2025-2026

NMKRV College

Department of PG
Biotechnology

[HIGHLIGHTS FOR REVIEW (ACADEMIC COUNCIL)]

Additions	Deletions

NMKRV College®

DEPARTMENT OF POST-GRADUATE BIOTECHNOLOGY

PROCEEDINGS OF BOARD OF STUDIES MEETING 2025-26

AND

APPROVED SYLLABUS

NMKRV College®

DEPARTMENT OF PG BIOTECHNOLOGY
Minutes of BOS meeting 2025-26

The BOS meeting for the academic year 2025-26 was held on 19th September 2025.

Dr. B. R. Mrunalini, Head of the Department, Department of PG Biotechnology welcomed the members.

The following were the agenda discussed in the meeting.

- To approve the proposed changes to M. Sc. Biotechnology I, II, III and IV semester syllabi to be followed during the academic year 2025-26
- To approve the BoE committee members and paper setters for the academic year 2025-26
- To approve the question paper pattern of theory and practical examinations

With reference to the existing syllabus under autonomy, the following changes were incorporated:

The following changes were proposed to the scheme of theory examination

Hard Core :

- The scheme now includes 3 Marks (Section A), 5 Marks (Section B) and 15 Marks (Section C) questions

Soft Core :

- The scheme now includes 2 Marks (Section A), 5 Marks (Section B) and 15 Marks (Section C) questions

These changes were approved by the committee.

- Dr. Srinivas suggested that the OE can be renamed as Basic Biotechnology instead of Applied Biotechnology since it deals with the basics of biotechnology for the beginners.
- Dr. Srinivas also suggested that the Industry Institutional Visit component cannot be taken away because it is imminent to give exposure to how the theories and techniques learnt in the class are applied in the real world. This would also help in the placements since they help in networking. He insisted that this has to be considered in the workload of the faculties and that the BoS can provide a letter to reflect the same. The report that is written for this can be presented in front of a committee and marked as such to contribute to the credits associated.
- Dr. Srinivas clarified that there needs to be a cap on the intake of the open elective to ensure smooth execution of the classes and that the rule is

existent in the current regulations. The university has a cap of max. 60 students and the selection is based on the merit basis of the 2nd semester marks.

- Dr. Srinivas suggested Hyderabad to be a good hub for the industrial/institutional visits with the presence of premier institutes such as CCMB, ICRISAT, NIN, ANGRAU etc. Dr, Eramma emphasized the same.
- Dr. Srinivas added to this that the Government of Karnataka has courses which can add to the skill development.
- Dr. Ramesh put forth a suggestion to change the terminology of hardcore and softcore into major and minor subjects wherein the major subjects are offered by the parent department and the minor subjects are offered by the allied departments. This would foster interdepartmental knowledge exchange and widen the horizons for the students. The major subjects can take up 70-75% and minor subjects can take up 25-30% of the syllabus.
- Dr. Ramesh emphasized on the inclusion of a experiential learning (in pedagogy) and that Indian Knowledge System can be given as an open elective from the department of Sanskrit.
- Dr. Ramesh suggested that the parent department can offer short term courses (mainly hands on training) during semester breaks. This can be arranged interdepartmental also.
- All board members agreed on the point that internships should be encouraged more.
- Dr. Ramesh had suggestions that included more inclusion of Invited Talks by subject experts, signing MoUs with institutes that offer courses based on AI-ML and their applications in biology
- Dr. Ramesh suggested the implementation of a system that collects feedback from the graduated students who can identify the industry-academia gaps, which can be implemented in the syllabus on the path to continuous quality improvement overall for the department. He suggested that an epistemology based approach in pedagogy would help.
- Ms. Jyothi suggested that MOOC courses on entrepreneurship offered by IIM-B would be of great aid to the students interested in growing their ideas into startups.
- On similar lines, Dr. Ramesh suggested that the faculty take up training under MMTTP which can enhance the CAS of faculty and the quality of teaching and research overall.
- Mr. Dinesh brought up the issue of how there is an industry – academia gap especially when it comes to the QA, QC departments,pahrmacovigilance and clinical data management hence industrial aspects can be included in the syllabus towards monitoring, testing and calibration - the same was emphasized by Dr. Eramma who

suggested that these can also be carried out in the form of value added courses.

- Dr. Srinivas pointed out that finishing schools set up by industries can contribute towards reducing this gap.
- Dr. Ramesh put forth a point that the first priority in training can go to the exposure to calibration of instruments that makes the students industry ready and the performance in lab can reflect on IA. All the board members agreed on the same.
- Dr. Ramesh suggested that an NABL accreditation for the lab would help elevate the lab; and that to include taxonomy aspects to the syllabus.

NAME	DESIGNATION	SIGNATURE
Dr. B R Mrunalini	Chairperson	19/9/25
Prof. Srinivas Chowdappa	BU Nominee	19/9/25
Dr. K V Ramesh	Subject expert	19/9/25
Dr. N Eramma	Subject expert	19/9/25
Mr. Dinesh Raveendraraju	Industry expert	19/09/2025
Mrs. Jyothi Upadhya	Alumni Nominee	19/09/2025
Dr. Aruna Nair U K	Member	19/09/2025
Mrs.Tanaya Naik	Member	—Absent—

NMKRV College®

DEPARTMENT OF PG BIOTECHNOLOGY

M. Sc. BIOTECHNOLOGY - BOS MEMBERS

NAME	DESIGNATION	SIGNATURE
Dr. B R Mrunalini	Chairperson	19/9/25
Prof. Srinivas Chowdappa	BU Nominee	19/9/25
Dr. K V Ramesh	Subject expert	
Dr. N Eramma	Subject expert	19/9/2025
Mr. Dinesh Raveendraraju	Industry expert	19/09/2025
Mrs. Jyothi Upadhya	Alumni Nominee	19/9/2025
Dr. Aruna Nair U K	Member	19/9/2025
Mrs.Tanaya Naik	Member	

NMKRV College®

DEPARTMENT OF PG BIOTECHNOLOGY

Board of Examiners 2024-26

1. **Chairperson**
   Dr. B R Mrunalini
   Head of the Department
   Department of PG Biotechnology
   NMKRV College
   Bengaluru-11
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2. **External Member**
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   Contact no.:9480700229

3. **External Member**
   Dr. Vanitha N M
   Associate Professor
   Department of Microbiology
   St. Joseph's University
   Bengaluru-27
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4. **Internal Faculty member**
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   Department of PG Biotechnology
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   Contact no.:9790714602

5. **Internal Faculty member**
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   Contact no.:9407507640

19/09/2025 19/9/2025 19/9/25 19/9/25 19/9/25 19/9/25

LIST OF EXTERNAL EXAMINERS – 2025-26

Dr. Sheshadri S A. Assistant Professor, Department of Biotechnology and Genetics, Jain Deemed-to-be University, Bengaluru sa.sheshadri@jainuniversity.ac.in 9481373162	Dr. Muktha, Assistant Professor, Department of Biotechnology and Genetics, M S Ramaiah College of Arts, Science and Commerce, Bengaluru muktha_biotech@msrcasc.edu.in 9945714848
Dr. Sowmya Kumar, Assistant Professor, Department of Life Science, Mount Carmel College, Bengaluru sowmya.kumar@mceblr.edu.in 9845783689	Dr. Vijayalakshmi T N, Assistant Professor, Department of Biotechnology and Genetics, M S Ramaiah College of Arts, Science and Commerce, Bengaluru drvijayalakshmi_bt@msrcasc.edu.in 9986009766
Dr. Vinutha, Assistant Professor, Department of Biotechnology and Genetics, M S Ramaiah College of Arts, Science and Commerce, Bengaluru vinutha_biotech@msrcasc.edu.in 9964083580	Dr. Jawahar G, Assistant Professor, Department of Biotechnology and Genetics, Jain (Deemed-to-be) University, Bengaluru g.jawahar@jainuniversity.ac.in 9642484857
Dr. Babitha B Associate Professor, Department of Biotechnology, Maharani Lakshmi Ammanni College for Women, Bengaluru drbabitha@mlacw.edu.in 9880412460	Dr. Jayashree D R, Professor, Department of Biotechnology and Genetics, M S Ramaiah College of Arts, Science and Commerce, Bengaluru jayashree_biotech@msrcasc.edu.in 9886272094
Dr. Vidya Jagadeeshan, Assistant Professor, Department of Microbiology, M S Ramaiah College of Arts, Science and Commerce, Bengaluru vidyajagadeeshan@gmail.com 9886564159	Dr. Suphiya Parveen, Assistant Professor, Department of Biotechnology and Genetics, Jain (Deemed-to-be) University, Bengaluru p.suphiya@jainuniversity.ac.in 8431995112
Dr. Bannhi Das Assistant Professor, Department of Biotechnology, Mount Carmel College, Bengaluru bannhi.das@mceblr.edu.in 9916977470	Dr. Suma S, Associate Professor, Department of Life Sciences, CHRIST Deemed-to-be University, Bengaluru suma@christuniversity.in 9880671846

19/09/2025 19/09/2025 19/9/25 19/9/25 19/9/25 19/9/25

M.Sc. BIOTECHNOLOGY (CBCS)

(Effective from the academic year 2025-26)
SCHEME OF INSTRUCTIONS AND EXAMINATION
SEMESTER SCHEME

Paper No.	Title of the paper	Type of paper	Periods/ Week	Duration of Exam (Hours)	IA	EA	Maximum Marks	Credits
I Semester			**Theory**					
BTH101	Cell Biology	H Core	4	3	30	70	100	4
BTH102	Molecular Genetics	H Core	4	3	30	70	100	4
BTH103	General Microbiology	H Core	4	3	30	70	100	4
BTH104	Biochemistry	H Core	4	3	30	70	100	4
BTS105	Biostatistics	S Core	2	2	15	35	50	2
			Practical					
BTP106	Cell Biology and Molecular Genetics	Pract	4	4	30	70	100	4
BTP107	General Microbiology and Biochemistry	Pract	4	4	30	70	100	4
Total Marks and Credits							**650**	**26**
II Semester			**Theory**					
BTH201	Biochemical Techniques and Enzymology	H Core	4	3	30	70	100	4
BTH202	Molecular Biology	H Core	4	3	30	70	100	4
BTH203	Immunology and Immunotechnology	H Core	4	3	30	70	100	4
BTH204	Environmental Biotechnology	H Core	4	3	30	70	100	4
BTS205	Bioinformatics	S Core	2	2	15	35	50	2
			Practical					
BTP206	Enzymology and Immunology	Pract	4	4	30	70	100	4
BTP207	Molecular Biology and Environmental Biotechnology	Pract	4	4	30	70	100	4
Total Marks and Credits							**650**	**26**

III Semester				**Theory**				
BTH301	Plant and Agricultural Biotechnology	H Core	4	3	30	70	100	4
BTH302	Animal Biotechnology	H Core	4	3	30	70	100	4
BTH303	Genetic Engineering	H Core	4	3	30	70	100	4
BTOE3.1	Open Elective : Basic Biotechnology	O E	4	3	30	70	100	4
BTS304	Research Methodology : Fundamentals of Scientific Inquiry	S Core	2	1.5	15	35	50	2
				Practical				
BTP305	Plant, Agricultural and Animal Biotechnology	Pract	4	4	30	70	100	4
BTP306	Genetic Engineering and Bioinformatics	Pract	4	4	30	70	100	4
BTP307	Industrial and Institutional Visit	Report					50	2
				Total Marks and Credits			**650**	**26**
IV Semester				**Theory**				
BTH401	Bioprocess Engineering	H Core	4	3	30	70	100	4
BTH402	Medical Biotechnology	H Core	4	3	30	70	100	4
BTH403	Genomics and Proteomics	H Core	4	3	30	70	100	4
				Practical				
BTP404	Bioprocess Engineering and Medical Biotechnology	Pract	4	4	30	70	100	4
BTP405	Project work	Pract	4	4	50	100	150	6
				Total Marks and Credits			**550**	**22**
				Grand Total Marks and Credits			**2500**	**100**

Scheme of valuation:

1. Continuous evaluation in theory papers: 10 marks for test, 5 marks for assignment, 10 marks for seminar and 5 marks for attendance.
2. Practical examinations-each practical examination shall carry 70 marks, 10 marks shall be allotted for viva voce to be conducted during each practical examination.
3. Practical IA: 5 marks for Record, 15 marks for test and 10 marks for attendance.

PROJECT WORK

1. Proposed to carry out the project work individually or in group to a maximum of 3 or 4 students.
2. Project shall be allotted at the beginning of the III semester to facilitate students to carry out during semester break.
3. In house projects are encouraged.
4. Students may be allowed to carry out the project work in other research institutes.
5. Faculty members of the respective colleges/ university department must serve as guides
6. Co- guides from the other institutions may be allowed.
7. One copy of the dissertation to be submitted to the University/College for evaluation.
8. Evaluation of dissertation has to be done by the two external examiners appointed by the University/College for 100 marks.
9. The formative assessment is for 50 marks (25 marks for poster and PPT, 25 marks for presentation during synopsis and colloquium)
10. The project viva voce examination will be held at the University/College by the external and internal examiners for 100 marks (70 marks project report, 30 marks viva voce).

SCHEME OF THEORY EXAMINATION
(Hard Core)

Time: 3 Hours **Max. Marks: 70**

Section A

Answer **any ten** of the following 3 x 10 = 30
1-12 questions

Section B
Answer **any five** of the following 5 x 5 = 25
13-20 questions

Section C
Answer **any one** of the following 15 x 1 = 15
21-23 questions

SCHEME OF THEORY EXAMINATION
(Soft Core)

Time: 1.5 Hours **Max. Marks: 35**

Section A

Answer **any five** of the following 2 x 5 = 10
1-8 questions

Section B
Answer **any two** of the following 5 x 2 = 10
9-12 questions

Section C
Answer **any one** of the following 15 x 1 = 15
13-15 questions

SCHEME OF PRACTICAL EXAMINATION

Question No.	Experiment	Marks
1	Major experiment/s	30
2	Minor experiment/s	30
3	Viva voce	10
	Max Marks	70

Programme Outcomes

PO1: Apply advanced concepts of biotechnology, molecular biology, and allied sciences to identify, analyse and solve complex biological problems and propose innovative solutions

PO2: Analyse experimental data, interpret research findings and critically evaluate scientific literature to draw evidence based conclusions and make informed decisions

PO3: Design and conduct independent or collaborative research using modern biotechnological tools adhering to ethical practices, biosafety standards and reproducibility principles

PO4: Use computational tools, bioinformatics platforms, statistical software, and laboratory instrumentation effectively for data acquisition, analysis, and presentation.

PO5: Communicate scientific concepts, methodologies, and research outcomes clearly and effectively through technical writing, oral presentations, and visual media to diverse audiences.

PO6: Evaluate the environmental and societal impact of biotechnological processes, and adopt eco-friendly, sustainable, and safe practices in research and development.

PO7: Engage with local and global communities to address health, agricultural, and environmental issues, demonstrating social responsibility, ethical conduct, and regulatory compliance.

PO8: Demonstrate empathy, inclusivity, and sensitivity to societal needs, ensuring that biotechnological solutions respect human dignity and contribute to societal well-being.

Programme Specific Outcomes

PSO1: Graduates will recall, explain, and integrate core facts and principles of molecular biology, genetics, microbiology, biochemistry, immunology, and bioprocess engineering as the foundation of biotechnology.

PSO2: Graduates will interpret and apply conceptual models of cell signaling, metabolic pathways, genetic regulation, and systems biology to understand biological functions and interactions.

PSO3: Graduates will perform experiments in genetic engineering, cell and tissue culture, fermentation, and analytical techniques with precision, ensuring adherence to biosafety, quality, and ethical standards.

PSO4: Graduates will design, analyze, and optimize biotechnological processes, innovate products, and translate research findings into practical applications addressing healthcare, agriculture, and environmental challenges.

FIRST SEMESTER

M.Sc. Biotechnology

THEORY

DISCIPLINE CORE: CELL BIOLOGY

Course Title: BTH101: CELL BIOLOGY (Hard core)	
Course Code: **BTH101**	L-T-P per week: **4-0-0**
Total Contact Hours: **52**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **3 h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **70**

Course Objectives:

The course aims at:

- Illustration of the basic characteristics of the cell and provide the students an understanding of the differences and similarities between prokaryotic and eukaryotic cells.
- Explaining the constitution and components of a cell.
- To emphasize on the importance of cell signaling and their pathways
- To understand the structure and functions of specialized cells.

Content of Course 01: Theory: BTH101: CELL BIOLOGY	**52 h**
Unit 1: **Basic Characteristics of the Cell:**	**6 h**
Structure, organization and composition of prokaryotic (Bacteria) and eukaryotic cell (Animal & plant cell) Sub-cellular organelles: Nucleus, mitochondria & chloroplasts, rough and smooth endoplasmic reticulum, Golgi bodies (lysosomes, peroxisomes).	
Unit 2 : **Membranes and Membrane transport**	**8 h**
Plasma membrane- structure and functions, membrane models. Transport across membrane- passive diffusion, osmosis, active transport, Ion channels, ABC transporters, Na^{+} and K^{+} pump, Ca^{2+} ATPase pump, co-transport, symport, antiport, endocytosis and exocytosis. Membrane vesicular traffic.	
Unit 3: **Extracellular matrix and Cytoskeleton:**	**8 h**
Extracellular matrix (collagen, proteoglycans, fibronectin, lamins). Nature of cytoskeleton, Actin filaments, actin binding proteins, Intermediate filaments, Microtubules, MAPs, Structure and functions of cilia and flagella.	
Unit 4 : **Cell Signalling**	**8 h**
Cell to cell interactions, Cell adhesion-integrins, selectins, cadherins. Cell Junction - Tight and gap junctions, desmosomes, plasmodesmata.	

General principles of cell signaling, signaling via G-protein coupled receptors, kinase receptors, role of secondary messengers.	
Unit 5 : **Cell Division:**	**6h**
Overview of mitosis and meiosis. Molecular events of cell division and cell cycle, regulation of cell cycle events- cyclins, cyclin dependent kinases, inhibitors.	
Unit 6 : **Cell aging and cell death:**	**8h**
Free radicals- ROS, RNS. Effect of free radicals on proteins, lipids and nucleic acids. Mechanism of antioxidant defense system- enzymatic and non-enzymatic. Senescence-theories and concepts of aging. Apoptosis and necrosis.	
Unit 7 : **Specialized Cells and Tissue:**	**8h**
Composition of Blood and their functions (Plasma, RBC, WBC, Platelets) Structure & functions of muscles (Striated, non-striated and cardiac). Molecular basis of muscle contraction. Structure of neuron, neuroglia. Mechanism of nerve transmission-Resting and action potential, electrical and chemical transmission, Neurotransmitters and their receptors.	

References:

1. Matthews, C.A. (2003). Cellular physiology of nerve and muscle. 4th Edn. Blackwell publishers.
2. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K., Watson, J.D. (1994). Molecular Biology of the Cell.
3. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
4. Darnell, J., Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.
5. Edwards and Hassall (1980). Biochemistry and Physiology of cell, 2nd Edn. McGraw Hill Company.
6. Garrett, R.H., Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
7. Holy Ahern (1992). Introduction to Experimental Cell Biology, Wm. C. Brown Publishers.
8. Karp, G. (1996). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
9. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastsydaira, P., Darnell, J. (2004). Molecular Cell Biology, Scientific American Books Inc. NY.
10. Tobin and Morel (1997). Asking about "Cells" Saunders College Publisher.
11. Wolfe, S.L. (1991). Molecular and Cellular Biology, Wordsworth Pub.Co.
12. Hallwell, B., Gutteridge, J.M.C. (2002). Free Radicals Biology and Medicine. Oxford Press.UK.
13. Kanugo, M.S. (2002) Genes and aging. Cambridge University Press.

Course Learning Outcomes:

At the end of the course, The students will be able to:

- **Recall** the structure and function of major cell organelles, including their roles in cellular transport, protein trafficking, and signaling pathways.
- **Describe** the mechanisms of membrane transport and explain their significance in maintaining cellular integrity.
- **Explain** how different organelles coordinate to maintain cellular function and structure.
- **Apply** foundational concepts of cell cycle regulation to interpret basic cellular processes.
- **Apply** knowledge of cellular signaling and transport mechanisms to understand introductory cancer biology concepts.

