Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2022-2023

COURSE HANDOUT (PART-II)

Date: 24.08.2022

Course No : **BIO G515**

Course Title : **Stem Cell and Regenerative Biology**

Instructor -in-charge : **VIVEK SHARMA**

Lab Instructors : Vivek Sharma, Swati,and Sumana Choudhury

Description : Introduction to stem cells and regenerative biology; embryonic stem cells, adult stem cells, manipulation of stem cells for replacing cells in diseased tissues; transplantation of embryonic and adult stem cells, replacing congenitally defective organs and damaged organs, tissue engineering, biodegradable and biocompatible materials, nano-devices, and regulatory perspectives.

1. Course Description:

This course is intended to provide a comprehensive overview of current understanding of stem cells, including their fundamental properties and interactions. The lectures will be organized into 3 sections. The first section will give an overview of embryonic & adult stem cells and their basic characteristics. This area will discuss general methods and unifying features and lay foundation for subsequent sections. The 2nd section will focus on Stem Cells in Tissues and Organ Development (Regenerative Medicine). The final section will focus on iPSCs, stem cell isolation methods, immunologic properties & potential therapeutic use of stem cells.

2. Scope and Objective of the Course:

The aim of this course is to provide an introduction to the subject of stem cells and approaches to regenerative biology. Stem cells have generated considerable interest recently in the scientific, clinical, and public arenas. It is essential that we gain a broader understanding of the factors that regulate the biology of stem cells: their ability for self-renewal, differentiation and plasticity, as well as the differences between embryonic and adult stem cells, and whether stem cells can be manipulated to replace cells in diseased tissues. Stem cells will also be discussed in the context of cancer and neurological disorders.

3. Text Book:

(i) **Robert Lanza. Essentials of Stem Cell Biology. 2009. Elsevier's, 2nd edition**

4. Reference Books:

(i) Walter C. Low. 2008. Stem Cells and Regenerative Medicine. World scientific, 1st edition.

(ii) Deb &Totey. 2009. Stem Cells; Basics and Applications. Tata Mc Graw Hill, 1st edition.

5. Course Plan (Text Book- TB; Reference Book- RB;Chapter-Ch; Hand Out- Research articles &/or reviews)**:**

Lect. #	Learning Objectives	Topics to be Covered	Reference
1	Prelude and Introduction	Overview of the Course, Definitions, Types, Characteristics, ES-Like Cells, Origin, Culture, growth and maintenance of ES cells	Part-1 TB
2-3	Adult Stem Cells	Types, Plasticity, Trans-differentiation, Characteristics, Multi-drug resistance, Molecular Basis of asymmetric cell division	Ch-3 TB
4-5	Pluripotency-Molecular Control and Stem Cell Niche	Signal Transduction- Extracellular Factors and Cytokines	Part I and Part II TB (Ch 4)
6-8	Transcriptional Regulation of Stem Cells	Oct4, Sox2, Nanog- Regulation and Function; p53 & stem cells,	Part IV TB, Hand Out
9-12	Stem Cells for Nervous System	Neural Stem Cells and their Differentiation and Therapeutic Perspectives; NSCs growth and maintenance *in-vitro*	Ch- 8 TB Reviews and articles
13-14	Stem Cell Renewal and Niche	Homeostasis, Metabolism, Types of Niche	Ch-5,6 TB Reviews and articles
15-18	Mesenchymal Stem Cells (MSCs)	MSCs Origin, Property, Immunogenicity, Application in Neurodegenerative Diseases	Part II TB Ch-8, 23 RBiii; Hand Out; Case studies Reviews

