



ACHARYA NARENDRA DEV COLLEGE

UNIVERSITY OF DELHI

Teaching Assistantship Proposal

Biological Sciences

(2022-23)



Prime Minister Research Fellow

Department of Biochemical Engineering and Biotechnology

IIT DELHI

# **Tools and Techniques in Biological Sciences [60 hours]**

## **Course objective**

Biotechnology is an indispensable field of research that has applications in daily life and innumerable industrial sectors like food, healthcare, diagnostics, waste treatment, mining and agriculture. It has received further recognition since the recent pandemic. The communities have realised the necessity to encourage rigorous research in the various areas of biotechnology. Even the Government of India has started several programmes and grants to support such research. Biotechnology is one of the important pillars for the upliftment of our society.

## **Course learning outcome**

Upon completion of the course, students would have,

1. Knowledge of basic concepts and important areas in biotechnology
2. Confidence in the major laboratory techniques
3. An updated outlook about the current research
4. An understanding about the working of various techniques even at large scale
5. Explored an area of interest to specialise

## **Course content**

**(No. of hours)**

### Unit-1: Good laboratory practices

(02)

Personal Protection Equipment, General safety precautions, Biosafety cabinets, Aseptic conditions, Labelling, Documentation, Standard Operating Procedures, Maintenance and calibration of the instruments, Storage facilities

### Unit-II: Cell culture techniques

(04)

Culturing and handling of bacteria, Animal, mammalian cell lines, Algae, Fungi, Mixed cultures and model organisms

### Unit-III: Analytical techniques

(04+04)

Microscopy (Light, Fluorescence, X-ray), Spectroscopy (Visible, UV, Infrared, NMR, XPS), Chromatography (Ion exchange, reverse phase, normal phase, hydrophobic interaction chromatography, ligand based chromatography, continuous chromatography), PCR, DNA and RNA isolation and quantification, Gel Electrophoresis (DNA and Protein)

Unit-IV: Bioprocess technology (04)

Sterilisation (physical, chemical and radiation), Death kinetics, Growth kinetics, Modes of reactor (batch, fed batch and continuous), Industrial reactors, Aeration and agitation, Rheology, Mixing, Scaleup, A case study

Unit-V: Genetic Engineering (04+04)

Gene transfer (transformation, transduction, transfection- transient and stable), Plasmids/ vectors, Basics of Cloning (primer designing, vector selection, screening of positive clones), RNAi technology (miRNAs, siRNAs), Online tools for retrieving gene sequences, BLAST

Unit-VI: Reading-writing research papers, resource searching (02+04)

Basic contents of a research article, Types of articles, Why are they necessary, Order in which you read an article - depends on what is the goal, Importance of literature survey in research, Care to be taken while conducting research, Plagiarism, Assignment - group presentation and term paper (included in class hours)

Unit-VII: Introduction to Bioinformatics & Functional Genomics (04+04)

Difference between information after DNA/ RNA sequencing, Available technologies and the principle, long-read/ short read and bulk/ single-cell, File formats, Information that is already known about the human genome & transcriptome [reference and annotation], Exploring github, Lab session - on galaxy platform - RNA-Seq, Differential gene expression, Gene ontology/pathway enrichment, Basics of command lines (brief about scripting languages and resources where one could start learning)

Unit-VIII: Nanobiotechnology (02)

What are nanomaterials, examples from nature, electroactive bacteria, production of nanomaterial, characterisation, applications, nanomaterials in the field of medicine, nanobiosensors, case study.

Unit-IX: Basics of Cancer biology (04)

Hallmarks of cancer, genetics, carcinogens - dna damage, inheritance, brief introduction to 'epigenetics' and tumour virus, diagnosis - characteristics of normal Vs tumour cells from histological images, treatment, current strategies - chemotherapy/ immunotherapy/ targeted drug delivery, how is cancer research conducted and the challenges

Unit-X: Waste treatment technology (04+04)

Characterization of waste and its regulation, Aerobic and anaerobic wastewater treatment, Suspended and attached cell biological treatment, Sludge treatment, Hazardous and toxic waste treatment, Bioleaching, Antimicrobial resistance (AMR)

## Teaching and Learning process

The various units included in the course will be taught by the research scholars from the Department of Biochemical Engineering and Biotechnology, IIT Delhi, who are working in that particular area and have had experience in dealing with the real world problems. The instructors would not only share the theoretical knowledge of the topics but share their personal experience in the laboratories.

Laboratory sessions for the topics can also be arranged depending on the availability of time and infrastructure. In addition, there would be demo sessions for the various techniques that would be discussed throughout the course to give the students a better understanding of their working. These sessions could be a video recorded by the instructors. This unit may not be taught as a whole in one go but it would be dispersed throughout the semester. 1-2 seminars would be conducted towards the end of the course by the instructors to introduce their own research giving them a holistic understanding of how the course content can be applied.

The students would be motivated to read more research articles and keep themselves updated. To do so, each instructor would introduce some interesting articles in every unit and circulate it amongst them. Towards the conclusion of the course, the students would be asked to write a short gist of as well as present their understanding of the research article of their choice.

