JYOTI NIVAS COLLEGE AUTONOMOUS BANGALORE – 560 095
DEPARTMENT OF BIOTECHNOLOGY
B.Sc. V SEMESTER BIOTECHNOLOGY PAPER V SYLLABUS (2021 NEP BATCH)
GENETIC ENGINEERING

COURSE TITLE	**GENETIC ENGINEERING**
COURSE CODE	**21VBT5 (T)**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**60 Hours**
DURATION OF ESE	**2 ½ Hours**
CONTINUOUS INTERNAL ASSESSMENT (CIA)	**40 Marks**
END SEMESTER EXAMINATION (ESE)	**60 Marks**

COURSE OBJECTIVES:

The objective of this course is

1. To demonstrate current tools, vector host systems, and cloning techniques were creatively used to create recombinants.
2. To familiarise the students with numerous tools and techniques used to deal with genes, proteins, and their expression strategies.
3. To facilitate candidates to comprehend the applications of genetic engineering across various fields, including medicine, gene therapy, forensics, agriculture, and others.
4. To become familiar with contemporary research approaches that use transgenic and recombinant DNA technology.

LEARNING OUTCOMES:

After successful completion of the course the students will be able to

1. Explore on various role of genetic engineering in Medicine, agriculture, forensics, regenerative medicines, transgenics and so on.

2. Recognise the value of fundamental understanding of transformation, screening, and transformant selection.
3. Assess the importance of chromosome and protein engineering, gene therapy, gene delivery and gene editing in various biological sectors.
4. Critically evaluate a range of laboratory techniques for real-world by using acquired scientific skills.

CO NO.	**Course outcomes statement**	**Knowledge level**
1	Explore on various role of genetic engineering in Medicine, agriculture, forensics, regenerative medicines, transgenics and so on.	K1, K3, K4
2	Recognise the value of fundamental understanding of transformation, screening, and transformant selection.	K1
3	Assess the importance of chromosome and protein engineering, gene therapy, gene delivery and gene editing in various biological sectors.	K1, K2, K5
4	Critically evaluate a range of laboratory techniques for real-world by using acquired scientific skills	K2, K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	✓	✓		✓	✓		✓			✓
CO2	✓				✓					✓
CO3	✓	✓		✓			✓			
CO4	✓	✓		✓			✓			

Programme Objectives aligned with Graduate attributes

PO1- Knowledge

PO2- Scientific thinking

PO3- Entrepreneurial skills

PO4- Analytical skills

PO5- Communication skills

PO6- Social commitment

PO7- Research and Inquiry

PO8- Conservation of Environment

PO9- Digital awareness and literacy

PO10- Academic orientation

UNIT 1: SCOPE and GENE CLONING STRATEGIES 15 HRS

Overview and scope of Genetic engineering, Milestones in Genetic engineering.

a. **DNA modifying enzymes:** REN, Polymerase, Reverse transcriptase, ligases, alkaline phosphatase, terminal deoxynucleotide transferases, nucleases -S1 nuclease. PNK.

b. **Vectors** – Plasmids, pBR322, pUC 18/19, cosmids, phagemids, artificial chromosomes – BAC & YAC. Binary vectors – animal and plant (SV40, Baculovirus, Ti plasmid)

c. **Expression vector and systems –** overview, need for gene construct, Promoter (Constitutive and inducible promoters, tissue specific promoters), ribosome binding sites, terminator. Reporter genes

d. **Fusion proteins and tag** – His, GST tags, purification and detection of tags

e. **Expression systems** – *E. coli*, Yeast, Insect cells, mammalian cell lines, Cell free extracts and systems – reticulocyte lysates,

UNIT 2: GENE TRANSFER AND TOOLS FOR ANALYSING GENE EXPRESSION

15 HRS

a) **Transformation and selection of recombinants** – physical, chemical and biological methods of transformation, visual screening of transformants.

b) **Problems and optimization of expression** – host compatibility, codon bias, media optimization, protein folding and solubilization,

c) **Analysis of DNA protein interactions** – Electrophoretic mobility shift assay (EMSA) and DNase I foot printing.

d) **Construction of DNA libraries –** Genomic and cDNA

alternative strategies for Gene cloning – site directed mutagenesis, protein engineering.