19-20	Embryonic Stem Cells (ESCs)	Cell Differentiation in Embryo, Amniotic Fluid and Cord Blood ,Orifin of ES cells, Derived Stem Cells; ESCs differentiation into Embryoid bodies SCNT,	Part II and III TB, (Ch 12-13, 15-16) Ch-6 RBiii
21	Primordial Germ Cells (PGCs)	Fragilis, Stella, Molecular Control of Migration of PGCs	Ch 12 RBi, Hand Out; Articles
22-23	Haematopoietic Stem Cells	Evidence, Property, Source, Genetic Control; Growth Factor & Regulation	Ch-22-23 TB, Articles
24-25	Cancer Stem Cells (CSCs)	Cancer Clonality, CSC Origin, CSC & Metastasis, Therapeutic Implications	Ch-12 TB; Ch-24 RBiii Hand Out
26-27	Cardiac Stem Cells, Hepatic Oval Cells and Gastro-intestinal Stem Cells	Cardiac Stem Cells and Regeneration; Renal Stem Cell, Oval Cells and Repopulating Cell, GI-Stem Cells	Ch 29, 32, 34 TB
28-29	Epigenetic Control over Stem Cells	Histone, Bivalent Structure, PCG, NuRD Complex and miRNA & stem cells	Part IV TB (Ch 18-19)
30-31	Cell Cycle Control of Stem Cells and Senescence	Stem Cell Quiescence, Cyclin-CDKs, Rb, p53 Chromatin Modifications, Ageing	Part III and IV TB; (Ch 26-27, 29, 31-32) Ch17-18 RBiiiCh
32	Multipotent Adult Progenitor Cells (MAPCs)	MAPCs and its Advantages in Therapy	Hand Out
33	Induced Pluripotent Stem Cells (iPSCs)	Properties & Methods to derive iPSCs, A Visit to Yamanaka's Experiment	Part IV and V TB; Hand Out
34	ESCs in Diabetes Therapy	B-Cell Replacement; Drug Discovery & Development.	Part IV and V TB Ch-9, 15 RBiii

35	Potential Uses of Stem Cells, Obstacles and Gene Therapy	Heart, Vascular System, Neurons, Skin & Spinal Cord	Part IV and V TB
36	Characterization, Isolation and Maintenance of Stem Cells	Human & Murine Embryonic Stem Cells; Matrigel, Serum & Feeder Free Culture, Surface markers.	Ch 35-36; 38, 40-42, 45, 47;48 TB
37	Stem Cell Current Perspectives and Conclusion	Mostly Review of Current Status of Stem Cell Research	Part VI TB

6. Evaluation Scheme:

Components	Duration	Weightage (%)	Date	Nature
Mid Semester	90 min	25	5/11 11-12:30 PM	CB
ASSIGNMENT (2)		10	TBA	OB
LABORATORY	Variable	30	TBA	OB
Comprehensive Examination	3hrs	35	29/12, FN	CB

List of experiments

1. Media preparation for mouse embryonic stem cell (ESCs) culture.
2. Thawing ES Cells
3. Plating, maintenance,and passaging of ES cells
4. Characterization of ESCs by evaluating pluripotency markers
5. Differentiation of ESCs into the embryoid body (EB)
6. Validation of lineage specific markers i.e. PAX6, GATA6 and TBXT in EB.

7. Grading Policy:

The histogram of marks would guide award of grades. Decision for cases on borderline of two grades will be based on the student's promptness and participation in classroom activities as well as satisfactory attendance in lecture and tutorial classes. If a student misses even a single component entirely or does not give sufficient opportunity for being assessed, he/she may be awarded 'NC' report regardless of his/her final total score in the course (see Clause 4.19 of *BITS Academic Regulations*).

8. Chamber Consultation:

By email (viveksharma@hyderabad.bits-pilani.ac.in).

9. Make-up Policy:

Make-up for Mid-Sem and Compre will be granted only if candidate is sick and hospitalized with appropriate evidence of illness. No make-up will be granted for assignments/LABS under any circumstances.

10. Course Announcements and Notices:

Announcements pertaining to the course will be made in the CMS. In some cases, printed notices shall be displayed in the notice board of only the Department of Biological Sciences.

11. Academic Honesty and Integrity Policy:

Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor-in-Charge

BIOG515