Manipal Institute of Regenerative Medicine, Bengaluru

M. Phil. Stem Cell Technology and Regenerative Biology

Syllabus (2018 onwards)

REGULATIONS

These regulations shall come into effect from January 2018 onwards. These regulations are subject to modifications from time to time by authorities of Manipal Academy of Higher Education.

1. **Minimum Qualification for Admission:**
   The candidates must have passed MSc in any branch of Life Sciences / MSc in Biotechnology / M. Pharm / MBBS / M.VSc / MDS / MD / MSc in Regenerative Medicine/ Clinical Embryology and other paramedical courses from a recognised University and a minimum of 50% marks in aggregate.

2. **Duration of Program:**
   One year.

3. **Attendance Requirement:**
   Each course of the semester will be treated as a separate unit to determine the attendance. Every student must have not less than 80% attendance in each unit to be eligible to appear for examination.

4. The M.Phil. Course shall comprise of 40 Credits divided into 2 parts :

   (a) **Part I** – Course Work (15 Credits).
   Course 1- Research Methodology.
   Course 2 - Clinical Application of Stem Cells/ Non Clinical Application of Stem Cells/ Intercellular communications in Stem Cell Niches/ Biomaterials and Tissue Engineering.

   (b) **Part II** – Dissertation (25 Credits)

COURSE STRUCTURE

M.Phil. Stem Cell Technology and Regenerative Biology
PART I: COURSE WORK (Total Credits=15)

(L= Lecture, T= Tutorial, P= Practical, C= Credit, IA= Internal assessment, UNI Exam= University Examination)

COURSE-1							
Code	**Course Title**	**Hours Per Week**		**C**	**Maximum Marks**		
		L	**P**		**IA**	***UNI EXAM**	**TOTAL**
RM 801	**Theory** Research Methodology	5		2	30	70	100
RM 803	**Lab** Research Methodology		9	3	40	60	100
	TOTAL			**5**			**200**
COURSE-2							
RM 802	**Theory** Clinical Application of Stem cells OR Non Clinical Application of Stem Cells OR Intercellular communications in Stem Cell Niche OR Biomaterials and Tissue Engineering	7		7	30	70	100
RM 804	**Lab** Clinical Application of Stem cells		9	3	40	60	100
	TOTAL			**10**			**200**

*Minimum marks for all University Examinations for a pass credit = 50%

PART II: DISSERTATION (Total Credits=25)

Code	**Course Title**	**Hours per week (Lectures per week)**			**C**	**Maximum Marks**		
		L	**T**	**P**		**M.Phil. Thesis Evaluation**	**Thesis Presentation/ Viva Voce**	**TOTAL**
RM 805	Dissertation Project	-		-	25	300	100	400

*Minimum marks for all University Examinations for a pass credit = 50%

SYLLABUS OF COURSE WORK

M.Phil. Stem Cell Technology and Regenerative Biology

Course 1: CLINICAL APPLICATIONS OF STEM CELLS
Theory: 20 Lectures*

	CLINICAL APPLICATIONS OF STEM CELLS
LECTURE 1	Disorders of endocrine system
LECTURE 2	Disorders of endocrine system
LECTURE 3	Generation of Gastro intestinal cells from stem cells
LECTURE 4	Generation of Gastro intestinal cells from stem cells
LECTURE 5	Endodermal organoid culture system
LECTURE 6	Modelling endodermal diseases using stem cells
LECTURE 7	Treatment of Parkinson's disease, cerebral stroke, multiple sclerosis and ALS with stem cells
LECTURE 8	Treatment of Parkinson's disease, cerebral stroke, multiple sclerosis and ALS with stem cells
LECTURE 9	Treatment of Parkinson's disease, cerebral stroke, multiple sclerosis and ALS with stem cells
LECTURE 10	Stem cells for the treatment of motor neuron disease and spinal cord injury
LECTURE 11	Stem cells for the treatment of motor neuron disease and spinal cord injury
LECTURE 12	Introduction to immunotherapy, activation and suppression. Immunotherapies
LECTURE 13	Transplantation immunity
LECTURE 14	Application of MSCs as an immunomodulator during transplantation
LECTURE 15	Autoimmune disorder and application of stem cells
LECTURE 16	Cancer immunotherapy
LECTURE 17	Engineering stem cells for immunotherapy
LECTURE 18	Hematopoietic stem cells: concepts, definitions
LECTURE 19	Disorders of HSCs: Blood disorders, Anaemia, Genetic disorders, Leukaemia, Multiple myeloma.
LECTURE 20	Differentiation of stem cells to hematopoietic cells

Practical: 3 Practicals*

Induction of type 2 diabetes in animal models with streptozotocin.
Isolation of pancreatic islets from normal and diabetic mice
Isolation of Neural stem cells (NSCs) from Sub ventricular zone (SVZ) of mouse brain and characterization by PCR and Immunofluorescence.