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Test /Assignment	10	70	**100**
Seminar	5		
Mid-Semester Exam	10		
Attendance	5		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTH101	**CO1**	3	1	–	–	–	–	–	–	3	2	–	–
	CO2	3	–	–	–	–	2	–	–	3	2	–	–
	CO3	3	2	–	–	–	–	–	–	3	2	–	–
	CO4	3	3	2	–	–	–	–	–	2	3	–	–
	CO5	3	2	1	–	–	2	–	–	2	3	–	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any ten** of the following **3 x 10 = 30**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

II) Section B

Answer **any five** of the following **5 x 5 = 25**

13.
14.
15.
16.
17.
18.
19.
20.

III) Section C

Answer **any one** of the following **15 x 1 = 15**

21.
22.
23.

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DISCIPLINE CORE: MOLECULAR GENETICS

Course Title: BTH102: MOLECULAR GENETICS (Hard core)	
Course Code: **BTH102**	L-T-P per week: **4-0-0**
Total Contact Hours: **52**	Course Credits: 0**4**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **3 h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **70**

Course Objectives:

The course aims at:

- Illustration of the basics of genetics and inheritance and provide the students an understanding of the molecular basis of genetics and Mendel's fundamental work on genetics.
- Explaining the concepts of Mendelian genetics and its exceptions
- Making the student understand mutation, recombination and transposable elements
- Explaining the molecular basis of evolution
- Explaining population genetics and application of Hardy-Weinberg principle

Content of Course 01: Theory: BTH102: MOLECULAR GENETICS	52 h
Unit 1: Physical basis of Heredity:	**4 h**
Introduction, concepts and theories of Mendelian genetics (monohybrid and dihybrid cross), non – Mendelian inheritance – recombination frequency, genetic mapping chromosome theory of inheritance, Nucleus, nucleolus and extra chromosomal inheritance	
Unit 2 : Chromosomes and Genes:	**10 h**
Structure and organization of prokaryotic and eukaryotic chromosomes: Super coiled loops, domains and scaffolds in eukaryotic chromosome - Heterochromatin, euchromatin and telomeres. Nucleosomes- Organization of DNA in the nucleosome, histone octamer. Split genes and overlapping genes, gene interaction. Difference between interphase chromatin and mitotic chromosomes. Human chromosomal aberrations: trisomy(e.g. Down's syndrome) & translocations (e.g. Philadelphia chromosome) Karyotype analysis- normal and abnormal karyotype.	
Unit 3: Genetic Recombination:	**8 h**
General or homologous recombination: Holliday-White house and Meselson-Radding models, **Illegitimate or nonhomologous** recombination: Szostach and Weaver model, translocations between different chromosomes or deletions that remove several genes. Enzymes involved in homologous and site-specific recombination. Breakage and reunion of DNA at specific sites. Synapsis of homologous duplexes, role of RecA in recombination. Topological manipulation of DNA.	
Unit 4 : Site-specific recombination and replicative recombination	**10 h**

Site-specific recombination: Integration of phages, rearrangement of immunoglobulin genes. Transformation, conjugation, transduction, plasmids and episomes. **Replicative recombination**: Transposable Genetic Elements: Transposons – Transposable elements in prokaryotes and eukaryotes – IS elements, Composite transposons, Tn3 elements, Ac and Ds elements, Ty transposon in yeast, P element in Drosophila, Retrotransposons and their significance. Transposable elements in human and their genetic and evolutionary significance.	
Unit 5 : Mutation:	**10 h**
Base pair and frame shift mutation, genetic suppression. Molecular basis of mutation – spontaneous and induced mutation and their role in evolution. Detection of mutation – Ames test, Mutation in – yeast, neurospora and chlamydomonas. Mutation studies in Drosophila – designation of phenotype Human disorders due to mutations – Chromosomal(sickle cell anemia and thalassemia) and Mitochondrial DNA mutation(Kearns–Sayre syndrome (KSS) and Leber's hereditary optic neuropathy (LHON)).	
Unit 6 : Sex Determination and Dosage Compensation:	**4 h**
Sex determination in *C. elegans*, Drosophila and mammals. Secondary sex determination in mammals. Dosage compensation in Drosophila and mammals.	
Unit 7 : Population Genetics:	**6 h**
Gene pools, allele frequencies, Hardy Weinberg equation, non-random mating, genetic drift, gene flow, natural selection, speciation. Protein and DNA sequence polymorphism, molecular basis of evolution in *Homo sapiens*. Quantitative Genetics: Correlation between relatives, dominance	

References:

1. David Freifelder. (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
2. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastsydairs and Darnell, J. (2004). Molecular cell biology. Scientific American Books Inc., NY.
3. Gardner/Simmons/Snustad. (2006). Principal of Genetics. 8th Edn. John Wiley & sons.
4. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.
5. Dale, J.W. (1994). Molecular Genetics of bacteria, John Wiley & Sons.
6. Streips and Yasbin. (2001). Modern microbial Genetics. Niley Ltd.
7. John Ringo (2004). Fundamental Genetics. Cambridge University Press.

Course Learning Outcomes:

At the end of the course, The students will be able to:

1. **Recall** the genetic basis of heredity, including Mendelian and non-Mendelian patterns of inheritance.
2. **Describe** the fundamental mechanisms of genetic recombination and the role of transposons in genome dynamics.
3. **Explain** various sex determination systems across different organisms and their genetic regulation.
4. **Apply** the concepts of gene and allele frequencies to solve basic problems in population genetics.
5. **Use** the Hardy-Weinberg equilibrium model to **demonstrate** population stability and predict genotype distributions.

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Test /Assignment	10	70	**100**
Seminar	5		
Mid-Semester Exam	10		
Attendance	5		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTH102	**CO1**	3	2	–	–	–	–	–	–	3	2	–	–
	CO2	3	2	–	–	–	–	–	–	3	3	–	–
	CO3	3	–	–	–	–	–	–	–	3	2	–	–
	CO4	3	3	–	–	–	–	–	–	2	3	–	–
	CO5	3	3	1	–	–	–	–	–	2	3	–	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any ten** of the following **3 x 10 = 30**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

II) Section B

Answer **any five** of the following **5 x 5 = 25**

13.
14.
15.
16.
17.
18.
19.
20.

III) Section C

Answer **any one** of the following **15 x 1 = 15**

21.
22.
23.

****

DISCIPLINE CORE: GENERAL MICROBIOLOGY

Course Title: BTH103: GENERAL MICROBIOLOGY (Hard core)	
Course Code: **BTH103**	L-T-P per week: 4-0-0
Total Contact Hours: **52**	Course Credits: 0**4**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **3 h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **70**

Course Objectives:

This course aims at:

- Introducing the student to the world of microbes with the updated classification of viruses, bacteria, fungi, algae and protozoa.
- Elucidating the different methods used for the identification and characterization of microbes
- Elaborating the structural and functional features of different microbes.
- Explaining the growth characteristics and requirements of microbes

Content of Course 01: Theory: BTH103: GENERAL MICROBIOLOGY	**52 h**
Unit 1 : Microbial classification	**12 h**
Methods of classification: Linnaeus system; Whittaker's five domain classification; Woese's three domain system of classification Criteria for microbial classification-morphological, staining techniques, biochemical methods, serological techniques, phage typing, fatty acid profiles, DNA base composition, DNA fingerprinting, rRNA sequence, Nucleic acid hybridization. Code for bacterial nomenclature and taxonomy, Adansonian classification using numerical taxonomy, Chemotaxonomy, Classification of bacteria according to Bergey's Manual of Systematic Bacteriology, Dichotomous keys. Phylogeny	
Unit 2 : Prokaryotic Microorganism- General properties, Structure, and Reproduction	**10 h**
Domain Bacteria: Proteobacteria (Alpha, Beta, Gamma, Delta and Epsilon Proteobacteria), Cyanobacteria, Chlorobium, Firmicutes (Mollicutes), Actinobacteria, Chlamydiae, Spirochaetes, Bacteroidetes, Fusobacteria. Domain Archea: Crenarchaeota, Euryarchaeota.	
Unit 3: Eukaryotic Microorganisms- General characters, Structure and Reproduction:	**8 h**
Mycota: Filamentous fungi and yeasts (Saccharomyces) Phycota: Algae (Spirulina) Protozoa: (Plasmodium) Myxomycetes: Slime molds (Physarum)	

Unit 4 : Viruses, Virioids and Prions (Acellular entities)	10 h
General characters, Structure, Criteria for classification of Viruses, Viruses that affect bacteria (phages), insects (baculoviruses), humans, animals and plants. Viral Multiplication (Lytic and lysogenic life cycle), Virioids and Prions - General properties and diseases caused by virioids and prions.	
Unit 5 : Microbial Growth and Control	**8 h**
Physical parameters (Temperature, pH, Osmotic Pressure), Chemical parameters (Carbon, Nitrogen, Phosphorous, Sulphur, Trace elements, oxygen), Growth factors, Culture Media, Phases of Growth, Growth Measurements, Microbial growth control -Physical methods (Heat, Pasteurization, Filtration, Radiation, Dessication, Low Temperature, High Pressure, Osmotic Pressure) and Chemical Methods (Phenols, Halogens, Alcohols, quaternary ammonium compounds). Isolation, cultivation and identification of Viruses (Growing in Bacteria, Living Animals, embryonated eggs, Cell Cultures).	
Unit 6 : Microbes in Biogeochemical cycles	**4 h**
Nitrogen cycle, phosphorus cycle, sulphur cycle and the role of microbes in maintaining them.	

References:

1. Microbiology by MJ Pelczar Jr, ECS Chan, NR Krieg 5th Edition, Pub: Tata Mcgra-HillPublishing Co Ltd.
2. Introductory Microbiology by Heritage Pub Heritage
3. General Microbiology by Stainer Pub; Ingraham and Wheeler (McMillan)
4. Alexander M (1977) Introduction to soil microbiology, John Wiley and Sons Inc.N.Y.
5. Atlas R.M. (1998) Microbiology, Fundamentals and applications 2nd Edition, Milan Publishing Co.
6. Brock T.D. and Madigan M.T (1992) Biology of Microorganisms 6th Edn. Prentice Hall, Eagle wood cliffs N.j.
7. Holt J.S. Kreig N.R., Sneath P.H.A and Williams S.T (1994) Bergey‟s Manual of Systemic Bacteriology 9th Edn. William and Wilkins, Baltimore.
8. Prescott L.M, Harley T.P and Klein D.A. (1996) Microbiology WMC. Brown publishers

Course learning outcomes:
At the end of the course, The students will be able to:

1. **Recall** the foundational principles of microbial classification and identify modern techniques used in taxonomy.
2. **Describe** the structural and functional characteristics used to broadly classify different types of microbes.
3. **Explain** general microbiological methods for studying microbial growth and control in various environments such as air, water, and soil.
4. **Apply** basic classification techniques to categorize microbes based on morphology, physiology, and ecological roles.
5. **Use** microbiological tools and procedures to assess microbial presence and activity in environmental samples.

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Test /Assignment	10	70	**100**
Seminar	5		
Mid-Semester Exam	10		
Attendance	5		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTH103	CO1	3	1	–	–	–	–	–	–	3	2	–	–
	CO2	3	–	–	–	–	–	–	–	3	2	–	–
	CO3	3	2	–	–	–	2	–	–	3	2	2	–
	CO4	3	2	–	–	–	2	–	–	3	3	2	–
	CO5	3	2	–	–	–	3						

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any ten** of the following **3 x 10 = 30**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

II) Section B

Answer **any five** of the following **5 x 5 = 25**

13.
14.
15.
16.
17.
18.
19.
20.

III) Section C

Answer **any one** of the following **15 x 1 = 15**

21.
22.
23.

****

DISCIPLINE CORE: BIOCHEMISTRY

Course Title: BTH104 : BIOCHEMISTRY (Hard core)	
Course Code: **BTH104**	L-T-P per week: 4-0-0
Total Contact Hours: **52**	Course Credits: 0**4**
Formative Assessment Marks: 3**0**	Duration of ESA/Exam: **3 h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: 7**0**

Course Objectives:
This course aims at:

- Introducing the student to the four major classes of biomolecules including carbohydrates, lipids, proteins and nucleic acids
- Elaborating the structural and functional characters of different biomolecules
- Elucidating the different metabolic pathways for carbohydrate and lipid metabolism
- Explaining the energy generated from the catabolism of various biomolecules

Content of Course 01: Theory: BTH104 : BIOCHEMISTRY	**52 h**
Unit-1 : Principles of Bioenergetics	**6 h**
Introduction, Laws of thermodynamics, Gibbs free energy, Relationship of Standard free energy to enthalpy, entropy and equilibrium constant, High energy compounds, ATP as universal currency of free energy, Oxidation-Reduction Reactions, Electromotive force, Half reactions, Redox potentials, Relationship of standard redox potential and standard free energy change. Standard redox potentials of some biologically important Half reactions.	
Unit-2: Carbohydrates	**12 h**
Classification, structure and Properties of mono, oligo and polysaccharides. Chirality and optical activity, stereoisomerism, cyclic structure of monosaccharide, (pyranoses and furanoses), structures of glucose. absolute and relative configuration (D & L and R & S nomenclature). Derived sugars- Sugar acids (aldonic, aldaric and saccharic acids), Amino sugars. Disaccharides-structures of Maltose, Lactose, Sucrose, Trehalose, Raffinose. Polysaccharides- structure and properties of homo and hetero polysaccharides. Storage polysaccharides. (Starch, Glycogen, Cellulose, Chitin) Glycosaminoglycans and glycoproteins. Carbohydrate metabolism: Glycogenolysis, Glycogenesis, Coordinated regulation of Glycogen metabolism. Glycolysis-Energetics and Regulation, Fermentation reactions (Lactic acid and alcoholic fermentation), Gluconeogenesis, Reciprocal regulation of Glycolysis and Gluconeogenesis, Citric acid cycle- Energetics and regulation, Glyoxylate cycle. Pentose phosphate pathway.	
Unit-3 : Lipids	**10 h**
Classification- Structure, properties, reactions and biological functions of lipids. Phospholipids, Sphingo and glyco lipids, Steroids-cholesterol-bile salts, steroid hormonesMetabolism of Lipids: Beta oxidation of Fatty acids-activation, transport to mitochondria, Beta oxidation reactions. Oxidation of unsaturated fatty acids. Alpha and omega oxidation. Biosynthesis of saturated and unsaturated fatty acids and cholesterol. Biological functions of eicosanoids (prostaglandin, leucotrienes and thromboxane).	

Unit-4 : Amino acids and Proteins	**10 h**
Amino acids and Proteins: Classification, structure and properties of amino acids, reactions of amino acids, peptide bond. Classification of proteins- Structural organisation of proteins (primary, secondary, tertiary and quarternary), conformational analysis, Ramachandran's plot. Thermodynamic aspects of protein folding. General aspects of amino acid metabolism: Transamination, Deamination, Decarboxylation, basic glutamine and glutamic acid pathways, urea cycle and its regulation, formation of uric acid.	
Unit-5 : Oxidative phosphorylation	**8 h**
Electron transport chain, Electron transfer reactions in mitochondria, Electron carriers, Ubiquinone, Cytochromes, Iron sulfur centers, Methods to determine sequence of electron carriers, Fractionation of Multi enzyme complexes I, II, III, IV of Mitochondria and their inhibitors, Oxidative phosphorylation, ATP synthesis, Chemiosmotic model, Proton gradient, Structure of ATP synthetase, Mechanism of ATP synthesis, Brown fat, Regulation of Oxidative phosphorylation.	
Unit-6 : Nucleic acids	**6 h**
Structure and properties- Bases, Nucleosides, Nucleotides, Polynucleotides. Nucleic acid metabolism: Biosynthesis of purines and pyrimidines, Denovo and Salvage pathways, biodegradation of purines and pyrimidines.	

References:

1. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub WH Freeman Co.
2. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3rd Indian edition, Pub. Oxford.
3. Mathews, Van Holde and Ahern, Biochemistry by 3rd edition, Pub Pearson education
4. Stryer, L. Biochemistry 4th Edn. W.H. Freeman and Co. NY.
5. Kuchel, P.W., Ralston Schaums, G.B. Outlines of Biochemistry 2nd edition Pub: Tata.
6. Voet, D., Voet J.G. (2004). Biochemistry 2nd Edn.
7. Devlin, T.M. (1997). Biochemistry with clinical correlations, Wiley-Liss Inc. NY
8. Zubey, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford.
9. Edwards and Hassall. Biochemistry and Physiology of the cell 2nd Edn. McGraw Hill Co. UK. Ltd.

Course learning outcomes:
At the end of the course, The students will be able to:

1. **Identify** and **illustrate** the molecular structures of key biomolecules including carbohydrates, lipids, proteins, and nucleic acids.
2. **Describe** the three-dimensional conformations of biomolecules and explain how structure influences function.
3. **Explain** the general and specialized functions of biomolecules based on their structural features.
4. **Recall** major metabolic pathways and **discuss** their biological significance.
5. **Apply** knowledge of biomolecular structure and metabolism to interpret basic biochemical processes in living systems.

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Test /Assignment	10	70	**100**
Seminar	5		
Mid-Semester Exam	10		
Attendance	5		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTH104	CO1	3	–	–	–	–	–	–	–	3	–	–	–
	CO2	3	2	–	–	–	–	–	–	3	2	–	–
	CO3	3	2	–	–	–	–	–	–	3	2	–	–
	CO4	3	3	–	–	–	–	–	–	3	3	–	–
	CO5	3	2	–	–	–	–	–	–	3	3	2	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any ten** of the following **3 x 10 = 30**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

II) Section B

Answer **any five** of the following **5 x 5 = 25**

13.
14.
15.
16.
17.
18.
19.
20.

III) Section C

Answer **any one** of the following **15 x 1 = 15**

21.
22.
23.

****

DISCIPLINE CORE: BIOSTATISTICS

Course Title : BTS105 : BIOSTATISTICS (Soft core)	
Course Code: **BTS105**	L-T-P per week: 2-0-0
Total Contact Hours: **26**	Course Credits: 0**2**
Formative Assessment Marks: 15	Duration of ESA/Exam: **2 h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: 35

Course Objectives:

The course aims at:

• Introducing some fundamental concepts mean, mode, median and percentiles.

• Providing understanding of the basic concepts of Probability and Probability Distribution

• Understanding of Statistical Quality Control, Correlation and regression analysis,Testing Hypothesis and Analysis of variance.

• Exploring the connection between basics as well the advance tools of the subject to demonstrate the link between theory and its real world applications

Content of Course 01: Theory: BTS105 : BIOSTATISTICS	**26 h**
Unit 1: Introduction to Biostatistics	**14 h**
Introduction to Bio-statistics, basic concepts, data types – Population and Sample. Need for statistical techniques for biological applications, replicable data, Tabulation of data, construction of graph and graphical representations of data. Different models of data presentations. Frequency distribution, Arithmetic mean, mode, median and percentiles. Measures of variability: Range, mean deviation. standard deviation and co-efficient of variation. Properties of the data- Organization of data, Central tendency, dispersion, linear regression and correlation-test of significance, skewness and kurtosis and their various measures, percentiles Simple linear correlation and regression analysis.	
Unit 2: Probability	**12 h**
Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions- Binomial, Poisson and Normal distributions and a few simple problems. Statistical Inference- Estimation, standard error, confidence interval for means and proportion. Testing of hypothesis: basic concepts and definitions, types of errors. Tests based on Normal, student's t, chi-square and F distributions, Analysis of Variance interpretation of 'p' value. Statistical package- Features of statistical software, MS Excel and SPSS for various applications in Bio- statistical programme.	

References:

1. Daniel (1999). Biostatistics (3rd edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods for environmental

Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York.
8. Wiley and Sons, Inc. NY.

Course Learning Outcomes:
At the end of the course, The students will be able to:

1. **Recall** and **explain** basic statistical measures including mean, median, mode, standard deviation.
2. **Describe** the principles of probability and various types of probability distributions.
3. **Explain** the concepts of Statistical Quality Control, correlation, and regression analysis.
4. **Apply** statistical techniques to perform hypothesis testing and analysis of variance (ANOVA) using MS Excel/SPSS software.
5. **Interpret** statistical outputs from MS Excel/SPSS to draw conclusions about data sets and validate hypotheses.

Pedagogy: Lectures, Presentations, videos, and Assignments.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Attendance	5	35	**50**
Mid-Semester Exam	10		
Total	**15**	**35**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTS105	CO1	2	3	–	3	–	–	–	–	2	2	–	–
	CO2	2	3	–	3	–	–	–	–	2	2	–	–
	CO3	2	3	–	3	–	–	–	–	2	2	–	–
	CO4	2	3	–	3	–	–	–	–	2	3	–	–
	CO5	2	3	–	3	–	–	–	–	2	3	–	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any five** of the following **2 x 5 = 10**

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

II) Section B

Answer **any two** of the following **5 x 2 = 10**

9.
10.
11.
12.

