IIT Mandi - Proposal for a New Course

Course Number : BE306
Course Name : Genetic Engineering: principles and applications
Credit Distribution : 3-1-0-4
Intended for : UG (IDD Bioengg, 3rd year)
Prerequisites : IC136 or consent of the faculty member
Elective or Core : Discipline core
Semester : Odd
Mutual Exclusion : None

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1. Preamble: The main objective of this course is to introduce the concepts, developments, and applications of genetic engineering or recombinant DNA technology (rDNA tech). This course provides a comprehensive understanding of plasmids/vectors, DNA modifying enzymes such as restriction enzymes that cut DNA, ligases that join DNA fragments, and polymerases that amplify DNA fragments. The students will learn how rDNA technology works by exploring various DNA cloning methods. By the end of this course, students will be able to understand the principles of recombinant DNA technology and methods associated with it such as cutting, joining, and amplifying DNA fragments. They will also get hands-on training on gene cloning methods and learn to use online tools to analyze DNA sequences and design primers. As a result of this course, the students will have strong foundations and first-hand scientific understanding and hands-on training in genetic engineering and how it can be used to generate genetically modified organisms for commercial, agricultural, and medical purposes.

2. Course Modules with quantitative lecture hours:

Module-1 Introduction ***[12 hours]***
Gene and mRNA structure and properties; analysis of DNA and RNA sequences, DNA and RNA modifying enzymes (Restriction Enzymes, DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase). Introduction to genetic engineering and GMOs.

Module-2 PCR and Its Applications ***[11 hours]***
Primer, Primer designing, Thermostable DNA polymerases, PCR, Types of PCR – multiplex, nested, reverse transcriptase, cDNA synthesis, real-time PCR, touchdown PCR, hot start PCR, colony PCR. Site-directed mutagenesis, Mutation detection, PCR in molecular diagnostics, Viral and bacterial detection.

Module-3 Cloning Vectors ***[8 hours]***
Bacterial and viral based plasmids (PUC19, Bluescript vectors, M13 vectors, SV-40 vectors, Phagemids, Cosmids); Artificial chromosome vectors (YACs; BACs); Plant based vectors, Ti and Ri as vectors, Selection of vectors, Expression vectors (pMal; GST; pET-based vectors)

Module-4 Cloning Methodologies ***[12 hours]***

Restriction Enzyme Based Cloning; PCR Cloning (TOPO or TA); Ligation Independent Cloning (LIC); Seamless Cloning (SC); Recombinational Cloning; Gibson Assembly (Isothermal Assembly Reaction); Expression cloning, Construction of genomic and cDNA libraries.

Module-5 Introduction of DNA into cells ***[7 hours]***

Introduction of DNA into bacterial cells (transformation methods), viruses (transduction methods), mammalian cells (Transfection techniques), plant tissues (Transfection techniques, particle bombardment), and model organisms (microinjections).

Module-6 Genetic engineering applications, case studies and ethical issues [6 hours]

Recent developments in genetic engineering methods; Applications of genetic engineering in agriculture and medicine; GMOs and GEMs; Socio-economic, cultural, and ethical issues.

3. Textbooks:

1. Terry A. Brown, Gene Cloning: An Introduction. 8th edition, Wiley-Blackwell, 2021; ISBN 978-1119640783.
2. Sandy B. Primrose, Richard Twyman, Principles of Gene Manipulation and Genomics. 8th edition, John Wiley Blackwell, 2016; ISBN 978-8126548392.

4. References:

1. Michael R. Green and J. Sambrook. Molecular Cloning: A Laboratory Manual (Fourth Edition), Vols 1-3, Cold Spring Harbor Laboratory Press, CSHL, 2012; ISBN 1936113422.
2. B. Alberts, R. Heald, A. Johnson, D. Morgan, M. Raff. Molecular Biology of the Cell, 7th edition, W.W. Norton & Co Inc, 2022; ISBN 978-0393884821

- Relevant research articles/reviews will be advised relating to the topic being taught.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.	Course Code	Similarity Content	Approx. % of Content
1.	BE202	PCR lab	5%

6. Justification of new course proposal if cumulative similarity content is >30%:

None