Course 2: RESEARCH METHODOLOGY

Theory 20 Lectures

Lecture no.	RESEARCH METHODOLOGY
Lecture 1	In situ RNA hybridization; Karyotyping, FISH. Genome Analysis: Microarrays; NGS; DNA methylation Studies; Chromatin immune-precipitation
Lecture 2	Bimolecular Interaction Studies: Protein-Protein- Yeast two hybrid system Protein DNA: DNA foot printing/ EMSA
Lecture 3	Spectroscopy: Principles and Methods of UV visible spectroscopy (Nano drop), Fluorescence spectroscopy, Mass Spectrophotometry, Circular dichroism, Nuclear magnetic resonance
Lecture 4	Flow Cytometry: Principles, methods and applications of flow Cytometry, Fluorescence activated Cell sorting, BrdU Incorporation, Immuno-phenotyping, Cells cycle analysis, Cell Sorting
Lectures 5	Cell Culture Techniques: Isolation of Primary Cultures; Embryonic Stem Cell Derivation; Generation of IPSCs, Organoid Cultures, Hybridoma
Lectures 6	Genetic Manipulation: Cloning (Nuclear Transfer; SCNT). Generation of Cell Lines (Transformation of primary cells to cell lines, Report Constructs; Selectable Markers).
Lectures 7	Gene Editing (Homologous Recombination –Cre/loxP system; CRISPR Cas9 system, RNA Interference using siRNA, miRNA, Selection of Recombinants).
Lecture 8	Introduction and basic concepts: Definition – Biostatistics, Examples of applications of statistics in Biology, Variable – Qualitative & Quantitative: Nominal, Ordinal, Discrete, and Continuous
Lecture 9	Sampling: Definitions: Population Sample, Advantages of Sample Studies, Types of Sampling (Probability & Non Probability Sampling), Methods of Sampling (Procedure, merits, demerits and applications only- Simple random sampling, stratified random sampling, systematic sampling, cluster sampling), Sampling error
Lecture 10	Descriptive statistics: Averages (Calculations, merits, demerits and uses), Arithmetic mean, Geometric mean, Median and Mode; Measures of dispersion (Computation, merits, demerits and application). Range, Inter Quartile Range, Variance, Standard deviation, Coefficient of Variation; Graphical Presentation of data (Pie chart, Bar diagram, Line graph, Histogram, Frequency polygon, Frequency Curve)

Lecture 11	Descriptive statistics: Averages (Calculations, merits, demerits and uses), Arithmetic mean, Geometric mean, Median and Mode; Measures of dispersion (Computation, merits, demerits and application). Range, Inter Quartile Range, Variance, Standard deviation, Coefficient of Variation; Graphical Presentation of data (Pie chart, Bar diagram, Line graph, Histogram, Frequency polygon, Frequency Curve)
Lecture 12	Probability and Probability distributions: Sample space, Events. Definition of probability (Classical, Relative Frequency, Axiomatic). Properties of probability (only statements), Conditional probability, Addition theorem, Multiplication theorem and Baye's theorem (only statements). Discrete probability distributions - Binomial and Poisson (concept and list of applications). Continuous probability distribution - Normal distribution (concept, properties and applications).
Lecture 13	Concepts of tests of significance: Null hypothesis, Alternate hypothesis. Type I error, Type II error. Level of significance. P-value. Power of the test. Tests of significance (Chi-square test, Z test (for proportions), Student's t-test (paired and unpaired), One-way analysis of variance (only introduction)). Confidence interval for mean and proportion.
Lecture 14	Correlation and regression: Dependent Variable, Independent Variable. Definition and properties of simple Pearson's correlation co-efficient. Test of significance of correlation co-efficient. Concept of simple linear regression. Scatter graph with regression line
Lecture 15	Sample size determination: Importance of sample size determination in Biological Sciences Research. Sample Size for -estimating mean, comparing two means, estimation proportion, comparing two proportions.
Lecture 16	Fundamental Ethical Principles
Lecture 17	Laboratory-based Human Embryonic Stem Cell Research, Embryo Research, and Related Research Activities: Review Processes, Procurement of Biomaterials, Derivation, Banking and Distribution of Human Pluripotent Stem Cell Lines and Mechanisms for Enforcement
Lecture 18	Clinical Translation of Stem Cells: Cell Processing and Manufacture, Preclinical Studies, Clinical Research, Stem Cell-based Medical Innovation and Clinical Application
Lecture 19	Clinical Translation of Stem Cells: Cell Processing and Manufacture, Preclinical Studies, Clinical Research, Stem Cell-based Medical Innovation and Clinical Application
Lecture 20	Communications and Standards in Stem Cell Research

Practical: 7 Practical

Cell Viability Assay (MTT)
Culture & Characterization of Mesenchymal Stromal Cells
Culture & Characterization of Embryonic stem cells
Descriptive statistics
Probability and probability distributions
Assessment of homologous sequences using phylogenetic analysis
Protein databases and visualization