III) Section C

Answer **any one** of the following **15 x 1 = 15**

13.
14.
15.

****

I SEMESTER (PRACTICAL)

Course 01: Practical: BTP106: CELL BIOLOGY AND MOLECULAR GENETICS	
Course Title: **CELL BIOLOGY AND MOLECULAR GENETICS**	Course Credits: **04**
Course Code: **BTP106**	L-T-P per week: 0-0-4
Total Contact Hours: **26**	Duration of ESA/Exam: 04 h
Formative Assessment Marks: 30	Summative Assessment Marks: 70

Course objective:
This course aims at:
• Preparing students to learn mounting and staining of polytene chromosomes, Barr bodies
• Visualise chromosomes by karyotyping
• Performing genetic studies, solving theoretical problems
• Isolation and determination of organelles and their functions in terms of enzyme activity

Experiments :

1. Mounting of polytene chromosomes
2. Mounting of Barr bodies
3. Study of Karyotyping in onion, humans (normal and abnormal)
4. Study of mutation in *E.coli* by UV light
5. Demonstration of multiple alleles by blood group in humans
6. Mounting of imaginal discs of drosophila
7. Study of Drosophila mutant type
8. Problems on (a) law of segregation (b) Independent assortment (c) Sex linked inheritance (d) population genetics
9. Study of mitosis by using onion root tips
10. Study of meiosis
11. Isolation of nucleus and determination of its purity
12. Isolation of mitochondria and determination of purity
13. Isolation of chloroplast by sucrose density gradient and determination of its purity
14. Determination of the rate of active transport of glucose across the intestinal membrane
15. Determination of muscle ATPase activity
16. Determination of acetylcholine esterase activity in the rat brain

Course Outcomes :

At the end of the course, The students will be able to:

1. **Observe** and **identify** polytene chromosomes and Barr bodies, describing their general characteristics through microscopic visualization.
2. **Examine** and **analyze** the morphology of chromosomes using cytogenetic techniques.
3. **Apply** both theoretical knowledge and laboratory methods to solve genetic problems involving inheritance patterns and chromosomal behavior.
4. **Visualize** cellular organelles and **interpret** their functions by assessing enzyme activity in experimental setups.
5. **Evaluate** experimental data to draw conclusions about cellular structure-function relationships and genetic mechanisms.

Assessment - Practical			
Formative assessment		**Summative Assessment**	
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	**Total Marks**
Record	10	70	**100**
Attendance	5		
Practical Tests	15		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTP106	CO1	3	2	–	–	–	–	–	–	3	–	3	–
	CO2	3	2	–	–	–	–	–	–	3	–	3	–
	CO3	3	3	2	–	–	–	–	–	3	2	3	–
	CO4	3	2	–	–	–	–	–	–	3	2	3	–
	CO5	3	3	2	–	–	–	–	–	3	3	3	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Practical Question Paper Scheme

BTP106: Cell biology and Molecular genetics

Time: 04 hours **Maximum Marks: 70**

Section – A (Major experiments)

1. Prepare a slide of Polythene chromosome/Mitosis/Meiosis, write principle, procedure. Comment on results. **15 Marks**

2. Isolate Mitochondria/Chloroplast from the given sample. Write principle, procedure and comment on results. **15 Marks**

3. Determine the ATPase activity/Acetyl CoA esterase activity in the given sample. Write principle, procedure and comment on results. **10 Marks**

Section - B (Minor experiments)

1. Prepare a slide of Barr body. Write Procedure and comment on results

   Or

   Prepare a Karyotype chart, identify and comment on results. **08 Marks**

2. Identify the given blood group and write the principle, procedure and comment on the results. **07 Marks**

3. Solve the given genetic problems **2 x 2.5 Marks = 05 Marks**

4. Viva-voce **10 Marks**

Scheme of valuation

Section – A (Major experiments)

1.	Performance	–	7 marks
	Principle	–	3 marks
	Procedure	–	2 marks
	Result & Comment	–	3 marks
2.	Performance	–	7 marks
	Principle	–	3 marks
	Procedure	–	2 marks
	Result & Comment	–	3 marks
3.	Performance	–	5 marks
	Principle & Procedure	–	2 marks
	Result & Comment	–	3 marks

Section - B (Minor experiments)

4.	Performance	–	4 marks
	Procedure	–	1 mark
	Result & Comment	–	3 marks
5.	Performance	–	3 marks
	Procedure	–	1 mark
	Result & Comment	–	3 marks
6.	Solution	–	5 marks
7.	Viva-voce	–	5 marks

I SEMESTER (PRACTICAL)

Course 01: Practical: BTP107: GENERAL MICROBIOLOGY AND BIOCHEMISTRY	
Course Title:**: GENERAL MICROBIOLOGY AND BIOCHEMISTRY**	Course Credits: **04**
Course Code: **BTP107**	L-T-P per week: 0-0-4
Total Contact Hours: **26**	Duration of ESA/Exam: 04 h
Formative Assessment Marks: 30	Summative Assessment Marks: 70

Course objective:

- To make students prepare the various nutrient media, sugar media and media for culturing and biochemical tests.
- To make the students perform the various staining such as endospores staining, nuclear material staining, capsule staining.
- To make the students perform the various techniques of isolation, biochemical characterization and enumeration of microorganisms.
- To make students perform estimation of biomolecules such as sugars, aminoacids, proteins.
- To make students determine lipid characteristics.

Experiments :

1. Determination of pI of amino acid by titration method
2. Estimation of glucose by Hagerdon and Jensen method
3. Estimation of total sugar by Anthrone method
4. Estimation of amino acid by Ninhydrin method
5. Estimation of protein by Lowry's method and Bradford method
6. Estimation of inorganic phosphate by Fiske-Subbarow method
7. Determination of (a) Iodine number and (b) Acetyl number of a lipid
8. Separation of amino acids by paper chromatography and TLC
9. Microbes culture in broth and solid media, colony characteristics and counting of colony (serial dilution method)
10. Bacterial growth assessment by turbidometry
11. Staining techniques (a) Simple staining (b) Gram staining (c) Endospore staining (d) Capsule staining (e) AFB staining (f) negative staining
12. Biochemical tests (a) Indole test (b) Methyl red test (c) Voges Proskauer test (d) Citrate utilization test (e) Triple sugar iron agar test (f) Starch hydrolysis test (g) Gelatin hydrolysis test (h) Catalase test (i) Oxidase test
13. Soil Microbiology: Isolation microflora of (a) rhizosphere (b) phylloplane (c) actinomycetes (d) Rhizobium from legume of root nodules (e) Sporocarp by sieve method (f) identification of Rhizobium and Agrobacterium
14. Air Microbiology: Isolation of air microflora (a) exposure plate method (b) rotorod

sampler method.

15. Water Microbiology: Testing of quality of water (coliform test), H2S strip method.
16. Estimation of lactate/ citrate from bacterial culture media

Course Outcomes :

At the end of the course, The students will be able to:

1. **Prepare** various types of nutrient and biochemical test media, demonstrating proper formulation and sterilization techniques.
2. **Perform** staining procedures to visualize morphology of the microorganisms and **interpret** staining results.
3. **Apply** microbiological techniques for isolation, biochemical characterization, and enumeration of microorganisms from diverse samples.
4. **Estimate** key biomolecules such as proteins, carbohydrates, and amino acids using standard biochemical assays.
5. **Analyze** lipid characteristics through biochemical methods.

Assessment – Practical			
Formative assessment		**Summative Assessment**	
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	**Total Marks**
Record	10	70	**100**
Attendance	5		
Practical Tests	15		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTP107	CO1	3	2	–	2	–	–	–	–	3	–	3	–
	CO2	3	2	–	–	–	–	–	–	3	–	3	–
	CO3	3	3	2	–	–	–	–	–	3	2	3	–
	CO4	3	2	–	–	–	–	–	–	3	–	3	–
	CO5	3	2	–	–	–	–	–	–	3	–	3	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Practical Question Paper Scheme

BTP107: General Microbiology and Biochemistry

Time: 04 hours **Maximum Marks: 70**

Section – A (Major experiments)

1. **A)** Estimate the amount of glucose by H-J/Anthrone method/ Inorganic phosphate by Fiske-Subbarow/
   Protein by Lowry method in the given sample by preparing the standard graph.
   Write the principle and procedure and comment on the result. **20 Marks**

   B) Estimate the amount of citrate produced by microorganism in the given sample by preparing a standard graph. Write the principle and procedure and comment on the result.

   Or

   Perform **any two** (Simple, Gram, Negative, endospore) staining for the given sample.
   Write the principle and procedure and comment on the result. **20 Marks**

Section – B (Minor experiments)

2. **A)** Estimate the amino acid content by Ninhydrin method in the given sample/
   Calculate the Rf value of amino acid by performing paper/ TLC.
   Write the principle and procedure and comment on the result. **10 Marks**

   B) Perform any two (Catalase, Starch hydrolysis, Gelatin hydrolysis, Methyl red, Voges- Proskauer, citrate utilization, oxidase test).
   Write the principle and procedure and comment on the result.

   Or

   Identify the microflora of soil/ air/ water (2 organisms) from the given sample.
   Write the principle and procedure and comment on the result. **10 Marks**
3. **Viva Voce** **10 Marks**

Scheme of valuation
Section – A (Major experiments)

1. A)	Performance	–	10 marks
	Principle & Procedure	–	5 marks
	Result & Comment	–	5 marks
1. B)	Performance	–	10 marks
	Principle & Procedure	–	5 marks
	Result & Comment	–	5 marks

Section - B (Minor experiments)

2. A)	Performance	–	5 marks
	Principle & Procedure	–	2.5 marks
	Result & Comment	–	2.5 marks
2. B)	Performance	–	5 marks
	Principle & Procedure	–	2.5 marks
	Result & Comment	–	2.5 marks
3.	Viva-voce	–	10 marks

SECOND SEMESTER

M.Sc. Biotechnology

THEORY

DISCIPLINE CORE: BIOCHEMICAL TECHNIQUES AND ENZYMOLOGY

Course Title : BTH201: BIOCHEMICAL TECHNIQUES AND ENZYMOLOGY (Hard core)	
Course Code: **BTH201**	L-T-P per week: **4-0-0**
Total Contact Hours: **52**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: 3 **h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **70**

Course Objectives:

The course aims at:

- Introducing various techniques used in the separation and structural characterization of molecules
- Elucidating the classification, properties and requirements of enzymes
- Elaborating the importance of coenzymes and cofactors for enzyme reactions

Content of Course 01: Theory: BTH201: BIOCHEMICAL TECHNIQUES AND ENZYMOLOGY	**52 h**
Unit 1 **Separation Techniques :**	**10h**
Physical Techniques: Absorption, adsorption, Distillation, liquid - liquid extraction Centrifugation, differential, gradient, ultra centrifugation, salt fractionation and dialysis. **Chromatographic Techniques** Principles and applications of gel filtration- ion exchange chromatography-thin layer chromatography-affinity chromatography- gas chromatography, high performance liquid chromatography (HPLC).	
Unit2 **Spectroscopy:**	**10 h**
The electromagnetic spectrum: Reflection and scattering of rays, elastic and non-elastic scattering, diffraction and interference. Absorption and emission of wavelengths. **Uses of each band of the electromagnetic spectrum:** Radioactivity (ϒ, α, β rays); X-ray diffraction: X-ray crystallography. Crystal formation and analysis of molecular structure; UV-visible spectroscopy, fluorimetry, IR spectroscopy, Raman spectroscopy, NMR spectroscopy. Application of scattering: Viscometry Application of emission: Flame photometry Mass spectroscopy.	
Unit 3 **Electrophoresis**	**6 h**
Principles and applications of moving boundary electrophoresis, zone electrophoresis, gel electrophoresis-PAGE and SDS PAGE agarose gel electrophoresis, isoelectric focusing and 2D Gel electrophoresis. Pulsed field electrophoresis.	
Unit 4 **Enzyme catalysis**	**6 h**
Introduction to enzymes; nomenclature and classification of enzymes; chemical nature and properties of enzymes, factors affecting enzyme activities, active site, allosteric site,	

coenzymes and co factors. Types of enzyme specificity, units of enzyme activity. Strategies of purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes.	
Unit 5 **Enzyme Kinetics and Mechanism of Enzyme catalysis**	**12 h**
Rate of a reaction, order of a reaction, zero, first and second order reactions. Activation energy in enzyme reactions. **Substrate binding:** Lock and key model, induced fit hypothesis, Entropy effect in substrate binding. Single and multi-substrate reactions. Uni-Uni, Bi-Bi and Ping-pong mechanisms. Allostery and cooperativity: concerted and sequential mechanism (ordered and random) for cooperativity. Quantification of substrate binding and Scatchard plots. **Enzyme Kinetics :** Derivation of Michaelis-Menton equation, K_m and V_{max} values. Mechanism of enzyme catalysis - Acid-Base catalysis, Covalent catalysis, metal ion catalysis and substrate strain theory (with lysozyme as a typical example). Enzyme inhibition : reversible and irreversible inhibition, competitive, uncompetitive, non competitive and mixed inhibitors. Use of Lineweaver Burk plot to study enzyme inhibition. Suicide inhibitors. Regulation of enzyme activity – Covalent modulation, Allosteric regulation, ligand interactions, feedback regulation, isozymes. Synthetic enzymes and enzyme models: Host-guest complexation chemistry with the example of serine proteases.	
Unit 6 **Coenzymes**	**8 h**
Structure and mechanism of action of some important co-enzymes NAD+, FAD, FMN, TPP, pyridoxal phosphate, lipoic acid, CoASH and vitamin B12	

References:

1. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry, 4th edition WH Freeman and Co.
2. Stryer, L. (1995). Biochemistry 4th edition. W.H. Freeman and Co. NY.
3. Purich, D., L., Simon, M., I., Abelson, J. (2000). Contemporary enzyme kinetics and mechanism.
4. Plowman, K.M. (1972). Enzyme kinetics. McGraw Hill Publishers.
5. Jack Kyte. (1995). Mechanism in protein chemistry, Garland Science publishers.
6. Gerhartz, W. (1990). Enzymes in industry: Production and applications. VCH publishers, NY.
7. Chaplin, M.F., Bucke, C. (1990). Enzyme technology. Cambridge University press, Cambridge.
8. Belter, P.A., Cussier, E. (1985) Bio separations, Wiley Publishers.
9. Asenjo, J. (1993) Separation processes in biotechnology. CRC Press, Boca Raton.
10. Upadhyay, A., Upadhyay, K., Nath, N. (2003). Biophysical chemistry, principles and techniques. Himalaya publishing house.

Course Outcomes :

At the end of the course, The students will be able to:

1. **Describe** the principles and applications of key techniques used for the separation of biomolecules such as chromatography, electrophoresis, and centrifugation.

2. **Identify** and **explain** analytical methods (e.g., spectroscopy, mass spectrometry, NMR) used in the structural characterization of biomolecules.
3. **Explain** the nomenclature and classification of enzymes based on their catalytic activity and substrate specificity.
4. **Apply** knowledge of enzyme mechanisms to understand catalytic processes and regulatory strategies in metabolic pathways.
5. **Analyze** the role of vitamins as coenzymes and metal ions as cofactors in enzyme catalysis, evaluating their biochemical significance.

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Test /Assignment	10	70	**100**
Seminar	5		
Mid-Semester Exam	10		
Attendance	5		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
BTH201	CO1	3	2	–	3	–	–	–	–	3	2	–	–
	CO2	3	2	–	3	–	–	–	–	3	2	–	–
	CO3	3	–	–	–	–	–	–	–	3	–	–	–
	CO4	3	2	–	–	–	–	–	–	3	2	–	–
	CO5	3	3	–	–	–	–	–	–	3	2	–	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any ten** of the following **3 x 10 = 30**

1.
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II) Section B

Answer **any five** of the following

5 x 5 = 25

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III) Section C

Answer **any one** of the following

15 x 1 = 15

21.
22.
23.

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DISCIPLINE CORE: MOLECULAR BIOLOGY

Course Title : BTH202: MOLECULAR BIOLOGY (Hard core)	
Course Code: **BTH202**	L-T-P per week: **4-0-0**
Total Contact Hours: **52**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **3 h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **70**

Course Objectives:

The course aims at:

- Familiarising the student with the structural and functional properties of DNA and RNA
- Elucidating the replication of DNA and repair mechanisms for damaged DNA
- Describing the steps involved in and regulation of transcription of DNA to RNA and the translation of mRNA to protein
- Relating protein sequence to organellar location

Content of Course 01: Theory: BTH202: MOLECULAR BIOLOGY	**52 h**
Unit 1 **Structure and Properties of DNA and RNA:**	**6h**
Information flow in biological systems: Central dogma. Biochemical evidences for DNA as genetic material. Watson and Crick model of DNA, different forms of DNA (A, B, Z, C and D). Properties and types of DNA. UV absorption, Denaturation and renaturation, thermodynamics of melting of the double helix, kinetics of unwinding of the double helix, Interaction with small ions. Structure and functions of different types of RNA.	
Unit 2 **Replication:**	**8 h**
Characteristics and functions of bacterial DNA polymerases, Mechanism of prokaryotic DNA replication, models of replications in prokaryotes. Fidelity of replication, Nearest neighbor frequency analysis. Eukaryotic DNA polymerases and mechanism of replication. Telomere synthesis-telomerases. Replication of viral DNA, rolling circle model. Inhibitors of replication	
Unit 3 **Transcription:**	**8 h**
Characteristics and function of bacterial RNA polymerases, mechanism of transcription and regulation. Eukaryotic RNA polymerases- transcription factors, mechanism of transcription and regulation. Stringent response. Post transcriptional modifications of mRNA (5‟CAP formation, poly adenylation, mechanism of splicing, Group I, II and III, spliciosome assembly, splicing editing, Group IV splicing), stablility. Processing of tRNA and rRNA. Inhibitors of transcription. Ribozyme technology: mechanism of action and applications.	
Unit 4 **Translation:**	**8 h**
Genetic code, Wobble hypothesis. Ribosome assembly, mechanism of activation of amino acids. Mechanism of translation in prokaryotes and eukaryotes. Differences between prokaryotic and eukaryotic protein synthesis, codon usage, Inhibitors of protein	

synthesis. Co and posttranslational modifications of proteins. Control of translation in eukaryotes (Antisense RNA, Heme and interferon).	
Unit 5 **Regulation of Gene expression:**	**10 h**
Gene regulation, Operon model-Inducible and repressible systems, lac, gal, trp, his and arabinose operon; Attenuation, positive and negative regulation, role of cAMP and CRP in the expression of lac genes, catabolite repression, regulation of eukaryotic gene expression transcriptional control, cis control elements, promoters, enhancers, transacting factors, homeobox in the control of developments in insects and vertebrates. DNA binding motifs of transcription factors, post transcriptional control.	
Unit 6 **Protein localization and Targeting:**	**5 h**
Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxysomes and membrane.	
Unit 7 **DNA damage and Repair:**	**5h**
DNA damage- alkylation, deamination, oxidation, UV radiation. Repair mechanisms- photo-reactivation, excision repair, post replication repair, mismatch repair and SOS repair.	
Unit 8 **Gene Silencing:**	**2h**
Definition, types –transcriptional and post transcriptional gene silencing, RNAi pathway (si RNA and mi RNA).	

References:

1. Principles of gene manipulation - An introduction to genetic engineering, Old R.W., Primrose S.B., Blackwell Scientific Publications, 1993.
2. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4th edition Pub WH Freeman Co.
3. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3rd Indian edition, Pub. Oxford.
4. Mathews, Van Holde, Ahern, Biochemistry by 3rd edition, Pub Pearson education.
5. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994). Molecular Biology of the Cell.
6. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
7. Darnell, J. Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.
8. Garrett, R.H. and Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
9. Karp, G. (1996). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
10. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastsydaira, P., Darnell, J. (2004). Molecular Cell Biology, Scientific American Books Inc. NY.

Course Outcomes :

At the end of the course, The students will be able to:

1. **Identify** the structure and function of various types of DNA and RNA, including their roles in genetic information flow.
2. **Explain** the types of DNA damage and describe the cellular mechanisms involved in DNA repair.
3. **Describe** the process of transcription and **explain** the significance of post-transcriptional modifications in mRNA maturation.
4. **Explain** the process of translation and **discuss** the importance of post-translational modifications in protein function.
5. **Analyze** the mechanisms of protein localization within the cell and **evaluate** their relevance to cellular structure and function.

