SHRI GNANAMBICA DEGREE COLLEGE: MADANAPALLE

(AUTONOMOUS)
BIOTECHNOLOGY
COURSE-7: GENETIC ENGINEERING
SEMESTER III
(W.E.F. 2025-2026)
Program: B.Sc. Biotechnology Honors

Hours per week: 4 **Credits: 3**

COURSE OUTCOMES (COS)

By the end of this course, students will be able to:

CO1: Explain the fundamentals, historical development, tools, and strategies of genetic engineering in plants and animals.

CO2: Analyze different types of cloning vectors and apply gene transfer methods for recombinant DNA technology.

CO3: Demonstrate understanding of PCR, hybridization techniques, and DNA labeling methods for molecular diagnostics.

CO4: Illustrate the construction of gene libraries and optimize gene expression in various biological systems.

CO5: Evaluate advanced gene editing techniques, sequencing methods, and therapeutic applications like gene therapy.

SYLLABUS

UNIT – I: Introduction to Genetic Engineering and Molecular Tools

1. Basics, history, scope, and recent developments in Genetic Engineering; guidelines; strategies in plant and animal genetic engineering.
2. Molecular tools in genetic engineering- Restriction enzymes: Endo & Exonucleases. Modifying enzymes
3. Ligation (cohesive & blunt end ligation) – linkers & adaptor.

UNIT – II: Cloning Vectors and Gene Transfer Methods

1. Cloning vectors: plasmid - definition, properties and types. pUC19 & pBR322- phage vectors (λ & M13);

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2. Cosmid vectors, Shuttle and expression vectors; YAC (*S. cerevisiae* as a model) & BAC (E. coli);
3. Screening and selection of recombinants; Gene transfer methods

Case Study: Insulin production using pBR322 vector in E. coli: One of the earliest successes in recombinant DNA technology, where human insulin was produced in bacteria using plasmid vectors, laying the foundation for biotech pharmaceuticals.

UNIT – III: Molecular Detection and Amplification Techniques

1. Hybridization techniques: Probes (radioactive & non-radioactive), detection.
2. Polymerase Chain Reaction (PCR) – Principle , Applications and types of PCR
3. Labeling of DNA- Nick translation, Random priming method & labeling by primer extension.

Case Study: COVID-19 detection via RT-dPCR: During the pandemic, digital PCR was used for highly sensitive SARS-CoV-2 detection, outperforming traditional qPCR in early infection stages.

UNIT – IV: Gene Expression and Functional Analysis

1. Construction of genomic & c DNA libraries.
2. Vector engineering & codon optimization, strategies of gene delivery, invitro translation
3. Expression in bacteria, yeast, insects, plant & mammalian cells

UNIT – V: Advanced Genetic Engineering Techniques

1. Chromosome engineering, targeted gene replacement,
2. gene editing, gene regulation & silencing. Site-directed mutagenesis.
3. DNA sequencing – Maxam Gilbert (chemical) & Sanger's, Nicolson sequencing, Pyrosequencing. Gene therapy, Human Genome Project.

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COURSE 7: GENETIC ENGINEERING - PRACTICALS

Practical **Credits: 1** **2 hrs/week**

1. Problem in Genetic engineering.
2. Transformation in Bacteria using plasmid
3. Restriction digestion of DNA and its electrophoretic separation.
4. Ligation of DNA molecules and their testing using electrophoresis.
5. Activity of DNAase and RNAse on DNA and RNA.
6. Isolation of Plasmid DNA
7. Demonstration of PCR

REFERENCES

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2. Principles of Gene Manipulation - 7th edition, 2006, By R.W. Old & S.B. Primrose, Publ: Blackwell

3. Molecular Biology & Biotechnology- 1996, By H.D. Kumar, Publ: Vikas

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5. Genes and Genomes – 1991, By Maxine Singer and Paul Berg

6. Genes VII- 2000, By B. Lewin - Oxford Univ. Press

7. Molecular Biology - 4th Edition, 2008, By D. Freifelder, Publ: Narosa Publishing house New York, Delhi

8. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.

9. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution.

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BIOTECHNOLOGY

COURSE-7: GENETIC ENGINEERING

SEMESTER III

(W.E.F.2025-2026)

Program: B.Sc. Biotechnology Honors

Question Paper Blue Print

Time : 3 Hrs **Max Marks: 70**

(Draw diagrams wherever necessary)

I. Answer any Four Questions 4 X 5 =20

1. .....
2. .....
3. .....
4. .....
5. .....
6. .....
7. .....
8. .....

II. Answer all the questions 5 X 10 = 50

1. (A).....

   Or

   (B).....
2. (A).....

   Or

   (B).....
3. (A).....

   Or

   (B).....
4. (A).....

   Or

   (B).....
5. (A).....

   Or

   (B).....

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BIOTECHNOLOGY

COURSE-7: GENETIC ENGINEERING

SEMESTER III

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Program: B.Sc. Biotechnology Honors

Model Question Paper

Time : 3 Hrs **Max Marks: 70**

(Draw diagrams wherever necessary)

I. Answer any Four Questions 4 X 5 =20

1. Differentiate between endonucleases and exonucleases with examples.
2. What is a shuttle vector? Mention its utility.
3. What is a DNA probe? Differentiate between radioactive and non-radioactive probes.
4. What is codon optimization? Why is it necessary in expression studies?
5. What is site-directed mutagenesis? How is it performed?
6. Define chromosome engineering. Mention one application in gene mapping.
7. Explain the principle of random priming in DNA labeling.
8. Mention two commonly used methods for screening recombinant colonies.

II.Answer all the questions 5 X 10 = 50

1. (A) Explain the historical development, scope, and modern advancements in genetic engineering.

Or

(B) Explain the process of ligation involving cohesive and blunt ends. Discuss the role of linkers and adaptors.

2. (A) Describe plasmid vectors in detail with reference to pUC19 and pBR322.

Or

(B) Elaborate on gene transfer techniques in prokaryotic and eukaryotic systems.

3. (A) Describe hybridization techniques using probes and explain how detection is carried out.

Or

(B) Explain the principle, steps, and types of PCR. Discuss its applications in research and diagnostics.

4. (A) Discuss various strategies of gene delivery and expression systems in genetic engineering.

Or

(B) Explain the process of constructing a genomic and cDNA library with their applications.

5. (A) Describe the principles and applications of different DNA sequencing techniques – Sanger's, Maxam-Gilbert, and pyrosequencing.

Or

(B) Describe gene therapy with examples. What are its types and challenges?

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