# Subject Description Form

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| **Subject Code** | BME32138 |
| **Subject Title** | **Cellular Engineering** |
| **Credit Value** | 3 |
| **Level** | 3 |
| **Prerequisite** | **Prerequisites**<br>ABCT2333 Human Physiology; and<br>ABCT2334 Human Pathophysiology; or<br>equivalent subjects |
| **Objectives** | ▪ Deliver knowledge in the fundamentals of cell biology with particular emphasis on cellular physiological and pathological processes.<br>▪ Introduce the principles of engineering methods/technologies applied in cellular/molecular biology and biomedical sciences.<br>▪ Prepare undergraduate students with basic concepts and skills for biomedical research using cellular engineering approaches. |
| **Intended Learning Outcomes** | Upon completion of the subject, students will be able to:<br>a. Understand the fundamental concepts in cellular/molecular biology and significances of cellular engineering in biomedical research and applications.<br>b. Comprehend the principles of technologies in cellular engineering.<br>c. Design experiments with cellular engineering methods to solve basic scientific questions in cell biology and biomedical sciences. |
| **Contribution to Programme Outcomes (Refer to Part I Section 10)** | ▪ Programme Outcome 1: Demonstrate an ability to apply knowledge of mathematics, science, and engineering appropriate to the Biomedical Engineering (BME) discipline. (Teach, Practice and Measure)<br>▪ Programme Outcome 2: Demonstrate an ability to design and conduct BME experiments, as well as to analyze and interpret data. (Practice and Measure)<br>▪ Programme Outcome 4: Demonstrate an ability to identify, formulate, and solve BME problems. (Teach, Practice and Measure)<br>▪ Programme Outcome 6: Demonstrate an ability to critically evaluate research and professional literature, and understand the principles and practice of conducting research in clinical and industrial environments relevant to BME. (Practice and Measure) |

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| **Subject Synopsis / Indicative Syllabus** | **Introduction**<br>▪ Cells and BME<br>▪ Overview of Cellular Engineering<br>**Cell Biology Basics**<br>▪ Cell Structure and Function<br>▪ Cell Chemistry and Bioenergetics<br>**Cell Membrane and Analysis**<br>▪ Membrane Structure and Analysis<br>▪ Membrane Transport and Analysis<br>▪ Cell Membrane and Bioelectricity Analysis (Voltage clamp, patch-clamp)<br>**Gene and Gene Expression**<br>▪ DNA Structure, Package and Replication<br>▪ Gene Expression<br>▪ Gene Expression Control<br>**Genetic Engineering Technologies**<br>▪ Analyse and Manipulate DNA (Restriction nucleases, Gel electrophoresis, DNA cloning, PCR, DNA sequencing)<br>▪ Study Gene Expression and Function (RNA extraction, reverse transcription, quantitative PCR, microarray, RNA sequencing, Selective pharmaceutical inhibition, RNA interference, Transgenic models, Conditional gene knockout/knock-in, Reporter gene, CRISPR-Cas9 technology, overexpression)<br>**Cell Signaling and Analysis**<br>▪ Principles of Cell Signaling<br>▪ Examples of Cell Signaling Pathways<br>▪ Cell Signaling Analysis (IP, Co-IP, Chromatin-IP, FRET, Phospho-specific Western Blot, ELISA, IF, IHC, Fluorescent indicators for live cell signaling detection)<br>**Stem Cells and Technologies**<br>▪ Stem Cell Biology<br>▪ Stem Cell Technology (Embryonic stem cells, Reprogramming and iPS cells, Organoids, Applications in treatment and drug discovery)<br>**Cell Culture Technologies**<br>▪ Cell Culture Basics<br>▪ Cell Isolation, Sorting, Immortalization and Others<br>**Cell Mechanics and Mechano-transduction**<br>▪ Technologies for cell mechanics measurement (Optical tweezers, Atomic force microscopy, and Magnetic twisting cytometry);<br>▪ Technologies for cellular traction measurement (Traction force microscope and Micropost array).<br>**Cell Positioning and Manipulation**<br>▪ Cell Positioning Techniques (Planar patch clamp, Cell micro-patterning technique)<br>▪ Cell Manipulation Techniques (Dielectrophoresis)<br>**Cell Imaging**<br>▪ Microscopy technologies (Light, fluorescence microscope etc.) |

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- Sample preparation (Tissue processing, staining, antibodies etc.)

**Cells and Human Diseases**

- Cancer Cell Biology Basics
- Virus Infection Basics

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<tr><td>Teaching and Learning Methodology</td><td>

**Lectures:** The major concepts and principles in cellular engineering will be delivered through lectures and invited seminars.

**In-class Discussion**: Students will be assigned to read, present and discuss recent research papers to gain knowledge in the latest advances and developments in cellular engineering.

**Laboratory:** Students will be grouped to observe and learn the laboratory techniques in cellular engineering.

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<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>

<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="7">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Assignments and quizzes</td><td>20%</td><td>√</td><td>√</td><td>√</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mid-term examination</td><td>40%</td><td>√</td><td>√</td><td>√</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Final examination</td><td>40%</td><td>√</td><td>√</td><td>√</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="7"></td></tr>
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*Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes*

**Assignments**: students are required to answer questions regarding the lab sessions. The understanding of the principles of experimental techniques is tested through this component.

**Mid-term and final examinations:** Students are required to answer questions related directly to the lecture materials. Reading a research article and answering related questions are also included. Both understanding of the lecture materials as well as thinking and applying skills are tested through these questions in these components.

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| **Student Study Effort Expected** | Class contact: | 39 Hrs. |
| | ▪ Lecture | 33 Hrs. |
| | ▪ Laboratory | 6 Hrs. |
| | Other student study effort: | 78 Hrs. |
| | ▪ Self-study | 60 Hrs. |
| | ▪ Assignment | 18 Hrs. |
| | Total student study effort | 117 Hrs. |
| **Reading List and References** | ▪ Alberts B. Molecular biology of the cell. Sixth edition. ed. New York, NY: Garland Science, Taylor and Francis Group; 2015.<br>▪ Bronzino JD, Peterson DR. Molecular, cellular, and tissue engineering. Fourth edition. ed. Boca Raton: CRC Press, Taylor & Francis Group; 2015.<br>▪ Cathomen T, Hirsch M, Porteus MH, American Society of Gene & Cell Therapy. Genome editing: the next step in gene therapy. New York: Springer; 2016.<br>▪ Lodish HF. Molecular cell biology. Eighth edition. ed. New York: W.H. Freeman-Macmillan Learning; 2016.<br>▪ Pörtner R. Animal cell biotechnology: methods and protocols. Third edition. ed. New York: Humana Press; 2014.<br>▪ Doulatov S, Daley GQ. Development. A stem cell perspective on cellular engineering. Science. 2013;342(6159):700-2.<br>▪ Nielsen J, Keasling JD. Engineering Cellular Metabolism. Cell. 2016;164(6):1185-97. | |
| **Date of Last Major Revision** | 8 October 2017 | |
| **Date of Last Minor Revision** | 29 June 2023 | |