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Test /Assignment	10	70	**100**
Seminar	5		
Mid-Semester Exam	10		
Attendance	5		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTH202	CO1	3	–	–	–	–	–	–	–	3	2	–	–
	CO2	3	2	–	–	–	–	–	–	3	2	–	–
	CO3	3	2	–	–	–	–	–	–	3	2	–	–
	CO4	3	2	–	–	–	–	–	–	3	2	–	–
	CO5	3	3	2	–	–	–	–	–	3	3	–	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any ten** of the following **3 x 10 = 30**

1.
2.
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II) Section B

Answer **any five** of the following

5 x 5 = 25

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III) Section C

Answer **any one** of the following

15 x 1 = 15

21.
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23.

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DISCIPLINE CORE: IMMUNOLOGY AND IMMUNOTECHNOLOGY

Course Title : BTH203: IMMUNOLOGY AND IMMUNOTECHNOLOGY (Hard core)	
Course Code: **BTH203**	L-T-P per week: **4-0-0**
Total Contact Hours: **52**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **3h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **70**

Course Objectives:

The course aims at:

- Giving the student a broad overview of the human immune system
- Elucidating the various cellular and soluble factors involved in the immune response
- Elaborating the importance of cell surface antigens in tissue compatibility
- Familiarising the student with relevant immunological techniques used for research, diagnostics and vaccine development

Content of Course 01: Theory: BTH203: IMMUNOLOGY AND IMMUNOTECHNOLOGY	**52 h**
Unit 1 **Immune system and Immune Response:**	**10h**
Innate and acquired immunity, structure and functions of immune cells- T cells, B cells, Macrophages, NK cells and dendritic cells, Eosinophils, Neutrophils, Mast cells. Organs of immune system- Primary and secondary lymphoid organs. Primary and secondary immune response, Clonal selection theory.	
Unit 2 **Antigens and Antibodies:**	**8 h**
Structure and properties of antigens –Iso and alloantigens-antigen specificity, Haptens and adjuvants- structure and properties. Immunoglobulins-Structure and properties, types and subtypes. Generation of immunological diversity. Complement system- component, properties and functions. Complement pathways and biological significance.	
Unit 3 **Major Histocompatibility Complex and Transplantation:**	**6 h**
Structure and functions of MHC and HLA systems. Genetic control of immune response. Tissue transplantation- Tissue typing methods for tissue and organ transplantations. Graft versus host reaction and rejection, xenotransplantation, immunosuppressive therapy.	
Unit 4 **Hypersensitivity Reactions, Lymphokines and cytokines:**	**8 h**
Hypersensitivity Reactions: Allergy, Hypersensitivity reactions- types (I, II, III, and IV), symptoms, immunodiagnosis. **Lymphokines and cytokines** : Interleukins and Interferons- Production, biological functions and assay methods. Immunological tolerance.	
Unit 5 **Autoimmunity and Immunomodulation:**	**8 h**
Autoimmunity- Autoimmune diseases- Hashimoto‟s disease, Systemic lupus erythematosus, Multiple sclerosis, Myasthenia gravis and their treatment.	

Immunomodulation(immunosuppression & immunostimulation), Immunotherapy, lymphocyte migration, homing and trafickking, antigen-induced lymphocyte proliferation, Granulysin mediated anti-microbial activity of T cells.	
Unit 6 **Immunological Techniques:**	**8 h**
Agglutination, precipitation, immune- fluorescence, immunoelectrophoresis, immunoblotting, ELISA, RIA, Surface Plasmon Resonance, Flow cytometry. Production and purification of antibodies, determination of antibody titre by RID and EID, production of hybridoma. T- cell cloning:Mechanism of antigen recognition by T and B -lymphocytes, Importance of antigen and MHC class II molecules in T-cell cloning. Antigen specific and alloreactive T-cell cloning - immunologically relevant antigens and T cell subtypes. Applications in vaccine development.	
Unit 7 **Immunization:**	**4h**
Vaccines- conventional, peptide vaccines, subunit, DNA vaccines. Toxoids, antisera, edible vaccines, plantibodies, ISCOMs, recombinant antibodies, Immune stimulatory complexes. Common immunization programmes- BCG, small pox, DPT, polia, measles, Hepatitis-B.	

References:

1. Abdul, K., Abbas, Andrew K. L., Jordan, S. P. (1998). Cellular and Molecular Immunology. Sanders College Pub.
2. Benjamine, E., Cocoi., Sunshine. (2000). Immunology 4 th edition- Wiley- Liss. Publ.NY.
3. Borrebacc, C.A.K. (1995). Antibody Engineering, 2nd eidtion. Oxford University Press.
4. Dimmock, N.J., Primrose, S.B. (1994). Introduction to Modern Virology, Blackwell Science Ltd.Oxfird.
5. Hyde, R.M. (1992). Immunology, 2nd edition, Williams and Wilkins, Baltimore.
6. Kuby, J. (2003). Immunology 5th Edition. WH. Freeman and Company, NY.
7. Klaus D. Elgert (1996). Immunology. ELBS, Blackwell Scientific Publishers, London.
8. Roitt, I.M. (1998). Essential Immunology, ELBS, Blackwell Scientific Publishers, London.
9. Richard A th Goldsby, Thomas, J., Kindt, Barbara, A., Osborne (2000). Kuby Immunology, 4th edition. W.H. Freeman and Company, NY.
10. Tizard I.R.(1995). Immunology, 4th edition, Saunder College Pub.
11. William E Paul (1989). Fundamentals in Immunology, Raven Press. NY.

Course Outcomes :

At the end of the course, The students will be able to:

1. **Describe** the major cells of the immune system, including T cells, B cells, and antigen-presenting cells, and their roles in immune defense.
2. **Analyze** the function of humoral components such as antibodies and cytokines in initiating and regulating immune responses.
3. **Explain** the consequences of immune system hyperactivity, including the mechanisms underlying allergies and autoimmune disorders.
4. **Evaluate** the role of antigens in tissue compatibility and the immunological basis of graft rejection.

5. **Apply** immunological techniques such as ELISA, flow cytometry, and hybridoma technology in the context of production of monoclonal antibodies and immune diagnostics.

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Test /Assignment	10	70	**100**
Seminar	5		
Mid-Semester Exam	10		
Attendance	5		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTH203	CO1	3	–	–	–	–	–	–	–	3	2	–	–
	CO2	3	3	–	–	–	–	–	–	3	3	–	–
	CO3	3	2	–	–	–	–	–	–	3	2	–	–
	CO4	3	2	–	–	–	–	–	–	3	2	–	–
	CO5	3	3	2	2	–	–	–	–	3	3	3	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any ten** of the following **3 x 10 = 30**

1.
2.
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II) Section B

Answer **any five** of the following **5 x 5 = 25**

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III) Section C

Answer **any one** of the following **15 x 1 = 15**

21.
22.
23.

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DISCIPLINE CORE: ENVIRONMENTAL BIOTECHNOLOGY

Course Title : BTH204: ENVIRONMENTAL BIOTECHNOLOGY (Hard core)	
Course Code: **BTH204**	L-T-P per week: **4-0-0**
Total Contact Hours: **52**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **3h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **70**

Course Objectives:

The course aims at:

- Giving the student an overview of environmental pollution and the use of biological techniques to alleviate its effects
- Elucidating the steps involved in the treatment of biowaste, waste water and ways to reduce greenhouse gases and acid rain
- Explaining the pros and cons of the use of biological sources of fuels, recovery of metals and removal of toxic waste
- Instilling the importance of conservation of environment and biodiversity

Content of Course 01: Theory: BTH204: ENVIRONMENTAL BIOTECHNOLOGY	**52 h**
Unit 1 **Environment and monitoring:**	**10h**
Introduction, renewable and non-renewable sources of energy; Enviromental pollution-water pollution, soil pollution and air pollution-sources. Xenobiotic compounds and their sources, Biomagnification, Bioindicators. Biomonitoring: Biosensors and biochips.	
Unit 2 **Water Management and waste water treatment:**	**12 h**
Water as a scarce natural resource, water management including rain water harvesting. Waste water characteristics, waste water treatment-physical, chemical, biological processes. Aerobic processes; Activated sludge, oxidation ditches, trickling filter, oxidation ponds; Anaerobic processes; Anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors. Reverse osmosis and ultrafiltration. Treatment of industrial effluents.	
Unit 3 **Biomining and Biodiesel:**	**4 h**
Bioleaching of ores to retrieve scarce metals, Bio-mining;. Biodiesel production from Jatropa, Pongamia and Castor	
Unit 4 **Bioremediation:**	**8 h**
Concept and principles, Bioremediation using microbes, *In situ* and *ex situ* bioremediation, biosorption and bioaccumulation of heavy metals; Phytoremediation, bioremediation of xenobiotics (heavy metals, pesticides, oil slicks, plastic). Bioremediation of soil and water contaminated with hydrocarbons and surfactants, biofilms.	
Unit 5 **Biowaste treatment:**	**12 h**
Microorganisms involved in the degradation of plant fibre, cell wall, lignin, fungal de-lignification and pulping of wood. Pitch problems in pulp and paper processes and solving by enzymes or fungi. Hemicellulases in pulp bleaching. Solving slime problem in the pulp and paper industry. Reduction of organochlorine compounds in bleach plant effluents.	

Solid wastes: Sources and management, waste as a source of energy. Production of oils and fuels from solid waste, composting, vermiculture, Biogas production, methanol production from organic wastes, byproducts of sugar industries.	
Unit 6 **Global environmental problems:**	**8 h**
Global warming, ozone depletion, UV-B, green house effect and acid rain, their impact and management. Biodiversity and its conservation, status of biodiversity, hotspots, Red data book.	

References:

1. Allsopp D and K.J Seal., Introduction to Biodeterioration-ELBS/Edward Arnold. 1999
2. Christon, J. Harst Manual of Environment Microbiology, ASM Press, Washington DC.1997.
3. Ericksson Ed., Biotechnology in the pulp and paper industry, Springer –Verleg.1997
4. Hurst CJ et al. eds., Environmental Microbiology, ASM Press, Washington, D.C. 1997
5. Larry Anderson and David A. Tilman., Fuels from waste, Academic Press. 1997.
6. Whitaker J R and S.Philip. Biocatalysis in agricultural Biotechnology, Washington ACS.1989
7. Jordening H J and Josef Winter Environmental biotechnology: concepts and applications (2nd Ed.) Wiley & Sons Publishers.UK.2005
8. Daniel Vallero., Environmental Biotechnology: A Biosystems Approach (1st Ed.) Academic press. New York.2010
9. Wang LK. Handbook of Environmental Engineering (1st Ed.) Springer Publishers.2010
10. Evans G G and Judy Furlong., Environmental Biotechnology: Theory and Application (2nd Ed.).Wiley publishers. 2011
11. Wang L.K, Ivanov V., Tay J.H., HungY.T (2010) Handbook of Environmental Engineering (1st Ed.) Springer Publishers
12. Gareth G. Evans, Judy Furlong (2010) Environmental Biotechnology: Theory and Application (2nd Ed.).Wiley publishers.

Course Outcomes :

At the end of the course, The students will be able to:

1. **Identify** and **describe** the major types of pollutants found in water, air, and soil, and their environmental impact.
2. **Explain** various biological methods used for the treatment and remediation of polluted environments.
3. **Describe** eco-friendly approaches for metal recovery and the biodegradation of xenobiotic compounds.
4. **Apply** theoretical knowledge to propose strategies for environmental protection and biodiversity conservation.
5. **Evaluate** the effectiveness of biotechnological interventions in waste management.

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Test /Assignment	10		

Seminar	5	70	**100**
Mid-Semester Exam	10		
Attendance	5		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO 4
BTH204	CO1	3	–	–	–	–	3	–	–	3	–	–	2
	CO2	3	2	–	–	–	3	–	–	3	2	–	2
	CO3	3	2	–	–	–	3	–	–	3	2	–	2
	CO4	3	2	–	–	–	3	2	–	3	2	–	3
	CO5	3	3	–	–	–	3	2	–	3	3	–	3

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any ten** of the following **3 x 10 = 30**

1.
2.
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II) Section B

Answer **any five** of the following **5 x 5 = 25**

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III) Section C

Answer **any one** of the following **15 x 1 = 15**

21.
22.

DISCIPLINE CORE: BIOINFORMATICS

Course Title : BTS205: BIOINFORMATICS (Soft core)	
Course Code: **BTS205**	L-T-P per week: **2-0-0**
Total Contact Hours: **26**	Course Credits: **02**
Formative Assessment Marks: **15**	Duration of ESA/Exam: **1.5 h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **35**

Course Objectives:

The course aims at:

1) To give the students the basic knowledge about computers, operating system, internet resources.

2) To acquaint the students with the various important tools and techniques of information technology, Metabolimics and Phylogenetic analysis .

3) To make the students understand the basics of biological databases, Methods of sequence alignment, Genomics & Proteomics, Protein structure prediction & drug designing.

Content of Course 01: Theory: BTS205: BIOINFORMATICS	**26 h**
Unit 1 **Computer Network, Programming Language and Databases**	**8 h**
Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls. C Programming and PERL- Algorithm and flowchart, Structure of C program, Header file, Global declaration, Main function, variable declarations, Control statement-conditional and unconditional - sub functions. Introduction to PERL, Application of Bioperl Introduction to Database - Relational Databases Management (RDMS) - Oracle, SQL, Database generation.	
Unit 2 **Introduction to bioinformatics and biological Databases**	**4 h**
Introduction to bioinformatics, Scope Datamining and applications, accessing bibliographic databases- Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB). Metabolic pathway data bank (Pub gene, KEGG), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb).	
Unit 3 **DNA Sequence Analysis and DNA Sequence Alignment**	**5 h**
Sequence alignment - Global and Local alignment, scoring matrices. Restriction mapping - NEB CUTTER, Similarity searching (FASTA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids and protein sequences, Identification of ORFs, Identification of motifs. PAM Matrix.	
Unit 4 **Protein Structure and Analysis**	**5 h**

Introduction to protein structure - secondary structure prediction, tertiary structure prediction, protein modelling- principles of homology and comparative modelling. Threading, structure evaluation and validation and *ab intio* Chou-Fasman Index, Hydrophobicity profile, Ramachandran Plot, Propensity and Protein structural analysis	
Unit 5 **Molecular Interaction**	**4 h**
Binding Site Residues, Modelling, Applications – Computer Aided Drug Designing (Molecular docking and screening – Autodoc).	

References:

1. Dhananjaya (2002). Introduction to Bioinformatics, www.sd-bio.com series
2. Jan (2001). Nucleic acid research, Genome Database issue
3. Higgins & Taylor (2000). Bioinformatics, OUP.
4. Baxavanis (1998). Bioinformatics.
5. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
6. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, John

Course Outcomes :

At the end of the course, The students will be able to:

1. **Identify** the basic internet-based resources relevant to biological research.
2. **Describe** key tools and techniques in information technology, including applications in metabolomics and phylogenetic analysis.
3. **Explain** the structure and utility of biological databases, and **apply** methods of sequence alignment in genomics and proteomics studies.
4. **Recognize** the syntax and structure of basic programming in C language, PERL and **describe** the use of Structured Query Language (SQL) for database management.
5. **Analyze** biological data using computational tools to interpret molecular patterns and evolutionary relationships.

Pedagogy: Lectures, Presentations, videos, and Assignments.

Assessment – Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Attendance	5	35	**50**
Mid-Semester Exam	10		
Total	**15**	**35**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTS205	CO1	3	–	–	2	–	–	–	–	3	–	–	–
	CO2	3	2	–	3	–	–	–	–	3	2	–	–
	CO3	3	2	–	3	–	–	–	–	3	2	–	–
	CO4	3	–	–	3	–	–	–	–	3	–	–	–
	CO5	3	3	–	3	–	–	–	–	3	3	–	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any five** of the following **2 x 5 = 10**

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

II) Section B

Answer **any two** of the following **5 x 2 = 10**

9.
10.
11.
12.

III) Section C

Answer **any one** of the following **15 x 1 = 15**

13.
14.
15.

****

II SEMESTER PRACTICAL

Course 03: Practical: BTP206: ENZYMOLOGY AND IMMUNOLOGY	
Course Title: **ENZYMOLOGY AND IMMUNOLOGY**	Course Credits: **04**
Course Code: **BTP206**	L-T-P per week: 0-0-4
Total Contact Hours: **26**	Duration of ESA/Exam: 04 h
Formative Assessment Marks: 30	Summative Assessment Marks: 70

Course objective:

This course aims at :

- Familiarising students with the measurement and analysis of enzyme activity
- Demonstrating antibody-antigen interactions and antibody purification and immunoelectrophoresis
- Introducing students to microscopic techniques to study various cells of the immune system

Experiments:

1. Isolation and Identification of enzymes from different plant sources
2. Isolation and assay of alpha-amylase activity from saliva
3. Isolation and assay of urease from horse gram or kidney gram
4. Isolation and assay of acid phosphatase from sweet potato
5. Determination of Km and Vmax
6. Effect of pH and temperature on enzyme activity
7. Determination of specific activity of an enzyme
8. Immobilization of enzyme (Urease/Amylase)
9. Partial purification of IgG by ammonium sulphate fractionation and Dialysis
10. Purification of IgG by column chromatography
11. Serum separation and serological reactions (a) agglutination (b) precipitation
12. Enzyme linked immunosorbant assay
13. Isolation of lymphocytes from peripheral blood
14. Ouchterlony double diffusion
15. Single radial immunodiffusion
16. Rocket immunoelectrophoresis

Course Outcomes :

At the end of the course, The students will be able to:

1. **Perform** enzyme assays to determine activity and **calculate** kinetic parameters such as Km and Vmax using experimental data.
2. **Identify** various immune cell types through staining and **analyze** antibody-antigen interactions using immunological techniques.
3. **Apply** biochemical and immunological methods to interpret experimental results and draw conclusions about molecular and cellular functions.
4. **Demonstrate** proficiency in handling lab equipment and reagents relevant to enzyme kinetics and immune cell profiling.

5. **Correlate** enzyme immobilisation technique and specific activity of the enzyme			
Assessment - Practical			
Formative assessment		**Summative Assessment**	
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	**Total Marks**
Record	10	70	**100**
Attendance	5		
Practical Tests	15		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTP206	CO1	3	3	2	2	–	–	–	–	3	2	3	–
	CO2	3	2	–	–	–	–	–	–	3	2	3	–
	CO3	3	3	2	2	–	–	–	–	3	2	3	–
	CO4	3	2	–	2	–	–	–	–	3	–	3	–
	CO5	3	3	2	2	–	–	–	–	3	3	3	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Practical Question Paper Scheme

BTP206: ENZYMOLOGY AND IMMUNOLOGY

Time: 04 hours **Maximum Marks: 70**

Section – A (Major experiments) **20 x 2= 40 marks**

1. Isolation and assay of α-amylase from saliva/ acid phosphatase from sweet potato/ urease from horse gram.

   Or

   Determination of specific activity of an enzyme.
2. Purification of IgG by ammonium sulphate fractionation.

   Or

   Isolation of lymphocytes from peripheral blood.

Section - B (Minor experiments) **10 x 2= 20 marks**

3. Immobilization of enzyme by sodium alginate method.

   Or

   Determine the effect of pH on enzyme activity.
4. Determination of blood group/ comment on any 2: ODD, RID, ELISA and RID.