## Assessment

1. **Quizzes:** Two quizzes would be conducted (pre-mid-semester and post-mid semester) to assess the conceptual understanding of the students. (02 hours)
2. **Assignment:** The students would be expected to read and understand at least one research article related to the course content. They would have to write a short term paper on it and present it to the class. (04 hours)
3. **Final evaluation:** A comprehensive assessment for the students to indicate their understanding of the course. (03 hours)

## Reading recommendation

Relevant chapters from various books, and review articles to better understand the course material will be shared along with the presentations, demo videos and other materials used in class. The following books would aid in understanding of the respective topics.

1. Doran, Pauline M. **Bioprocess** engineering principles. Elsevier, 1995.
2. Baird, Rodger B., Andrew D. Eaton, and Lenore S. Clesceri. Standard methods for the examination of water and **wastewater**. Ed. Eugene W. Rice. Vol. 10. Washington, DC: American public health association, 2012.
3. Brown, T. A. (2020). *Gene Cloning and DNA Analysis: An Introduction*. Wiley. <https://books.google.co.in/books?id=prEWEAAAQBAJ>
4. Introduction to **Genomics** by Arthur M. Lesk
5. Introduction to **Computational Genomics** by Nello Cristianini and Matthew W. Hahn
6. Introduction to **Bioinformatics** by Arthur M. Lesk
7. The Molecular Basis of **Cancer**: Mendelsohn J, Howley PM, Israel MA, Gray JW, Thompson CB (eds); Saunders Elsevier, Philadelphia; 3rd edition; 2008
8. The biology of **Cancer**: Weinberg RA; Garland Science; 2007.
9. Field's **Virology**: David M. Knipe, Peter M. Howley, Diane E. Griffin, Robert A. Lamb, Malcolm A. Martin, Bernard Roizman, Stephen E. Straus; Lippincott Williams & Wilkins; 5th edition; 2007.

Unit	Topic	Subtopic	Name of student	No. of hours
1	Good Lab practices	General safety instructions, documentation, labelling, common laboratory waste separation and management, storage instructions (Tutorial and assignment)	Preetha, Pallavi	2
2	Cell culture techniques	Bacteria and mammalian cultures, and model organisms Principles and Demo sessions for Laminar and autoclave	Preetha, Aastha, Pallavi	2
		Algal cells and mixed cultures Lab sessions on handling common lab equipments	Supraja, Rewati	2
3	Analytical techniques	Microscopy, spectroscopy, chromatography (Tutorial and demo class)	Supraja, Rewati	2
		Isolation and characterization of nucleic acids	Aastha, Prakrithi, Preetha	2

		Lab session (Nucleic acid isolation and PCR)	Pallavi, Aastha, Prakrithi, Preetha	4
4	Bioprocess technology	Sterilization and Kinetics of growth, types of reactors (laboratory+industry)	Supraja, Rewati	2
		Mixing, aeration and agitation and case study	Supraja, Rewati	2
5	Genetic engineering	Cloning I (Basics of primer designing and demo in computer lab)	Aastha, Pallavi	2
		Cloning II (vectors, digestion, transformation and screening)	Aastha, Preetha	2
		Lab session (Blue-white screening)	Aastha, Preetha	4
6	Reading and writing research papers	Contents, citations, types, search engines and plagiarism	Preetha, Pallavi	2
		Student presentation	Prakrithi, Supraja, Rewati	4
7	Introduction to Bioinformatics	Theory of DNA and RNA sequencing	Pallavi, Prakrithi	2
		Downstream applications	Pallavi, Prakrithi	2
		Lab session in computer lab - File formats and handling, RNA-Seq analysis on Galaxy platform	Pallavi, Prakrithi	4
8	Nanobiotechnology	Inspiration from nature, electroactive organisms, Production and characterisation of nanomaterials Applications and case studies Demo sessions for biological production and zeta potential measurement	Preetha, Rewati, Supraja	2

9	Basics of Cancer biology	Introduction to Epigenetics and cancer hallmarks	Aastha, Prakrithi	2
		Diagnosis and treatment	Aastha, Prakrithi	2
10	Waste treatment	Aerobic and anaerobic treatment	Supraja, Rewati	2
		Suspended and attached cell treatment	Supraja, Rewati	2
		Lab session (sludge visualisation under microscope, estimation of COD demo), Talk on AMR	Supraja, Rewati	4
11	Quizzes	Quiz 1 + Quiz 2	Aastha, Pallavi, Preetha	2

Name	No. of hours	Contact details
Aastha	22	<a href="mailto:bez198182@iitd.ac.in">bez198182@iitd.ac.in</a>
Rewati	22	<a href="mailto:bez198187@iitd.ac.in">bez198187@iitd.ac.in</a>
Supraja	22	<a href="mailto:bez208516@iitd.ac.in">bez208516@iitd.ac.in</a>
Pallavi	22	<a href="mailto:qiz218228@iitd.ac.in">qiz218228@iitd.ac.in</a>
Prakrithi	22	<a href="mailto:qiz218241@iitd.ac.in">qiz218241@iitd.ac.in</a>
Preetha	22	<a href="mailto:bez208521@iitd.ac.in">bez208521@iitd.ac.in</a>