

## COURSE OUTLINE

<b>Academic Year</b>	AY2022	<b>Semester</b>	Summer
<b>Course Coordinator</b>	Associate Professor Yeong Wai Yee		
<b>Course Code</b>	MA5030		
<b>Course Title</b>	Bioprinting: Principles and Applications		
<b>Pre-requisites</b>	-		
<b>No of AUs</b>	3		
<b>Contact Hours</b>	Lectures: 39 hours		
<b>Proposal Date</b>	Summer 2023		

### Course Aims

This course aims to provide a comprehensive understanding of Bioprinting. Bioprinting is a multidisciplinary technology that merges the fields of cell culture, biomaterials science and mechanical engineering. This is a new manufacturing paradigm that has huge potential impact in the development of advanced biological tissue models and medical therapeutic products. The topics covered are tissue engineering, prototyping of scaffolds, cell sources, biomaterials and applications.

### Intended Learning Outcomes (ILO)

Upon successful completion of the course, you will be able to:

- 1) Discuss the multidisciplinary nature of bioprinting and its potential
- 2) Describe the fundamental building block i.e. the cell used in the bio-printing process, the cell processing and 3D cell culture techniques.
- 3) Differentiate various fabrication techniques of scaffolds via additive manufacturing and evaluate the strengths and shortcomings of each technique
- 4) Give examples of biomaterials for bioprinting, select the right material based on the requirements.
- 5) Explain and apply computational design and simulation process in bioprinting

### Course Content

	Topic	Hours
1	<b>Introduction to Tissue Engineering</b> Definitions, scope and current key developments, cell-based tissue engineering, scaffold-based tissue engineering, decellularised scaffolds, bioprinting	3
2	<b>Scaffolds for Tissue Engineering</b> Conventional scaffold fabrication methods, advanced manufacturing techniques	4
3	<b>Cell Sources for Bioprinting</b> Cell sources, the potential for expansion and differentiation, different formats of cells for printing	3
4	<b>3D Cell Culture Techniques</b> Principles and major techniques/tools used for 3D cell culture	3
5	<b>Bioprinting Techniques</b>	9

	Inkjet-based, extrusion-based, laser-based techniques	
6	<b>Materials for Bioprinting</b> Biomaterials, polymers, hydrogels	8
7	<b>Computational Design</b> Recent development of computer-aided tissue engineering	3
8	<b>Workshop exposure to bioprinters</b> Lecture conducted on shop floor.	3
9	<b>Assessment</b>	3

#### Assessment (includes both continuous and summative assessment)

Component	Course LO Tested (ILO1 – ILO8)	Related Programme LO or Graduate Attributes	Weighting	Team/Individual	Assessment rubrics
1. Continuous Assessment 1 – Quiz	ILO1-2	EAB SLO a, b	15%	Individual	
2. Continuous Assessment 2 – Quiz	ILO3	EAB SLO a,b	15%	Individual	
3. Continuous Assessment 3 – Quiz	ILO4-5	EAB SLO a,b,c,h	20%	Individual	
4. Final Examination – Closed book; 2 hrs	ILO1-5	EAB SLO a,b,c,h	50%	Individual	
Total			100%		

#### Formative feedback

The quiz outcome will be discussed in the class after the quiz to explain the learning. Case studies will be presented to encourage critical thinking and in-class discussion, for you to verify your learning. Feedback will be welcomed throughout the course, where you could write in to the lecturers for constructive suggestions.

#### Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lecture	Discussion of various aspects of the bioprinting technology
Case Study	Illustrate the real-world applications of bioprinting and discuss its pros and cons
Lab tour	Experience the bioprinting in action

## Reading and References

### Textbooks

1. Bioprinting: Principle and Applications. Chua CK and Yeong WY, World Scientific Publishing (Jan 2015)

### References

1. Biofabrication: Micro- and Nano-fabrication, Printing, Patterning and Assemblies by Gabor Forgacs and Wei Sun (Mar 18, 2013)

2. Principles of Tissue Engineering, 4<sup>th</sup> Edition by Robert Lanza, Robert Langer and Joseph P. Vacanti (Nov 29, 2013)

3. Biomaterials Science: An Introduction to Materials in Medicine, 2<sup>nd</sup> Edition by B.D. Ratner, 2nd ed. Amsterdam : Academic Press. 2004

## Course Policies and Student Responsibilities

As a student of the course, you are required to abide by both the University Code of Conduct and the Student Code of Conduct. The Codes provide information on the responsibilities of all NTU students, as well as examples of misconduct and details about how students can report suspected misconduct.

The university also has the Student Mental Health Policy. The Policy states the University's commitment to providing a supportive environment for the holistic development of students, including the improvement of mental health and wellbeing. These policies and codes concerning students can be found in the following link.

<http://www.ntu.edu.sg/SAO/Pages/Policies-concerning-students.aspx>

## 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

### Special Term II

Instructor	Office Location	Phone	Email
Prof Yeong Wai Yee			<a href="mailto:WYYeong@ntu.edu.sg">WYYeong@ntu.edu.sg</a>

## Planned Lesson Schedule

Lesson	Topic	Course LO	Readings/ Activities
1	Overview and introduction	1	Chapter 1
2	Tissue engineering scaffold	2	Chapter 2
3	Tissue engineering scaffold	2	Chapter 2 and lab tour
4	Cell source	2	Chapter 5
5	3D Cell culture technique	2	Chapter 6 and CA1
6	Intro to bioprinting	3	Chapter 3
7	Extrusion technique for bioprinting	3	Chapter 3
8	Inkjet technique for bioprinting	3	Chapter 3
9	Other techniques for bioprinting	3	Chapter 3, lab tour and CA2
10	Materials for Bioprinting	4	Chapter 4
11	Materials for Bioprinting	4	Chapter 4
12	Materials for Bioprinting	4	Chapter 4
13	Computational design for bioprinting	5	Chapter 7 and CA3