5. Viva- voce **10 marks**

Scheme of valuation
Section – A (Major experiments)

1.	Performance	–	10 marks
	Principle	–	3 marks
	Procedure	–	2 marks
	Result & Comment	–	5 marks
2.	Performance	–	10 marks
	Principle	–	3 marks
	Procedure	–	2 marks
	Result & Comment	–	5 marks

Section - B (Minor experiments)

3.	Performance	–	5 marks
	Principle & Procedure	–	2 marks
	Result & Comment	–	3 marks
4.	Performance	–	5 marks
	Procedure	–	2 marks
	Result & Comment	–	3 marks
5.	Viva-voce	–	10 marks

Course 03: Practical: BTP207 MOLECULAR BIOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY	
Course Title: **MOLECULAR BIOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY**	Course Credits: **04**
Course Code: **BTP207**	L-T-P per week: **0-0-4**
Total Contact Hours: **26**	Duration of ESA/Exam: **04** h
Formative Assessment Marks: **30**	Summative Assessment Marks: **70**

Course objective:

This course aims at:

- Familiarising the students with the use of spectrophotometric methods for the estimation of nucleic acids
- Demonstrating the extraction and gel electrophoresis of genomic and plasmid DNA
- Demonstrating the modes of DNA transfer in *E.coli*
- Familiarising students with the basic tests involved in the analysis of waste water

Experiments:

1. Isolation of Genomic DNA from animal source
2. Isolation of total RNA and analysis by formaldehyde gel electrophoresis
3. Quantitative analysis of DNA and RNA (Cot Kinetics and T_m)
4. Qualitative analysis of DNA and RNA
5. Estimation of DNA by diphenyl amine method
6. Estimation of RNA by orcinol method
7. Isolation of Plasmid DNA and agarose gel electrophoresis
8. Molecular weight determination of a protein by gel electrophoresis
9. Determination of total dissolved solids, BOD and COD of water sample
10. Estimation of Chromium in Industrial effluent by colorimetry
11. Estimation of Calcium in water sample by titration method
12. Isolation of bacteriophages from sewage
13. Vermicomposting
14. Biodegradation of industrial aromatic compounds
15. Determination of Phosphate and nitrate from sewage samples
16. Microbial analysis of water-MPN

Course Outcomes :

At the end of the course, The students will be able to:

1. **Perform** basic molecular biology techniques such as nucleic acid estimation and agarose gel electrophoresis, and **interpret** the results for DNA/RNA analysis.
2. **Demonstrate** the qualitative and quantitative techniques to assess the purity of the isolated DNA/RNA samples
3. **Conduct** standard tests for wastewater analysis, including microbial load, biochemical oxygen demand (BOD), and chemical oxygen demand (COD), and **evaluate** water quality based on experimental data.
4. **Apply** biochemical and microbiological techniques to assess environmental samples and draw conclusions about contamination and remediation potential.
5. **Analyze** experimental outcomes to understand the relationship between microbial activity and environmental health indicators.

Assessment – Practical			
Formative assessment		**Summative Assessment**	
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	**Total Marks**
Record	10	70	**100**
Attendance	5		
Practical Tests	15		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTP207	CO1	3	2	–	3	–	–	–	–	3	2	3	–
	CO2	3	2	2	–	–	–	–	–	3	3	3	–
	CO3	3	3	2	–	–	3	–	–	3	2	3	3
	CO4	3	2	2	2	–	3	–	–	3	2	3	3
	CO5	3	3	2	2	–	3	–	–	3	3	3	3

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Practical Question Paper Scheme

BTP207 MOLECULAR BIOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY
Time: 04 hours **Maximum Marks: 70**

Section – A (Major experiments) **(20 x 2= 40 marks)**

1. Isolation of genomic DNA **or** plasmid DNA.
2. Determination of BOD of the given sample **or** Determination of Calcium in water sample.

Section - B (Minor experiments) **(10 x 2= 20 marks)**

3. Estimation of DNA **or** RNA by colorimetric method.
4. Determination of chromium from the given sample

   Or

   Estimation of TDS in the given sample.
5. Viva-voce **(10 marks)**

Scheme of valuation
Section – A (Major experiments)

1.	Performance	–	10 marks
	Principle	–	3 marks
	Procedure	–	2 marks
	Result & Comment	–	5 marks
2.	Performance	–	10 marks
	Principle	–	3 marks
	Procedure	–	2 marks
	Result & Comment	–	5 marks

Section - B (Minor experiments)

3.	Performance	–	5 marks
	Principle & Procedure	–	2 marks
	Result & Comment	–	3 marks
4.	Performance	–	5 marks
	Procedure	–	2 marks
	Result & Comment	–	3 marks
5.	Viva-voce	–	10 marks

THIRD SEMESTER

M.Sc. Biotechnology

THEORY

DISCIPLINE CORE: PLANT AND AGRICULTURAL BIOTECHNOLOGY

Course Title : BTH301: PLANT AND AGRICULTURAL BIOTECHNOLOGY (Hard Core)	
Course Code: **BTH301**	L-T-P per week: **4-0-0**
Total Contact Hours: **52**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **3h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **70**

Course objectives :

This course aims at:

• Giving the students a broad overview of tissue culture and its use in the development of new and improved varieties of plants

• Familiarising students with the use of in vitro cultures for the industrial production of chemicals and secondary metabolites in plants

• Elucidating the processes involved in generating recombinant and genetically modified plants and their uses and abuses

• Elaborating on the efficacy of biotechnology in improving crop yield, disease resistance and post-harvest preservation

Content of Course 03: Theory: BTH301: PLANT AND AGRICULTURAL BIOTECHNOLOGY	**52 h**
Unit 1 : Plant tissue culture	**8 h**
Scope and Importance of plant tissue culture- Media composition and types, hormones and growth regulators, explants for organogenesis, somaclonal variation and cell line selection, production of haploid plants and homozygous cell lines. Micro propagation, somatic embryogenesis, protoplast culture and somatic hybridization. Selection and maintenance of cell lines, cryopreservation, germplasm collection and conservation, plant tissue culture certification.	
Unit 2: Plant transformation techniques	**10 h**
Mechanism of DNA transfer – *Agro bacterium* mediated gene transfer, Ti and Ri plasmids as vectors, role of virulence genes; design of expression vectors; 35S promoter, genetic markers, reporter genes; viral vectors. Direct gene transfer methods-particle bombardment, electroporation and microinjection. Binary vectors, plasmid vectors-pBluescript IIKs, pBin19, pGreen vectors, Transgene stability and gene silencing	
Unit-3 : Metabolic engineering of plants:	**10 h**
Plant cell culture for the production of useful chemicals and secondary metabolites (Hairy root culture, Biotransformation, Elicitation) - pigments, flavanoids, alkaloids; mechanism and manipulation of shikimate pathway. Production of Industrial enzymes, biodegradable plastics, therapeutic proteins, edible vaccines and antibiotics using transgenic technology.	
Unit 4 : Plant Development	**6 h**

Plant growth regulators, auxin, gibberlins, cytokinins, abscicic acid, acetylene. Biological nitrogen fixation, importance and mechanism. Biofertilizers-types, production, VAM, Rhizobium, Azotobacter, Mycorhiza, Actinorhiza, Biopesticides, Biocontrol agents.	
Unit 5 : GM Technology	**10 h**
Crop improvement, productivity, performance and fortification of agricultural products–Bt cotton, Bt brinjal. Herbicide resistance, viral resistance, bacterial resistance, fungal resistance crops. Golden rice and transgenic sweet potato. Strategies for engineering stress tolerance. transgenic plants; Current status of transgenic plants in India and other countries, Ethical issues associated with GM crops and GM food; labeling of GM plants and products. Importance of integrated pest management and terminator gene technology. Environmental impact of herbicide resistance crops and super weeds	
Unit 6 : Post-harvest technology	**8 h**
RNAi and antisense RNA technology for extending shelf life of fruits and flowers (ACC synthase gene and polygalacuronase); delay of softening and ripening of fleshy fruits (tomato, banana, watermelons). Post-harvest protection of cereals, millets and pulses.	

References:

1. Chrispeels M.J.et al. Plants, Genes and Agriculture-Jones and Bartlett Publishers, Boston.1994.
2. Gamborg O.L. and Philips G.C.Plant cell, tissue and organ culture (2nd Ed.) Narosa Publishing House. New Delhi.1998
3. Hammound J, P McGravey & Yusibov.V. Plant Biotechnology, Springer verlag.2000
4. Heldt. Plant Biochemistry and Molecular Biology. Oxford and IBH Publishing Co. Pvt.Ltd. Delhi. 1997
5. Lydiane Kyte and John Kleyn. Plants from test tubes. An introduction to Micropropagation (3rd Ed.). Timber Press, Portland. 1996
6. Murray D.R. Advanced methods in plant breeding and biotechnology.Panima Publishing Corporation.1996
7. Nickoloff J.A.Methods in molecular biology, Plant cell electroporation and electrofusion protocols-Humana press incorp, USA. 1995.
8. Sawahel W.A. Plant genetic transformation technology. Daya Publishing House, Delhi.1997
9. Gistou, P and Klu, H.Hand book of Plant Biotechnology (Vol. I & II).John Publication.2004
10. Slatu A et al.The genetic manipulation of plant. Oxford University Press.2003
11. Kirakosyan A and Kaufman P.B.Recent Advances in Plant Biotechnology (1st Ed.).Springer Publishers.2009
12. Halford N.G. Plant biotechnology: current and future applications of genetically modified crops. John Wiely Publishers.2006

Course Outcomes :

At the end of the course, The students will be able to:

1. **Describe** the techniques used in plant tissue culture and the methods involved in generating genetically modified plants.
2. **Explain** the procedures for producing plant-based intermediates, enzymes, and proteins, and **discuss** their commercial applications.
3. **Illustrate** the mechanisms used in designing genetically modified crops for resistance against diseases, drought, and pests.
4. **Evaluate** the ethical, environmental, and socio-economic implications of using genetically modified organisms (GMOs) in agriculture.
5. **Analyse** the role of biopesticides and biofertilisers in sustainable farming and **assess** their effectiveness compared to conventional agrochemicals

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Test /Assignment	10	70	**100**
Seminar	5		
Mid-Semester Exam	10		
Attendance	5		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTH301	CO1	3	2	–	–	–	–	–	–	3	2	–	2
	CO2	3	2	–	–	–	–	–	–	3	2	–	3
	CO3	3	2	–	–	–	2	–	–	3	2	–	3
	CO4	3	2	–	–	–	3	2	–	3	2	–	3
	CO5	3	2	–	–	–	3	2	–	3	2	–	3

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any ten** of the following **3 x 10 = 30**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

II) Section B

Answer **any five** of the following **5 x 5 = 25**

13.
14.
15.
16.
17.
18.
19.
20.

III) Section C

Answer **any one** of the following **15 x 1 = 15**

21.
22.

DISCIPLINE CORE: ANIMAL BIOTECHNOLOGY

Course Title : BTH302: ANIMAL BIOTECHNOLOGY (Hard Core)	
Course Code: **BTH302**	L-T-P per week: 4-0-0
Total Contact Hours: **52**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: 3 **h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **70**

Course objectives :

This course aims at:

- Introducing the student to techniques and uses of animal cell culture
- Familiarising students with the isolation and use of stem cells
- Elucidating the protocols for the generation of transgenic animals and their use
- Making students aware of the ethical issues involved in the genetic manipulation of animals and the precautions to be taken

Content of Course 03: Theory: BTH302: ANIMAL BIOTECHNOLOGY	**52 h**
Unit 1 : Animal Cell Culture	**15 h**
Introduction, cell culture laboratory-design, layout and maintenance. Equipment and Instrumentation. Methods of sterilization, types of culture media, composition, preparation and metabolic functions. Role of CO2, Serum, supplements, growth factors (EGF, PDGF, NGF, Gap-43). Serum and protein free defined media. Culture and maintenance of primary and established cell lines. Biology of cultured cells- culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, cytotoxicity, growth parameters, cell death and Apoptosis. Expression of culture efficiency.	
Unit 2: Stem cells and Tissue Engineering	**7 h**
Scope, embryonic, adult and umbilical cord stem cells, progenitor cells, germline stem cells, niche , properties, identification, , stem cells culture, techniques and their applications in modern clinical sciences- Stem cell therapy. Tissue engineering, biomaterials used in tissue engineering, three-dimensional culture and transplantation of engineered cells. Tissue engineering - skin, bone and neuronal tissues.	
Unit-3 : Transgenic Animals and Animal cloning	**10 h**
Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Gene knockout and mice models for tackling human diseases. Animal cloning: methods of cloning and their importance with reference to domestic animals. IVF- technology for livestock and humans.	

Unit 4 : Applications of Animal Biotechnology	**8 h**
Improvement of biomass, disease resistant, recombinant vaccines for poultry, livestock-pharming products. Pharmaceutical products produced by mammalian cells - plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, interferons, Cell culture- based vaccines.	
Unit 5 : Bioethics	**6 h**
Bioethics in Biodiversity, ethics of resource management, impact of patenting on biodiversity rich developing countries. Ethical issues associated with consumptions of genetically modified foods. Ethical implication of human genome project, international ethical and legal issues connected with human genome diversity research. Genetic studies of ethnic races. Use of cell cultures as alternative for animal models for research. Testing of drugs on human volunteers, use of animals for research and testing; animal and human cloning- ethical and social issues, organ transplantation and xeno transplantation.	
Unit 6 : Biosafety	**6 h**
The Cartagena protocol on biosafety. Biosafety management: Key to the environmentally responsible use of biotechnology. Ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons. Biosafety regulations and national and international guidelines with regard to rDNA technology, transgenic science, GM crops,. Experimental protocol approvals, levels of containment. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP). Use of genetically modified organisms (crippling organisms) and their release to environment.	

References:

1. Ballinic C.A., Philips J.P and Moo Young M.Animal Biotechnology. Pergamon press, New York. 1989.
2. Watson J.D.et al. Molecular Biology of Gene (6^{th} Ed.) Publisher Benjamin Cummings.2007.
3. Berger S. L. and A.R. Kimmel.Methods in enzymology guide to molecular cloning techniques (Vol 152). Academic Press Inc. San Diego.1996
4. Glick, B.R. and Pasternak J.J. Molecular Biotechnology.ASM Press, Washington DC.2003.
5. Jenni,P, Mather and David Barnes, Methods in Cell Biology (Vol 57) Academic Press.2001
6. Ratlege, C. and B. Kristiansen, Basic Biotechnology. Cambridge Univ. Press, London. 2001
7. Watson J.D et al. Molecular Biology of the Gene(6^{th} Ed), The Benjamin Cummings Pub.Co.Inc.USA.2008
8. Shantharam, D., Jane F Montgomery. Biotechnology, Biosafety & Biodiversity: Scientific & Ethical issues for Sustainable development. 1999
9. Jan Freshney. R .Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (6^{th} Ed.) Wiley & Sons. 2010
10. John Davis., Animal Cell Culture: Essential Methods (1^{st} Ed.) Wiley-Blackwell and Sons publisher. 2011

11. Ernst-L Winnacker, From Genes to Clones: Introduction to Gene Technology. WILEY-VCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi. 2003

Course Outcomes:

At the end of the course, The students will be able to:

1. **Describe** the types of media, optimal culture conditions, and safety precautions required for successful animal cell culture.
2. **Explain** the procedures for stem cell isolation and maintenance, and **discuss** their applications in tissue engineering.
3. **Recognize** and **interpret** the methods involved in generating transgenic animals, including associated ethical considerations.
4. **Apply** knowledge of cell culture and genetic engineering techniques to evaluate experimental outcomes in biomedical research.
5. **Evaluate** the scientific, ethical, and societal implications of using transgenic animals in biotechnology research.

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Test /Assignment	10	70	**100**
Seminar	5		
Mid-Semester Exam	10		
Attendance	5		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTH302	CO1	3	2	–	–	–	–	–	–	3	2	–	–
	CO2	3	2	–	–	–	–	–	–	3	2	–	–
	CO3	3	3	–	–	–	–	–	–	3	3	–	–
	CO4	3	2	–	–	–	–	–	–	3	2	–	–
	CO5	3	3	–	–	–	–	–	–	3	3	–	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any ten** of the following **3 x 10 = 30**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

II) Section B

Answer **any five** of the following **5 x 5 = 25**

13.
14.
15.
16.
17.
18.
19.
20.

III) Section C

Answer **any one** of the following **15 x 1 = 15**

21.
22.
23.

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DISCIPLINE CORE: GENETIC ENGINEERING

Course Title : BTH303: GENETIC ENGINEERING (Hard Core)	
Course Code: **BTH303**	L-T-P per week: **4-0-0**
Total Contact Hours: **52**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: 3 **h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **70**

Course objectives :

This course aims at:

• Introducing the student to the basic concepts of cloning and recombinant DNA technology

• Elucidating the step-by-step protocols for cloning and expression of genes, construction of gene libraries, screening and selection of recombinants

• Explaining associated techniques of sequencing, labeling and chemical synthesis of oligonucleotides

Content of Course 03: Theory: BTH303 : GENETIC ENGINEERING	**52 h**
Unit 1 : Introduction to Genetic Engineering	**2 h**
Scope and importance of Genetic Engineering	
Unit 2: Tools of Genetic Engineering	**14 h**
Enzymes : Endo & exonucleases, DNase, RNase. Restriction endonucleases- types, nomenclature, recognition sequences and products. Modification methyltransferases DNA polymerases : DNA pol I and its large (Klenow) fragment, T4 DNA polymerase, Taq polymerase, Reverse Transcriptase, Terminal deoxynucleotidyl transferase. Enzymes that modify DNA: Kinases, phosphatases, polynucleotide phosphorylase, polynucleotide kinases. DNA ligases: T4 ligase, *E. coli* DNA ligase and their mechanism of action. RNA modification: Types and applications. **Vectors**: Important features of cloning vectors: Multiple cloning sequences (MCS), origin of replication (Ori) and copy number, selectable markers. Naturally occurring plasmids, plasmids as vectors. Construction of pBR322, pUC18 and 19 vectors. Phage vectors: Lambda based vectors, cosmids, phagemids and M13 derived vectors. Vectors for large DNA fragments: Minichromosomes, BACs, YACs, Important features of expression vectors: Promoters (lac promoter, trp promoter, hybrid tac promoter, lambda pL promoter), ribosome binding sites, codon selection, lac Z (blue-white) selection for expression. Shuttle vectors: Features and applications. Plant vectors: Ti plasmids, CaMV 35S promoter. Animal vectors: SV40, Bovine papilloma virus.	

Unit-3 : Gene Cloning Strategies and Construction of Gene Libraries	14 h
Gene Cloning Strategies: Restriction digestion of vectors. Purification of vector and insert DNA, end modification, cloning of foreign genes (from mRNA, genomic DNA, synthetic DNA) **Construction of Gene Libraries:** Cloning from mRNA: Isolation and purification of RNA, synthesis of cDNA, Isolation of plasmids, cloning cDNA in plasmid vectors, cloning cDNA in bacteriophage vectors. cDNA library. **Cloning of genomic DNA:** Isolation and purification of DNA, preparation of DNA fragments and cloning. Construction of genomic libraries (Using λ gt 10 and 11 vector). In vitro packaging of λ phage and amplification of libraries. Advanced cloning strategies: Synthesis and cloning of cDNA, Use of adaptors and linkers, homopolymer tailing in cDNA cloning, expression of cloned DNA molecules.	
Unit 4 : Transformation and transfection techniques	**8 h**
Preparation of competent cells and protoplasts of bacteria, spheroplast generation in yeast, protoplast generation in plant cells. Physical methods of transformation- Electroporation, gene gun method (microparticle bombardment), ultrasound. Chemical methods of transformation- Calcium phosphate precipitation method, liposome mediated method. Polylysine and polyethyleneimine enabled transformation. Biological methods: Transfection of cells with viruses/ phages Introduction of recombinant DNA into bacteria, yeast, mammalian and plant cells, transformation and transfection efficiency. **Selection, screening and analysis of recombinants:** Genetic selection, insertional inactivation, chromogenic substrates, complementation of defined mutations, nucleic acid hybridization, screening methods for cloned libraries, PCR screening protocols, immunological screening, restriction mapping of cloned gene, blotting techniques, sequencing methods. Purification strategies of expressed His- tagged proteins.	
Unit 5 : Labelling and Detection Techniques	**8 h**
Labeling of DNA, RNA and Proteins by radioactive isotopes, non-radioactive labeling, *in vivo* labeling, autoradiography and autofluorography. DNA sequencing by enzymatic and chemical methods, Agarose gel electrophoresis, PAGE, PFGE. Methods of nucleic acid hybridization; Southern & Northern blotting. Protein detection: Western Blotting techniques.	
Unit 6 :Chemical Synthesis of Genes and PCR	**6 h**
Chemical Synthesis of Genes and applications of genetic engineering: Phosphodiester, phosphotriester and Phosphite ester methods of oligonucleotide synthesis. Applications of oligonucleotides: Oligonucleotide directed mutagenesis, DNA and RNA Binding assays, primers, adaptors, linkers PCR amplified DNA: Essential features of PCR, primers, Taq polymerases, reverse transcriptase-PCR.	

PCR-Nested, inverse, RAPD-PCR, RT-PCR (real time PCR), Applications of PCR. Gene editing: Zinc finger nucleases (ZFNs), Transcription activator like endonucleases (TALENS), CRISPR- Cas9 editing. Synthesis of complete genes.	