UNIT 3: TECHNIQUES IN GENETIC ENGINEERING 15 HRS

Principle and scope of transgenic technology,

a. Concept of gene editing – targeted genome editing – ZFNs, CRISPRs and TALLENS,

b. Gene targeting – Gene knock in and knock out strategies, miRNA and siRNA induced silencing.

c. Gene delivery- Strategies involved in gene delivery, gene replacement/augmentation.

d. Molecular markers- RFLP, RAPD and AFLP, DNA fingerprinting, SNP analysis.

Brief note on chromosome engineering and gene therapy.

UNIT4: APPLICATIONS OF GENETIC ENGINEERING 15 HRS

a. **Molecular Tools in Genetic engineering** – Medical Genetics, Gene therapy, Human Genome project, Plant transgenics.

b. **Application of Genetic Engineering** in Biopharmaceutical industries, Biotherapeutics, molecular diagnostics, vaccine developments, biofuels, food industries and environment pollution management.

c. O**mics technologies** - transcriptomics, proteomics, metagenomics, metabolomics nutrigenomics.

d. **Bioethics and Biosafety** – biosafety levels. Biosafety issues, Genetic Engineering guidelines.

REFERENCES:

1. M. R. Green, J. Sambrook. Molecular Cloning: A Laboratory Manual, 4th Edition, Cold Spring Harbor, 2012.
2. M. Wink. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology, 2nd Edition, Wiley publishers. 2011.
3. K. Wilson, J. Walker. Principles and Techniques of Biochemistry and Molecular Biology, 7th Edition, Cambridge University Press, 2010.
4. T. A. Brown, Gene Cloning and DNA Analysis: An Introduction, 7th Edition, Wiley Blackwell. 2020
5. Sandy B. Primrose, Richard Twyman & Bob Old, Principles of gene manipulation primrose: An introduction to genetic engineering, 6th Edition, Blackwell Science. 2021
6. H.M. Eun. Enzymology. Primer for Recombinant DNA Technology, Academic Press, 1996.
7. Bernard R. Glick and Cheryl L. Patten, Principles and Applications of Recombinant DNA - Molecular Biotechnology., 5th ed, ASM Press, United states. 2017.
8. Desmond S.T Nicholl, An Introduction to Genetic Engineering. 3rd Edition, Cambridge University Press, New York. 2008.
9. J. J. Pasternak, Molecular Biotechnology 3rd Edition, American society for microbiology, 1996.

BIOTECHNOLOGY PRACTICAL PAPER 5

COURSE TITLE	**GENETIC ENGINEERING**
COURSE CODE	**21VBT5 (P)**
COURSE CREDITS	**02**
TOTAL CONTACT HOURS	**4 hours/week**
DURATION OF ESE	**03 hours**
CONTINUOUS INTERNAL ASSESSMENT (CIA)	**25 Marks**
END SEMESTER EXAMINATION (ESE)	**25 Marks**

Experiments

1. Calculation and Preparation of buffer and stock solutions.
2. Isolation of plant genomic DNA using CTAB method.
3. Isolation of RNA from yeast cells/ animal cells
4. Isolation of plasmid DNA from alkaline lysis method.
5. Determination of molecular weight of plasmid DNA by electrophoretic method.
6. *In vitro* DNA Ligation.
7. Transformation, Screening and selection of transformants using Blue white colony screening method.
8. Precipitation of protein by salting in and out method from plant samples.
9. *In silico* prediction and analysis
    a. Restriction mapping
    b. Primer designing
    c. Melting temperature of DNA.
10. Design of protocol for isolation of genomic DNA from tissues and environment samples.