biomaterial scaffolds	13	Lecture (and notes) on topic 12
13	Scaffold Fabrication and the environment in tissue engineering	14 – 15	Lecture (and notes) on topic 13, tutorial on topics 11-12
14	CA 2	9 – 15	CA quiz on topics 9 to 13