References:

1. Nicholl D.S.T. Introduction to Genetic Engineering Cambridge (3rd Ed.) University press.UK. 2008
2. Old R.W., Primrose S.B. Principles of gene manipulation - An introduction to genetic engineering (5th Ed.), Blackwell Scientific Publications, UK. 1996.
3. David S L. Genetics to Gene Therapy – the molecular pathology of human disease (1st Ed.) BIOS scientific publishers, 1994.
4. Ernst-L Winnacker, From Genes to Clones: Introduction to Gene Technology. WILEY-VCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi. 2003
5. Benjamin Lewis, Genes VIII (3rd Ed.) Oxford University & Cell Press,NY.2004
6. Robert Williamson.Genetic Engineering (1st Ed.) Academic Press.1981.USA
7. Rodriguez. R.L (Author), Denhardt D.T. Vectors: A Survey of Molecular Cloning Vectors and Their Uses (1st Ed.) Butterworth-Heinemann publisher.UK. 1987
8. Ansubel F.M., Brent R., Kingston R.E., Moore D.D. et al. Short protocols in molecular biology(4th Ed), Wiley publishers. India. 1999.
9. Sambrook J et al. Molecular cloning Volumes I, II and III. Cold Spring Harbor laboratory Press, New York, USA. (1989, 2000)
10. Terence A Brown. Genomes, (2nd Ed.) BioScientific Publishers.UK.2002
11. Anthony JF Griffiths, William M Gelbart, Jeffrey H Miller, and Richard C Lewontin Modern Genetic Analysis (1st Ed.)W. H. Freeman Publishers.NY. 1999
12. S. B. Primrose, Richard M. Twyman.Principles of gene manipulation and genomics (7th Ed.) John Wiley & Sons publishers.2006

Course Outcomes:

At the end of the course, The students will be able to:

1. **Describe** the tools and techniques of genetic engineering, including cloning and expression vectors, restriction enzymes, host strains, and selection media.
2. **Explain** the strategies for cloning genes, including the construction of genomic and expression libraries, transformation methods, and selection criteria.
3. **Demonstrate** familiarity with protocols for DNA separation, labeling, sequencing, and identification.
4. **Apply** molecular techniques to design and troubleshoot gene cloning experiments.
5. **Evaluate** the efficiency and accuracy of genetic engineering protocols in achieving

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Test /Assignment	10	70	**100**
Seminar	5		
Mid-Semester Exam	10		
Attendance	5		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTH303	CO1	3	2	2	–	–	–	–	–	3	2	–	–
	CO2	3	3	2	–	–	–	–	–	3	3	–	–
	CO3	3	2	2	–	–	–	–	–	3	2	–	–
	CO4	3	3	2	–	–	–	–	–	3	3	–	–
	CO5	3	3	2	–	–	–	–	–	3	3	–	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any ten** of the following **3 x 10 = 30**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

II) Section B

Answer **any five** of the following **5 x 5 = 25**

13.
14.
15.
16.
17.
18.
19.
20.

III) Section C

Answer **any one** of the following **15 x 1 = 15**

21.
22.
23.

****

DISCIPLINE CORE: APPLIED BIOTECHNOLOGY (OPEN ELECTIVE)

Course Title : BTOE3.1: APPLIED BIOTECHNOLOGY (Hard Core)	
Course Code: **BTOE3.1**	L-T-P per week: **4-0-0**
Total Contact Hours: **52**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **3 h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **70**

Course objectives:

This course aims at:

- To understand the biotechnological principles behind sustainable agriculture, food production, and public health solutions.
- To acquire hands-on experience in small-scale biotechnological production systems.
- To develop entrepreneurial thinking and awareness of industrial applications.
- To promote critical thinking on biotechnology's role in solving environmental and health-related challenges.

Content of Course 03: Theory: BTOE3.1: BASIC BIOTECHNOLOGY	**52 h**
Unit 1 Introduction to Biotechnology **Genetic Engineering and GMOs – Biotechnology in Action**	**2 h 8 h**
Definition, principles – biomolecules and central dogma, branches and scope of biotechnology, interdisciplinary research. • Foundations of Genetic Engineering • Genetically Modified Organisms (GMOs) • Applications and Societal Impact • Bioethics, Safety, and Regulations • Practical : Simple DNA Extraction from banana	
Unit 2 Plant and Animal Biotechnology **Agricultural Biotechnology Applications**	**8 h 14 h**

Plant tissue culture, micropropagation, rDNA technology, transgenic plants, crop improvement, Bt cotton, Bt brinjal, golden rice, production of enzymes, biodegradable plastics, therapeutic proteins, edible vaccines. Animal cell culture, stem cells and tissue engineering, transgenic animals
 	
• **Vermicomposting**
  ○ Biology of earthworms, composting process, factors affecting quality
  ○ Practical: Setting up a small-scale vermicomposting unit
• **Mushroom Cultivation**
  ○ Life cycle of *Pleurotus* and *Agaricus*, substrate preparation, spawn inoculation, harvesting
  ○ Practical: Cultivation of oyster mushrooms in the lab
  ○ Biopesticides and biofertilizers (overview)	

Unit 3 Medical and Nano Biotechnology **Food Biotechnology Applications**	**8 h 16 h**
Microbial diseases of humans, antigen antibody interaction, vaccines, regenerative medicine, gene therapy. Nanoparticles – definition and types,	

nanobiosensors, drug and gene delivery, risk potential of nanomolecules
 	
• **Winemaking**
  ○ Role of yeast (*Saccharomyces cerevisiae*), fermentation process, quality parameters
  ○ Practical: Setting up a micro-fermentation unit
• **Probiotic Foods**
  ○ Definition, benefits, strains of probiotic bacteria, applications in health
  ○ Practical: Preparation of yogurt/fermented drink with probiotic strains
• **Single-Cell Protein**
  ○ Production using algae, fungi, and bacteria, nutritional significance
  ○ Practical: Cultivation of *Spirulina* or yeast-based SCP	

Unit 4 Sustainable Technologies Medical Biotechnology Applications	**10 h**

Pollution, Global warming, Ozone depletion, Acid rain. Renewable sources of energy, carbon footprint, biofuels – plant based and microbial. Waste management – Solid Waste and Waste water treatment. Microflora and their contribution to ecosystem, biodegradation, bioremediation – principle and types
 	
• **Blood Typing**
  ○ Principles of ABO and Rh grouping
  ○ Practical: Blood typing using slide agglutination method
• **Vaccines**
  ○ Types of vaccines (live, attenuated, subunit, mRNA), production principles
  ○ Role of biotechnology in vaccine development (case study: COVID-19 vaccines)
• **Vector-Borne Diseases**
  ○ Malaria, Dengue, Chikungunya: epidemiology, diagnostics, biotech solutions	

Unit 5 Fermentation Technology Innovation, Sustainability, and Entrepreneurship	**8h 4 h**
Fermentation: Definition – History of fermentation, types of fermentation, parts of fermentor, benefit of fermentation - nutritive value of fermented foods - microbial changes in fermented foods - microorganism - proteolytic, lipolytic and fermentative bacteria. Fermented Foods – Idly, bread, Soya Sauce, Tempeh, Miso, Natto, pickles, fish, meat and dairy based fermented foods. Environmental parameters for fermentation process; safety criteria of fermented foods • Designing low-cost biotechnological setups (for rural deployment)	

• Intellectual property rights (IPR) and patents in applied biotechnology • Market opportunities: biofertilizers, nutraceuticals, SCP products • Group project: Design a prototype product/business plan based on any one unit topic	
Unit – 6 Bioinformatics and statistics for biologists Introduction to Database, Biological Databases – DNA and Protein databases, DNA sequence analysis - Human Genome Project, Protein structure and analysis, Molecular interaction – docking, drug designing Importance of Biological data analysis and visualization, Hypothesis and Testing – t, Z, X2, ANOVA	10 h
Unit – 7 Entrepreneurship, Bioethics and IPR Potential entrepreneurship activities in biotechnology Bioethics, ethical issues related to consumption of GM crops, usage of animal models and ethical issues related to Human Genomics. Clinical trials – definition and phases IPR, patenting of biotech products, examples: turmeric, basmati rice, neem	**6 h**

References:

- Nicholl, D. S. T. (2008). *An introduction to genetic engineering*. https://doi.org/10.1017/cbo9780511800986
- Singh, K. (2021). *Textbook of Vermicompost, Vermiwash and Biopesticides* (1st ed.). Biotech Books.
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- Rao, S. (1993). *Biofertilizers in agriculture and forestry*. https://openlibrary.org/books/OL12143806M/Biofertilizers_in_Agriculture_Forestry
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- Harmening, D. M. (1983). *Modern blood banking and transfusion practices*. http://ci.nii.ac.jp/ncid/BA10280643
- Plotkin, S. A., Orenstein, W., & Offit, P. A. (2008). *Vaccines*. Elsevier Health Sciences.
- Service, M. (2008). *Medical entomology for students*. https://doi.org/10.1017/cbo9780511811012

Course learning outcomes:

At the end of the course, The students will be able to:

1. **Explain** the fundamental principles of applied biotechnology and describe its role in agriculture, food, healthcare, and environmental sustainability.
2. **Perform** basic biotechnological techniques such as vermicomposting, mushroom cultivation, winemaking, probiotic preparation, single-cell protein production, and blood typing under laboratory/field conditions.
3. **Analyze** the scientific basis, advantages, limitations, and safety concerns of genetically modified organisms, vaccines, and vector-control strategies.
4. **Evaluate** the ethical, regulatory, and societal implications of biotechnological applications in food, health, and environment.
5. **Design** a small-scale, cost-effective prototype or business plan for a biotechnological product or process (e.g., biofertilizer unit, probiotic drink, SCP production model) and present it effectively

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Test /Assignment	10	70	**100**
Seminar	5		
Mid-Semester Exam	10		
Attendance	5		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTOE3.1	CO1	3	2	–	–	–	2	–	–	3	–	–	2
	CO2	3	2	–	–	–	3	–	–	3	–	–	2
	CO3	3	2	–	–	–	3	2	–	3	–	–	3
	CO4	3	2	–	–	–	3	2	–	3	–	–	3
	CO5	3	3	–	–	–	3	2	–	3	–	–	3

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any ten** of the following **3 x 10 = 30**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

II) Section B

Answer **any five** of the following **5 x 5 = 25**

13.
14.
15.
16.
17.
18.
19.
20.

III) Section C

Answer **any one** of the following **15 x 1 = 15**

21.
22.
23.

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DISCIPLINE CORE: Research Methodology: Fundamentals for Scientific Inquiry

Course Title : BTS304: Research Methodology: Fundamentals for Scientific Inquiry (Soft core)	
Course Code: **BTS304**	L-T-P per week: **2-0-0**
Total Contact Hours: **26**	Course Credits: **02**
Formative Assessment Marks: **15**	Duration of ESA/Exam: **1.5 h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **35**

Course Objectives:

This course aims at:

- Develop an understanding of the foundations, scope, and ethics of research.
- Learn how to identify problems, formulate hypotheses, and design studies.
- Gain an introduction to qualitative, quantitative, and mixed approaches.
- Acquire basic knowledge of measurement, sampling, and data analysis.
- Learn essentials of research writing, referencing, and publishing

Content of Course 01: Theory: BTS304: Research Methodology: Fundamentals for Scientific Inquiry	**26 h**
Unit 1 **Foundations of Scientific Inquiry:**	**4 h**
Nature, objectives, and significance of research Scientific method: concepts, constructs, variables Theory, deduction, induction, and empiricism Research ethics: plagiarism, integrity, authorship	
Unit 2 **Research Problem, Hypothesis, and Design:**	**5 h**
Identifying research problems and framing questions Hypothesis: types, qualities, and testing logic Research design: exploratory, descriptive, and experimental basics Independent and dependent variables	
Unit 3 **Approaches, Measurement, and Sampling:**	**5 h**
Qualitative vs. quantitative approaches Measurement issues: validity, reliability, and levels of measurement Sampling techniques: probability and non-probability Practical considerations in determining sample size	
Unit 4 **Data Analysis and Interpretation:**	**6 h**
Preparing and cleaning data Descriptive statistics: mean, median, mode, percentages, charts Bivariate analysis: cross-tabulations, chi-square test Basics of hypothesis testing Interpretation and presentation of findings	

Unit 5 **Communicating and Documenting Research:**	**6 h**
Structure of a research paper, dissertation, and thesis Referencing styles and citation management (Zotero, Mendeley) Use of academic databases (Scopus, PubMed, IEEE Xplore) Publication ethics, plagiarism detection, and impact factor journals	

References:

1. Kothari, C. R. & Garg, G. (2019). Research Methodology: Methods and Techniques. New Age International Publishers.
2. Walliman, N. (2017). Research Methods: The Basics. Routledge
3. American Psychological Association (2020). Publication Manual of the APA (7th Edition).
4. Cooper, D. R. & Schindler, P. S. (2017). Business Research Methods. McGraw Hill.
5. Creswell, J. W. & Creswell, J. D. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Sage Publications
6. Saunders, M., Lewis, P. & Thornhill, A. (2019). Research Methods for Business Students. Pearson Education.

Course Outcomes :

At the end of the course, The students will be able to:

1. Explain the principles and process of research.
2. Formulate research problems and hypotheses.
3. Apply appropriate sampling and data collection strategies.
4. Analyze data using basic statistical methods.
5. Prepare a research proposal and communicate results ethically.

Pedagogy: Lectures, Presentations, videos, and Assignments.

Assessment – Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Attendance	5	35	**50**
Mid-Semester Exam	10		
Total	**15**	**35**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTS304	CO1	3	2	–	–	–	–	–	–	–	–	–	–
	CO2	3	3	–	–	–	–	–	–	–	–	–	–
	CO3	3	3	–	–	–	–	–	–	–	–	–	–
	CO4	2	3	–	–	–	–	–	–	–	–	–	–
	CO5	3	2	–	–	3	–	2	–	–	–	–	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

IV) Section A

Answer **any five** of the following **2 x 5 = 10**

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

V) Section B

Answer **any two** of the following **5 x 2 = 10**

9.
10.
11.
12.

VI) Section C

Answer **any one** of the following **15 x 1 = 15**

13.
14.
15.

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III SEMESTER PRACTICAL

Course 03: Practical: BTP305: PLANT, AGRICULTURAL AND ANIMAL BIOTECHNOLOGY	
Course Title: **PLANT, AGRICULTURAL AND ANIMAL BIOTECHNOLOGY**	Course Credits: **04**
Course Code: **BTP305**	L-T-P per week: 0-0-4
Total Contact Hours: **26**	Duration of ESA/Exam: 04 h
Formative Assessment Marks: 30	Summative Assessment Marks: 70

Course objective:

This course aims at :

- Familiarising the students with the basic techniques of plant and animal tissue culture
- Demonstrating the importance of tests to determine viability of in vitro cultures
- Introducing the students to the effect of biopesticides and biofertilisers on plant growth

Experiments:

1. Preparation of plant tissue culture media and Organ culture (Shoot tip, nodal and leaf culture)
2. Callus culture: Initiation and regeneration.
3. Anther culture for the production of haploids.
4. Isolation, culture and fusion of protoplasts
5. Isolation of plant genomic DNA from pea shoot tip/ Cauliflower by CTAB method
6. *Agrobacterium* culture, selection of transformants
7. Suspension culture and production, separation and estimation of secondary metabolites β-carotene from carrot and anthocyanin from beetroot
8. Study of VAM, isolation of spores, arbuscles and vesicles from roots
9. Production of synthetic seeds
10. Mushroom Cultivation
11. Study and culture of biocontrol agents *(Trichoderma viridae, Trichoderma harzianum, Aspergillus awamori)*
11. Animal cell culture: Preparation of (serum and non serum supplemented) media, cell culture, assessment of viability and counting using trypan blue exclusion method
12. Primary culture of fibroblast cells/liver cells/testis-leydig cells
13. Determination of GST enzyme activity in cytotoxicity induced cells
14. Estimation of lipid peroxides (Malondialdehyde) in cytotoxicity induced cells
15. MTT assay for cell viability and growth
16. Visit to industries or biotech park - report to be submitted along with the record

Course Outcome:

At the end of the course, The students will be able to:

1. **Generate** plant calluses using appropriate explants and culture conditions, and **monitor** their growth and morphology.
2. **Observe** and **relate** biotechnological processes used in industry to the concepts learned in class
3. **Identify** the use of biofertilisers in controlled setups.
4. **Understand** fundamental animal cell culture techniques, including media preparation, aseptic handling, and **determine** cell viability using standard assays.
5. **Analyze** experimental outcomes to assess the success of plant tissue culture, genetic modification, and cell viability protocols

Assessment - Practical			
Formative assessment		**Summative Assessment**	
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	**Total Marks**
Visit Report	10	70	**100**
Attendance	5		
Practical Tests and Record	15		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTH305	CO1	3	2	2	–	–	2	–	–	3	2	3	2
	CO2	3	2	2	–	–	2	–	–	3	2	3	2
	CO3	3	3	2	–	–	3	–	–	3	2	3	3
	CO4	3	2	2	–	–	3	–	–	3	2	3	3
	CO5	3	3	2	–	–	3	–	–	3	3	3	3

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Practical Question Paper Scheme

BTP305: PLANT, AGRICULTURAL AND ANIMAL BIOTECHNOLOGY
Time: 04 hours **Maximum Marks: 70**

Section – A (Major experiments)

1. Perform plant genomic DNA isolation from the provided sample **A** by CTAB method , write principle, procedure. Comment on results.

15 Marks

2. Determine GST enzyme activity in the cytotoxicity induced sample **B** cells

Or

Estimate the lipid peroxides in cytotoxicity induced sample **B** cells

15 Marks

Section - B (Minor experiments)

1. Perform staining and identification of VAM from the given sample **C**

10 Marks

2. Isolate and identify protoplasts from the given sample **D**

Or

Estimate β-carotene/anthocyanin from the given sample **D**

10 Marks

3. Identify and comment on spotters **E & F**

5 X 2 = 10 Marks

4. Viva-Voce

10 Marks

Scheme of valuation
Section – A (Major experiments)

1.	Performance	–	7 marks
	Principle	–	3 marks
	Procedure	–	2 marks
	Result & Comment	–	3 marks
2.	Performance	–	7 marks
	Principle	–	3 marks
	Procedure	–	2 marks
	Result & Comment	–	3 marks

Section - B (Minor experiments)

3.	Performance	–	2 marks
	Principle	–	3 marks
	Procedure	–	2 marks
	Result & Comment	–	3 marks
4.	Performance	–	2 marks
	Principle	–	3 marks
	Procedure	–	2 marks
	Result & Comment	–	3 marks
5.	Identification	–	5 marks
	Comments	–	5 marks
6.	Viva-voce	–	10 marks

Course 03: Practical: BTP306: GENETIC ENGINEERING AND BIOINFORMATICS	
Course Title: **GENETIC ENGINEERING AND BIOINFORMATICS**	Course Credits: **04**
Course Code: **BTP306**	L-T-P per week: **0-0-4**
Total Contact Hours: **26**	Duration of ESA/Exam: **04** h
Formative Assessment Marks: **30**	Summative Assessment Marks: **70**

Course objective:

This course aims at:

- Familiarising students with basic techniques in molecular biology and recombinant DNA technology
- Getting the students to have hands-on experience in cloning and overexpression of genes
- Demonstrating DNA-DNA and DNA-RNA hybridization techniques

Introducing students to various bioinformatics tools and interpretation of the results obtained from their use

Experiments:

1. Electrophoresis of restriction digested plasmid DNA, determination of molecular weight of digested DNA fragment
2. Restriction mapping of Plasmid DNA
3. Ligation of DNA and analysis by electrophoresis
4. DNA amplification by PCR and RAPD
5. Preparation of competent cells and transformation by $CaCl_2$ method and Selection of Transformed colony by X-Gal method
6. Determination of molecular weight of proteins by SDS PAGE and analysis by Western blotting
7. Analysis of DNA by Southern blotting
8. Labelling of proteins by dinitroflurobenzene and analysis
9. Restriction mapping, Sequence (FASTA and BLAST) searches.
10. Pair wise comparison of sequences, multiple alignments of sequences.
11. Evolutionary studies / Phylogenetic analysis.
12. Identification of genes in Genomes and Primer Design
13. Protein databank retrieval and visualization Ros mol
14. Ramachandran plot-secondary structure prediction of proteins.
15. Introduction to Auto doc
16. Calculation of SD, Variance and plotting the graph by using MS Excel

Course Outcome :

At the end of the course, The students will be able to:

1. **Perform** genetic modification in bacterial systems using appropriate vectors and host strains.
2. **Identify** and **characterize** recombinant proteins using techniques such as SDS-PAGE, Western blotting, and spectrophotometry.
3. **Utilize** bioinformatics tools to **compare** genomic sequences and **construct** phylogenetic trees to infer evolutionary relationships.
4. **Apply** computational software to **study** and **predict** protein structure and function, including secondary and tertiary modeling.
5. **Analyze** experimental and computational data to assess gene expression outcomes and protein functionality.

Assessment - Practical			
Formative assessment		**Summative Assessment**	
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	**Total Marks**
Record	10	70	**100**
Attendance	5		
Practical Tests	15		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTH306	CO1	3	2	2	–	–	–	–	–	3	2	3	–
	CO2	3	2	2	–	–	–	–	–	3	2	3	–
	CO3	3	3	2	–	–	–	–	–	3	3	3	–
	CO4	3	2	2	–	–	–	–	–	3	2	3	–
	CO5	3	3	2	–	–	–	–	–	3	3	3	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Practical Question Paper Scheme

BTP306: GENETIC ENGINEERING AND BIOINFORMATICS

Time: 04 hours **Maximum Marks: 70**

Section – A (Major experiments)

1. Perform electrophoresis of restriction digested plasmid DNA from sample **A** and determine its molecular weight. Write principle, procedure and comment on results.

15 Marks

2. Create a phylogenetic tree from the given sequence data **B**

Or

Determine the binding parameters of the given ligands/ protein complex **B** using docking

15 Marks

Section - B (Minor experiments)

1. Solve the following problems **C&D** on restriction mapping

5 X 2 = 10 Marks

2. Identify and comment on spotters **E & F**

5 X 2 = 10 Marks

3. Using the respective softwares, design primers / restriction sites, analyse and comment on the results

10 Marks

4. Viva-Voce

10 Marks

Scheme of valuation
Section – A (Major experiments)

1.	Performance	–	7 marks
	Principle	–	3 marks
	Procedure	–	2 marks
	Result & Comment	–	3 marks
2.	Performance	–	7 marks
	Principle	–	3 marks
	Procedure	–	2 marks
	Result & Comment	–	3 marks

Section - B (Minor experiments)

3.	Procedure (Steps Involved)	–	3 marks
	Result & Comment	–	2 marks
4.	Identification	–	1 mark
	Comment	–	4 marks
5.	Performance	–	5 marks
	Analysis & Result	–	5 marks
6.	Viva-voce	–	10 marks

FOURTH SEMESTER

M.Sc. Biotechnology

THEORY

DISCIPLINE CORE: BIOPROCESS ENGINEERING

Course Title : BTH401: BIOPROCESS ENGINEERING (Hard Core)	
Course Code: **BTH401**	L-T-P per week: **4-0-0**
Total Contact Hours: **52**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **3h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **70**

Course Objectives:

The course aims at:

- Giving an overview of the design of fermentors, types of fermentors , equipments, instruments used,
  sterilization processes, fermentation media, inoculum preparation, Scale up processes.
- To give a detailed explanation to various downstream processes of fermentation industries.
- Emphasizing the importance of immobilization, Biotransformation and their applications.
- To give an overview of IPR, patenting and aspects of Bioethics and Biosafety.

Content of Course 01: Theory: BTH401: BIOPROCESS ENGINEERING	**52 h**
Unit 1 **Introduction:**	**1 h**
Scope and importance of bioprocess engineering technology	
Unit 2 **Bioreactors:**	**10 h**
Typical structure of advanced Bioreactor and their working mechanism; Design features; Heat transfer and Mass transfer; Specialised bioreactors- design and their functions; Airlift bioreactor, Tubular bioreactors, Membrane bioreactors, Tower bioreactors, Fluidized bed reactor, Packed bed reactors and Photo bioreactors.	
Unit 3 **Fermentation media and Fermentation Process:**	**10 h**
Natural and synthetic media; Strategies for media formulation, sources of carbon, nitrogen, vitamins and minerals. Role of buffers, precursors, inhibitors, inducers and antifoam agents. Development and strain improvement of industrially important microorganisms. Types of fermentation processs-submerged fermentation, surface or solid state fermentation, batch fermentation, continuous fermentation, kinetics of fermentation process, bioprocess control, monitoring of variables-temperature, agitation, pH and pressure.	
Unit 4 **Downstream processing:**	**8 h**
Cell disruption, precipitation methods, Distillation, solid-liquid separation, liquid-liquid extr filtration, centrifugation, chromatography, drying devices (Lyophilization and spray dr technology), crystallization Food processing: food preservation, and spoilage. Sterilization and pasteurization, canning	

and packing of foods.	
Unit 5 **Immobilization and Biotransformation :**	**5 h**
Methods of immobilization, adsorption, cross- linking, ionic bonding, entrapment, encapsulation; Advantages and industrial applications of Immobilization of enzymes and whole cells. Biotransformation of antibiotics, steroids and their applications.	
Unit 6 **Production of Industrially important products:**	**10 h**
Alcohol: Ethanol, glycerol, butanol; Acetone; Organic acids: citric, acetic, and gluconic acid; Amino acids: lysine, glutamic acid; Antibiotics: penicillin, streptomycin, tetracycline; Vitamins: riboflavin, Enzymes: amylase, protease, biodegradable plastic: polyhydroxyalkanoates (butyarate, propionate.); Recombinant protein- Insulin, hepatitis-B vaccine – Issues with recombinant proteins (misfolding and inclusion bodies). Fermented foods-sausages, olives, bread, idly and acidophilus milk.	
Unit 7 **Intellectual Property Rights (IPRs) and Entrepreneurship:**	**8h**
IPRs– implications for India, WTO, WIPO, GATT, TRIPS. Patenting and the procedures involved in the application for patents and granting of a patent, compulsory licenses, patent search, Patent Cooperation Treaty (PCT), examples of patents in biotechnology, legal implications, traditional knowledge commercial exploitation, protection. Entrepreneurship – Potential entrepreneurship activities in biotechnology, product development, marketing, research and training units. Industrial licensing, venture capital, startup culture. Biotechnology Industries in India and the potential job opportunities.	

References:

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
3. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997.
4. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, (2nd Ed). Taylor & Francis Ltd, UK, 2007.
5. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (2nd Ed.).Cambridge University Press. 2002.
6. Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 1984
7. Michael, L. Shulers and Fikret Kargi. Bioprocess Engineering: Basic concepts (2nd Ed.) Prientice Hall Publishers. 2001

1. Paulins, M. D. Bioprocess Engineering Principles. John Wiley Publishers.2003

Course Outcomes:

At the end of the course, The students will be able to:

1. **Explain** the design and operation of fermentors, including types, equipment, instrumentation, and sterilization protocols used in bioprocessing.
2. **Describe** the components of fermentation media, **outline** inoculum preparation, and **evaluate**

scale-up and downstream processing strategies in fermentation industries.
3. **Apply** principles of mass and energy balance, microbial growth kinetics, and bioreactor operation to analyze basic bioprocess problems.
4. **Demonstrate** proficiency in microbial screening techniques and **analyze** the roles of primary and secondary metabolites in industrial applications.
5. **Design** a bioprocess workflow integrating fermentation, metabolite extraction, and product formulation for a selected industrial application.

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Test /Assignment	10	70	**100**
Seminar	5		
Mid-Semester Exam	10		
Attendance	5		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTH401	CO1	3	2	2	–	–	–	–	–	3	2	3	2
	CO2	3	2	2	2	–	–	–	–	3	2	3	2
	CO3	3	3	2	2	–	–	–	–	3	3	3	2
	CO4	3	2	2	2	–	–	–	–	3	2	3	3
	CO5	3	3	2	2	–	–	–	–	3	3	3	3

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any ten** of the following **3 x 10 = 30**

1.
2.
3.
4.
5.
6.
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9.
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11.
12.

II) Section B

Answer **any five** of the following **5 x 5 = 25**

13.
14.
15.
16.
17.
18.
19.
20.

III) Section C

Answer **any one** of the following **15 x 1 = 15**

21.
22.
23.

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DISCIPLINE CORE: MEDICAL BIOTECHNOLOGY

Course Title : BTH402 : MEDICAL BIOTECHNOLOGY (Hard Core)	
Course Code: **BTH402**	L-T-P per week: **4-0-0**
Total Contact Hours: **52**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **3h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **70**

Course Objectives:

The course aims at:

- Giving an overview of the various diseases that infects humans and their microbial source
- Introduction to Cancer biology and detection techniques
- An overview to Nanobiotechnology, Molecular therapeutics and Drug discovery with the techniques involved and their applications.

Content of Course 01: Theory: BTH402 : MEDICAL BIOTECHNOLOGY	**52 h**
Unit 1 **Microbial Diseases of Humans**:	**8h**
mode of infection, symptoms, detection, epidemiology and control measures of disease caused by Viruses (AIDS, Hepatitis- B, Rabies, HSV-1) Bacteria (Typhoid, STD, TB, Plague) Fungi(Aspergillosis, Histoplasmosis, Cryptococcosis) Protozoa(Malaraia, Amoebiasis)	
Unit 2 **Cancer Biology:**	**6 h**
Tumors, types of tumors, pre-disposing factors, cellular changes involved in tumor formation, genes associated with cancer (oncogenes, tumor suppressive genes etc.), methods of tumor detection, tumor markers, treatment of cancer-chemo therapy, radio therapy, immunotherapy and gene therapy.	
Unit 3: Human Diseases and Organ Functions:	**8 h**
Human Diseases: Symptoms and treatment of the Genetically inherited diseases: PKU, Alkaptonuria, Galactosemia, Von"Gierke disease, Lesch-Nyhan syndrome, Gout, Sickle cell aneamia, Beta Thalesimia and Diabetes **Evaluation of organ functions:** liver, kidney, cardiac and gastric function tests. Significance of biochemical markers-amino transferases, creatine kinase, LDH,amylase and γ-glutamyl trans-peptidase	
Unit 4: Nanobiotechnology:	**6 h**
Introduction, types and synthesis of nanomaterials, protein-based nano structures, DNA-based nano structures, Applications of nanomaterials, nanobiosensors, drug and gene delivery, disease diagnostics and therapy, risk potential of nanomaterials	
Unit 5: Molecular Therapeutics:	**10 h**
Drugs, drug receptors, Relationship between drug concentration and response, agonists, drug clearance, biological half life, drugs accumulation, basic concepts of toxic effect. Gene therapy, barriers to gene delivery, overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome mediated gene delivery. Cellular therapy; use of stem cells. Recombinant therapy; Erythropoietin; Insulin analogs and its role in diabetes. Streptokinase and urokinase in thrombosis	

Unit 6 **Drug Discovery:**	**6 h**
Introduction, conventional drug design approaches, irrational Vs rational, Lipinski's rule of five, ADME, Calculation of LD 50 and ED 50. Acute, subacute and chronic toxicity studies. Irwin profile test, Drug development process (Preclinical , clinical and toxicological studies). Novel Drug Development approaches - QSAR (quantitative structure activity relationship), High-throughput screening.	
Unit 7 **Clinical research:**	**8h**
Past, Present and future. Importance, Mile stones of regulations. FDA, US, Indian clinical research, global scenario of clinical research, Regulatory agency. Designing clinical trials- History, principles, scheme for conducting clinical trials, planning defining, objectives, variables, study populations, testable hypothesis, prediction of errors and bioselection of appropriate study design, Execution steps. Ethical Issues in clinical research- Introduction, codes, declaration and guidelines, Informed concent, special issues, Roles and responsibilities of IRBS, issues with ethics review. ICH-GCP- History of ICH, Objectives, ICH structure, Guidelines, Future of ICH.	

References:

1. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier publications, 2008
2. S N Jogdand Medical Biotechnology 2nd Edition Himalaya publishers 2008
3. Keith Wilson & John Walker, Practical Biochemistry- 5th edition, Cambridge University Press, UK 2000
4. Bartram G. Katzung, Basic & Clinical Pharmacology, 9th Edition, Mc Graw Hill Publications 2004
5. Devlin TM, Text book of biochemistry with Clinical Correlations 5th edition 2002
6. Richard B Silverman, Organic Chemistry of Drug design and Drug action Elsevier Science, Academic Press
7. Warren Levinson, Ernest Jawetz, Medical Microbiology and Immunology: Examination and Board Review 7th edn. McGraw Hill Publications 2003
8. Jawetz, Melnuk and Adelgerg, Medical Microbiology, Appleton & Lange pub 1971.

Course Outcomes :

At the end of the course, The students will be able to:

1. **Identify** the symptoms, diagnostic approaches, and treatment strategies for major human diseases and disorders.
2. **Explain** and **evaluate** advanced diagnostic and therapeutic techniques, including molecular diagnostics, and personalized medicine.
3. **Analyze** the advantages and limitations of drug use, and **interpret** the globally accepted protocols and ethical standards governing clinical trials.
4. **Critically assess** the impact of emerging biotechnological tools on public health and disease management.
5. **Design** a conceptual framework for improving disease diagnosis or treatment using innovative biotechnological approaches.

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Test /Assignment	10	70	**100**
Seminar	5		
Mid-Semester Exam	10		
Attendance	5		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTH402	CO1	3	2	–	–	–	–	–	–	3	2	–	–
	CO2	3	2	–	–	–	2	–	–	3	2	–	–
	CO3	3	3	2	–	–	–	–	–	3	3	–	–
	CO4	3	2	2	–	–	–	–	–	3	2	–	–
	CO5	3	3	2	–	–	2	–	–	3	3	–	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any ten** of the following **3 x 10 = 30**

1.
2.
3.
4.
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12.

II) Section B

Answer **any five** of the following **5 x 5 = 25**

13.
14.
15.
16.
17.
18.
19.
20.

III) Section C

Answer **any one** of the following **15 x 1 = 15**

21.
22.
23.

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DISCIPLINE CORE: GENOMICS AND PROTEOMICS

Course Title : BTH403 : GENOMICS AND PROTEOMICS (Hard Core)	
Course Code: **BTH403**	L-T-P per week: **4-0-0**
Total Contact Hours: **52**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **3h**
Model Syllabus Authors: **Curriculum Committee**	Summative Assessment Marks: **70**

Course Objectives:

The course aims at:

- Introducing students to the genome sequencing, the fine structure of genomes and the concepts of genome analysis
- Giving an overview about comparative genomics and its significance
- Elucidating the techniques used in the analysis of gene expression, including protein profiling and protein-protein interactions

Introducing the concept of metabolomics in order to understand the integration of all the omic

Content of Course 01: Theory: BTH403 : GENOMICS AND PROTEOMICS	**52 h**
Unit 1 **Introduction**:	**4h**
Concept of genomics, structural genomics, Functional Genomics, Transcriptomics, RNAmics proteomics, and metabolomics.	
Unit 2 **Genomics:**	**10 h**
Genome sequencing, Fluorescence method, automated sequencing, shot-gun approach. Clone contig method, Genome sequencing projects of *E.coli*., yeast, and human genome project. Genome sequence data bases, expressed sequenced tags (ESTs), Gene variation and Single Nucleotide Polymorphisms (SNPs), disease association, diagnostic genes and drug targets, genotyping - DNA Chips, diagnostic assays, Genome sequence analysis. Principle, salient features & drawbacks of methods of gene prediction / gene modeling: GRAIL, GENEMARK, GLIMMER. Promoter prediction methods.	
Unit 3: **Genome Analysis, Genome Organization and Structure:**	**15 h**
C-Values of genomes, Repetitive and coding sequences, Methods of physical mapping**.** Molecular markers, Hybridization based markers restriction fragment length polymorphism (RFLP‟s), random amplification of polymorphic DNA (RAPD‟s) and amplified fragment length polymorphisms (AFLP). Multiple arbitrary amplicon profiling using short oligonucleotide primers, SCAR, micro satellites and other markers, length polymorphisms in simple sequences repeats (SSR and ISSR). Approaches to mapping, fluorescence in-situ hybridization (FISH) - DNA amplification markers; Telomerase as molecular markers, T-DNA tagging, Transposon tagging, Features of Viral and Bacterial genomes . Organization of *E.coli* genome, Arabidopsis genome, Rice genome, Human genome, Unusual structure of Y chromosome, Chloroplast and Mitochondrial genomes. Commercializing the genomics, polymorphisms, Personalised medicine.	

Unit 4: **Functional and Comparative Genomics:**	**5 h**
Transcriptomes-transcripts of a tissue, use of Northern blot, substractive and additive library, Rnase protection assay, RT-PCR, Analysis of steady state gene expression by EST tags and cDNA library, Microarray techniques, sequence analysis of gene expression (SAGE). Massively parallel signature sequencing (MPSS), Expression profiling in human diseases. Orthologs, homologs, paralogs, gene evolution, protein evolution by exon shuffling, comparative genomics of closely related bacteria.	
Unit 5: **Proteomics:**	**10 h**
Expression analysis and characterization of proteins-separation of proteins-2D PAGE (2DGE), multiplexed analysis, multidimensional liquid chromatography, high throughput screening by Mass spectrometry, MALDI-TOF, peptide fingerprinting, protein micro array- antibody arrays, antigen arrays, general protein arrays, biochips. Analysis of protein structures-Sequence analysis by Tandem Mass Spectrometry, structure prediction, X-ray, NMR and CD and Bio-informatic approaches. Protein–protein interactions-genetic, comparative genomic, biochemical approaches. Large scale analysis of protein intreractions-yeast two hybrid interaction screens, post-translational modification analysis, proteomics databases & analysis.	
Unit 6 **Metabolomics:**	**8 h**
Concepts, Levels of metabolite analysis, metabolomics in humans, sample selection and handling, over view of different methods used for analysis of metabolites. Metabolic regulation network at genome level, Basic concept of metabolic engineering.	

References:

1. Peter M Gresshoff .Plant Genome Analysis (1st Ed.), CRC Press.UK.1994
2. John R S Finchman. Genetic Analysis – Principles, Scope and Objectives (1st Ed.). Blackwell Science. Singapore.1994.
3. Smith D.W. Biocomputing Informatics and the Genome Projects (1st Ed.) Academic Press.USA.1993.
4. Benjamin Lewis. Genes VIII (7th Ed.). Oxford University & Cell Press.UK.1999
5. Benjamin Lewis. Genes IX (9th Ed.). Jones and Bartlett publishres.USA. 2007
6. Principles of Gene manipulation and Genomics, SB Primrose and RM. Twyman, 7th Ed.). Blackwell publishers.UK.2007
7. Dubitzky W et al. Fundamentals of data mining in genomics and proteomics (1st Ed.) Springer publishres.USA.2007
8. Liebler D C. Introduction to Proteomics-Tools for the New Biology (2nd Ed.).John R. Humana Press Totowa. NJ. 2002
9. Terence A B.Genomes (2nd Ed.).Bios Scientific Publishers.UK.2002
10. Griffiths AJF.An Introduction to Genetic Analysis (7th Ed.). W. H. Freeman publisher.NY.2000
11. Michel Blot. Prokaryotic Genomics (1 Ed.) Springer publishers.2002
12. Josip Lovric Introducing Proteomics: From concepts to sample separation, mass spectrometry and data analysis. Wiley-Blackwell publishers.UK.2011

13. Richard Twyman, Principles of Proteomics (1st Ed.).Wiley-Blackwell publishers.UK.2004

Course Outcomes :

At the end of the course, The students will be able to:

1. **Explain** the relationship between genome sequence and organismal complexity, considering gene content, regulatory elements, and non-coding regions.
2. **Evaluate** the connection between genotypes and phenotypes by interpreting genetic variation, expression patterns, and molecular traits.
3. **Analyze** experimental techniques such as protein-protein interaction assays, mass spectrometry, and structural biology tools to study protein function and biomolecular interactions.
4. **Integrate** knowledge of biochemical pathways with signal transduction mechanisms, gene regulation networks, and protein structure-function relationships.
5. **Design** experimental approaches to investigate molecular mechanisms underlying organismal traits.

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Assessment - Theory			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Theory Exam**	
Test /Assignment	10	70	**100**
Seminar	5		
Mid-Semester Exam	10		
Attendance	5		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTH403	CO1	3	2	2	–	–	–	–	–	3	2	–	–
	CO2	3	2	2	–	–	–	–	–	3	2	–	–
	CO3	3	3	2	–	–	–	–	–	3	3	–	–
	CO4	3	2	2	–	–	–	–	–	3	2	–	–
	CO5	3	3	2	–	–	–	–	–	3	3	–	–

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Theory Question Paper Scheme

I) Section A

Answer **any ten** of the following **3 x 10 = 30**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

II) Section B

Answer **any five** of the following **5 x 5 = 25**

13.
14.
15.
16.
17.
18.
19.
20.

III) Section C

Answer **any one** of the following **15 x 1 = 15**

21.
22.
23.

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IV SEMESTER PRACTICAL

Course 03: Practical: BTP404: BIOPROCESS ENGINEERING AND MEDICAL BIOTECHNOLOGY	
Course Title: **BIOPROCESS ENGINEERING AND MEDICAL BIOTECHNOLOGY**	Course Credits: **04**
Course Code: **BTP404**	L-T-P per week: **0-0-4**
Total Contact Hours: **26**	Duration of ESA/Exam: **04** h
Formative Assessment Marks: **30**	Summative Assessment Marks: **70**

Course objective:
This course aims at:

- Demonstrating simple biotechnological methods used in the production of economically important products
- Introducing the student to commonly used tests for the diagnosis of diseases/disorders

Experiments:

1. Study of fermentor- Demonstration.
2. Production and isolation of antibiotics (Pencillin and Streptomycin)
3. Production and analysis of Single cell protein (Spirulina and yeast)
4. Production of yoghurt and estimation of lactic acid at different time intervals
5. Production of wine
6. Estimation of percentage of alcohol, total acidity & volatile acidity in wine.
7. Production and assay of α-amylase from *Aspergillus niger*
8. Purification and assay of α amylase by simple precipitation using sodium sulphate, poly amines and organic solvents and immobilization
9. Blood urea analysis by diacetyl monoxyme method
10. Analysis of acid and alkaline phosphatase from serum samples
11. Estimation of serum cholesterol
12. Assay of SGOT enzyme activity
13. Assay of SGPT enzyme activity
14. Blood sugar analysis by Folin -Wu method
15. Estimation of Creatine and Creatinine from urine samples
16. Study of cancer cell and visit to cancer research Institute
16. Visit to industries/Biotech park-report to be submitted along with the record

Course Outcomes:
At the end of the course, The students will be able to:

1. **Operate** simple fermenters to produce selected commercial products by applying knowledge of design and process control parameters.
2. **Perform** diagnostic tests to determine diseased states, including biochemical, hematological, or microbial assays.
3. **Interpret** diagnostic reports and **analyze** clinical data to correlate findings with probable healthy or diseased conditions.
4. **Apply** biotechnological tools in both industrial and clinical settings to evaluate product quality and patient health indicators.
5. **Assess** experimental outcomes to improve fermentation efficiency and diagnostic accuracy.

Assessment - Practical			
Formative assessment		**Summative Assessment**	
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	**Total Marks**
Record	10	70	**100**
Attendance	5		
Practical Tests	15		
Total	**30**	**70**	

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTP404	CO1	3	2	2	2	–	–	–	–	3	2	3	2
	CO2	3	2	2	–	–	–	–	–	3	2	3	–
	CO3	3	3	2	2	–	–	–	–	3	3	3	2
	CO4	3	2	2	–	–	–	–	–	3	2	3	–
	CO5	3	3	2	2	–	–	–	–	3	3	3	2

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

Summative Assessment (ESE): Practical Question Paper Scheme

BTP404: BIOPROCESS ENGINEERING AND MEDICAL BIOTECHNOLOGY

Time: 04 hours **Maximum Marks: 70**

Section – A (Major experiments)

1. Estimate the percentage of lactic acid in the given sample. Write principle, procedure and comment on results.

15 Marks

2. Estimate the amount of serum cholesterol in the given sample. Write principle, procedure and comment on results. **15 Marks**

Section - B (Minor experiments)

3. Perform the assay of SGOT/SGPT enzyme activity **5 X 2 = 10 Marks**

4. Estimation of Creatine and Creatinine from urine samples **5 X 2 = 10 Marks**

5. Identify and comment on spotters **E & F** **5 X 2 = 10 Marks**

6. Viva-Voce

10 Marks

Scheme of valuation
Section – A (Major experiments)

1.	Performance	–	7 marks
	Principle	–	3 marks
	Procedure	–	2 marks
	Result & Comment	–	3 marks
2.	Performance	–	7 marks
	Principle	–	3 marks
	Procedure	–	2 marks
	Result & Comment	–	3 marks

Section - B (Minor experiments)

3.	Procedure (Steps Involved)	–	3 marks
	Result & Comment	–	2 marks
4.	Procedure (Steps Involved)	–	3 marks
	Result & Comment	–	2 marks
5.	Identification	–	1 mark
	Comment	–	4 marks
6.	Viva-voce	–	10 marks

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Course 03: Practical: BTP405: PROJECT WORK	
Course Title: **PROJECT WORK**	Course Credits: **06**
Formative Assessment Marks: **50**	Summative Assessment Marks: **100**

Course objective:

This course aims at:

- Enable students to apply theoretical concepts learned during their M.Sc. program to real-world biotechnological problems.
- Develop students' understanding of research design, experimental setup, data collection, and analysis specific to biotechnology.
- Foster the ability to critically evaluate scientific literature, identify gaps in research, and develop innovative solutions.
- Enhance practical laboratory skills, including advanced techniques in molecular biology, microbiology, biochemistry, and genetic engineering.
- Equip students with the ability to interpret experimental results, utilize statistical tools, and draw valid scientific conclusions.
- Develop time management, organization, and communication skills necessary for effective project execution, including budgeting, resource allocation, and collaboration.

Assessment - Practical				
Formative assessment		**Summative Assessment**		
Assessment Occasion / type	**Weightage in Marks**	**Assessment Occasion / type**	**Weightage in Marks**	**Total Marks**
Poster and PPT	25	Project Report	70	**150**
Presentation Skills (Synopsis + Colloquium)	25	Viva Voce	30	
Total	**50**	**100**		

Course Outcomes:

At the end of the course, The students will be able to:

1. **Design**, **execute**, and **analyze** a biotechnology research project by applying appropriate methodologies, experimental techniques, and data analysis tools.
2. **Demonstrate** advanced laboratory skills, including precise handling of equipment, accurate preparation of reagents, and adherence to experimental protocols.
3. **Critically analyze** experimental data to identify patterns, troubleshoot anomalies, and **draw informed conclusions** based on scientific evidence.
4. **Present** research findings effectively through well-structured written reports and oral presentations tailored to both academic and non-academic audiences.
5. **Collaborate** with peers, faculty, and industry professionals to foster interdisciplinary teamwork and **develop solutions** to complex biotechnological problems.
6. **Manage** research projects efficiently by balancing time, resources, and milestones, and **evaluate** progress toward defined objectives.
7. **Create** a personalized career pathway by integrating technical expertise, research experience, and communication skills to pursue roles in industry, academia, or advanced studies.

CO-PO-PSO Mapping

Course Code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
BTP405	CO1	3	3	3	3	3	–	–	–	3	3	3	3
	CO2	3	3	3	3	3	–	–	–	3	3	3	3
	CO3	3	3	3	3	3	–	–	–	3	3	3	3
	CO4	3	3	3	3	3	–	–	–	3	3	3	3
	CO5	3	3	3	3	3	–	–	–	3	3	3	3

3 = High Relevance ; 2 = Medium Relevance; 1 = Low Relevance; – = No Relevance

LIST OF MOOC COURSES OFFERED BY NPTEL SWAYAM

Course Title: Advances in Omics (July – September)	
Total Contact Hours: **8 weeks**	Course Credits: 0**2**
CRITERIA TO GET A CERTIFICATE ***(As per the guidelines of NPTEL)*** • Average assignment score = 25% of average of best 6 assignments out of the total assignments given in the course. • Exam score = 75% of the proctored certification exam score out of 100 • Final score = Average assignment score + Exam score • Please note that assignments encompass all types (including quizzes, programming tasks, and essay submissions) available in the specific week. • A certificate will be awarded only if an average assignment score of at least 10/25 and an exam score of at least 30/75 are obtained. If either of the two criteria is not satisfied, the certificate will not be awarded even if a final score of 40/100 or more is secured. • The certificate will contain the name, photograph, and the score in the final exam along with the detailed breakup. The logos of NPTEL and IISER Bhopal will also be displayed on it.	
ABOUT THE COURSE: The course begins with a historical perspective to genomics and how the human genome project catalyzed the development of Next-Generation sequencing technologies. Instead of following a standard textbook format of chapters, the course is designed to use the latest articles in leading journals to keep the course focused on the recent advances in the field. However, the course is well grounded in the basics and exposes the students to practical NGS data analysis. In contrast to traditional course on genomics and proteomics, this course has a strong evolutionary flavor.	
INTENDED AUDIENCE: BE/ME/MS/BSc/MSc/PhD	
PREREQUISITES: Basics of biological molecules	

Content of Course: Theory: Advances in Omics	**8 weeks**
Unit 1	**Week 1**
Introduction to genomics: Historical perspective with examples from Human genome project and Advent of NGS. Genomic assembly approaches.	
Unit 2	**Week 2**
Detailed discussion of the principles of sequencing technologies and comparison of advantages and disadvantages. Applications and Challenges in the use of NGS technologies	
Unit 3	**Week 3**
Omics data avalanche: 1000 genomes project, ENCODE project, ExAC, TCGA	
Unit 4	**Week 4**

Importance of evolutionary viewpoint in genomics, Signatures of selection in primates (with prominent examples from Human studies), Whole-genome duplication, comparative and population genomics, tests of selection (codon based and site frequency-based tests).	
Unit 5	**Week 5**
Introduction to transcriptomics, proteomics and Integration of Multi-Omic data. Other types of omic datasets resulting from high-throughput use of assays (Ex: Repli-Seq, Ribo-Seq, Tag-Seq)	
Unit 6	**Week 6**
Omics databases organization and utility. NCBI, UCSC genome browser, Short Read Archive, Proteome Exchange, Peptide Atlas, KEGG	
Unit 7	**Week 7**
Introduction to linux, use of command line interface, Tutorial on analysis of NGS data (Genomics, Transcriptomics)	
Unit 8	**Week 8**
Course summary and Exam	

References:

Selected Readings: Latest papers and review articles in each topic (from journals including, but not limited to, Nature, Curr. Opin. Chem. Biol., Cell, Nature Biotech., Science, Trends series). This will be provided in the class.

Further details on instructor and course can be accessed at :
https://onlinecourses.nptel.ac.in/noc25_bt45/preview

Course Title: Cell Culture Technologies (August – October)	
Total Contact Hours: **8 weeks**	Course Credits: 0**2**

CRITERIA TO GET A CERTIFICATE ***(As per the guidelines of NPTEL)***

- Average assignment score = 25% of average of best 6 assignments out of the total assignments given in the course.
- Exam score = 75% of the proctored certification exam score out of 100
- Final score = Average assignment score + Exam score
- Please note that assignments encompass all types (including quizzes, programming tasks, and essay submissions) available in the specific week.
- A certificate will be awarded only if an average assignment score of at least 10/25 and an exam score of at least 30/75 are obtained. If either of the two criteria is not satisfied, the certificate will not be awarded even if a final score of 40/100 or more is secured.
- The certificate will contain the name, photograph, and the score in the final exam along with the detailed breakup. The logos of NPTEL and IIT Kanpur will also be displayed on it.

ABOUT THE COURSE:

The course will be a short primer to understand how 'animal cell culture technologies' have strengthen the bio-medical research from basic research to the modern drug discovery. Animal cell culture was first performed in the very first decade of 19th century. Since then, tremendous development has taken place in this field. The lectures will help the researcher to appreciate the developments during last hundred years and will help them to independently set up cell culture laboratories. For non-biologist, it will be an informal way to demystify the intriguing routes of biomedical research where cell culture is a very 'potent tool'.

INTENDED AUDIENCE: UG and PG students pursuing biology, biotechnology, zoology and bio-engineering.

PREREQUISITES: Biology at standard 10th (Secondary school examination)

Content of Course: Theory: Cell Culture Technologies	**8 weeks**
Unit 1	**Week 1**
Introduction & biology of cultured cells	
Unit 2	**Week 2**
Equipments, aseptic techniques, safety protocols	
Unit 3	**Week 3**
Culture vessels & media development	
Unit 4	**Week 4**
Serum-free medium development & sterilization	
Unit 5	**Week 5**
Primary culture, secondary culture, cloning & selection	

Unit 6	**Week 6**
Cell separation, characterization, differentiation & transformation	
Unit 7	**Week 7**
Contamination, cryo-preservation & cyto-toxicity	
Unit 8	**Week 8**
Organo-typic culture & specialized cell culture techniques	

References:

- Culture of Animal Cells by R Ian Freshney
- Cell culture technology: Recent advances and future prospects (Euroscicon Meeting Reports Book 1) by Bruserud, Øystein and Astrid Englezou
- Vertebrate Cell Culture II and Enzyme Technology: Volume 39 (Advances in Biochemical Engineering/ Biotechnology) by A.F. Bückmann and G. Carrea
- Animal Cell Culture and Technology (The Basics) (Garland Science)) by Michael Butler
- The Immortal Life of Henrietta Lacks by Rebecca Skloot

Further details on instructor and course can be accessed at :
https://onlinecourses.nptel.ac.in/noc25_bt80/preview

Course Title: Introduction to Proteomics (July – September)	
Total Contact Hours: **8 weeks**	Course Credits: 0**2**

CRITERIA TO GET A CERTIFICATE ***(As per the guidelines of NPTEL)***

- Average assignment score = 25% of average of best 6 assignments out of the total assignments given in the course.
- Exam score = 75% of the proctored certification exam score out of 100
- Final score = Average assignment score + Exam score
- Please note that assignments encompass all types (including quizzes, programming tasks, and essay submissions) available in the specific week.
- A certificate will be awarded only if an average assignment score of at least 10/25 and an exam score of at least 30/75 are obtained. If either of the two criteria is not satisfied, the certificate will not be awarded even if a final score of 40/100 or more is secured.
- The certificate will contain the name, photograph, and the score in the final exam along with the detailed breakup. The logos of NPTEL and IIT Bombay will also be displayed on it.

ABOUT THE COURSE:

This course introduces to the basic biology of proteins and the new advanced science called as proteomics which aims to look into the protein properties from a global perspective, i.e., not undertaking one protein at a time, but an entire set of proteins in the milieu. The course will cover in detail the two major aspects of proteomics i.e., Gel-based proteomics and Mass spectrometry-based proteomics. The gel-based module will cover different techniques like SDS-PAGE, 2-DE, 2D-DIGE etc. These techniques had a major contribution in transition from protein chemistry to proteomics. Mass spectrometry, on the other hand, is an advanced analytical technique for accurate mass measurement. In this module, we will discuss the basics of mass spectrometry, sample preparations, liquid chromatography, hybrid mass spectrometers and quantitative proteomics techniques such as iTRAQ, SILAC and TMT using mass spectrometry. The course will also provide the basic knowledge about sample preparation, mass spectrometry workflow, different chromatography technologies and quantitative proteomics.

INTENDED AUDIENCE: It would be applied to B.Sc., M.Sc. and MS.

PREREQUISITES: Any B.Sc. or M.Sc. The target audiences of this course are required to have a basic introduction to biology.

Content of Course: Theory: Introduction to Proteomics	**8 weeks**
Unit 1 : Basics of Proteins and Proteomics	**Week 1**
Lecture 1 : Introduction to amino acids Lecture 2 : Introduction to Proteins Lecture 3 : Protein folding & misfolding Lecture 4 : Introduction to Proteomics Lecture 5 : Lab session – Protein-protein interaction using label-free biosensors	
Unit 2 : Gel-based proteomics	**Week 2**
Lecture 6: Sample preparation and pre-analytical factors Lecture 7 : Sample preparation: Pre-analytical factors (contd.)	

Lecture 8 : Sample preparation: Protein extraction and quantification Lecture 9 : One-dimensional electrophoresis Lecture 10 : Introduction to 2-DE	
Unit 3 : Two-dimensional gel electrophoresis (2-DE)	**Week 3**
Lecture 11 : 2-DE: Second dimension, staining & destaining Lecture 12 : 2-DE: Gel analysis Lecture 13 : 2-DE Applications Lecture 14 : 2-DE Applications (contd.) & Challenges Lecture 15 : Lab session - Protein/peptide pre-fractionation using OFFGEL FRACTIONATOR & data analysis	
Unit 4 : Difference in gel electrophoresis (DIGE) & Systems Biology	**Week 4**
Lecture 16 : 2D-DIGE: Basics Lecture 17 : 2D-DIGE: Data analysis Lecture 18 : 2D-DIGE: Applications Lecture 19 : Systems biology and proteomics – I Lecture 20 : Systems biology and proteomics - II	
Unit 5 : Basics of mass spectrometry	**Week 5**
Lecture 21 : Fundamentals of mass spectrometry Lecture 22 : Chromatography technologies Lecture 23 : Liquid chromatography Lecture 24 : Mass spectrometry: Ionization sources Lecture 25 : Mass spectrometry: Mass analyzers	
Unit 6 : Basics of mass spectrometry and sample preparation	**Week 6**
Lecture 26 : MALDI sample preparation and analysis Lecture 27 : Hybrid mass spectrometry configurations Lecture 28 : Lab session - Demonstration of Q-TOF MS technology Lecture 29 : In-gel & in-solution digestion Lecture 30 : Lab session - Sample preparation: tissue sample preservation technology	
Unit 7 : Quantitative proteomics	**Week 7**
Lecture 31 : Introduction to quantitative proteomics Lecture 32 : SILAC: In vivo labelling Lecture 33 : iTRAQ: In vitro labelling Lecture 34 : TMT: In vitro labelling Lecture 35 : Quantitative proteomics data analysis	
Unit 8 : Advancement in Proteomics	**Week 8**
Lecture 36 : Proteomics applications Lecture 37 : Challenges in proteomics Lecture 38 : OMICS and translational research Lecture 39 : Lab session – Targeted proteomics using triple quadrupole mass spectrometry Lecture 40 : Lab session – Targeted proteomics: multiple reaction monitoring	

Further details on instructor and course can be accessed at :
https://onlinecourses.nptel.ac.in/noc25_bt80/preview

Course Title: Cell Signaling (August – October)	
Total Contact Hours: **8 weeks**	Course Credits: 0**2**

CRITERIA TO GET A CERTIFICATE ***(As per the guidelines of NPTEL)***

- Average assignment score = 25% of average of best 6 assignments out of the total assignments given in the course.
- Exam score = 75% of the proctored certification exam score out of 100
- Final score = Average assignment score + Exam score
- Please note that assignments encompass all types (including quizzes, programming tasks, and essay submissions) available in the specific week.
- A certificate will be awarded only if an average assignment score of at least 10/25 and an exam score of at least 30/75 are obtained. If either of the two criteria is not satisfied, the certificate will not be awarded even if a final score of 40/100 or more is secured.
- The certificate will contain the name, photograph, and the score in the final exam along with the detailed breakup. The logos of NPTEL and IISER Bhopal will also be displayed on it.

ABOUT THE COURSE:

The course will emphasize on the fact that all living beings respond to environmental as well as cues initiated from other living organisms. Our growth (post-partum and embryonic more so) is well connected to responses we mount to the signaling. In this Course I will primarily focus on how living beings engage in signaling to stay healthy and grow normally. The focus will largely be on the receptors prevalent in the animal kingdom primarily in Mammals, but I will also introduce aspects of microbial and plant signaling events.

PREREQUISITES: A course in Cell Biology and Molecular Biology

Content of Course: Theory: Cell Signaling	**8 weeks**
Unit 1	**Week 1**
Cell signaling, components and types of signaling	
Unit 2	**Week 2**
Types of ligand, regulation of ligand, receptor binding proteins, G-proteins and signaling	
Unit 3	**Week 3**
Kinases, Types of receptors, Mechanoreceptors, Structure and Function, Receptor activation, modes of intracellular signaling	
Unit 4	**Week 4**
Signaling in Microbial world, Two-component signaling	
Unit 5	**Week 5**
Receptors Serine-threonine kinase, diversity in receptor activation	
Unit 6	**Week 6**

Discovery of Tyrosine kinases, Receptor tyrosine kinase (RTK) signaling ,diversity in RTKs	
Unit 7	**Week 7**
Growth factor signaling, cancer and diseases due to RTK malfunction	
Unit 8	**Week 8**
G-protein coupled receptor (GPCRs), G-proteins type, regulation of GPCR signaling	

References:

- Molecular Biology of Cell by Bruce Alberts
- Published research and review articles

Further details on instructor and course can be accessed at :
https://onlinecourses.nptel.ac.in/noc25_bt88/preview

Course Title: Computer Aided Drug Design (July – September)	
Total Contact Hours: **8 weeks**	Course Credits: 0**2**

CRITERIA TO GET A CERTIFICATE *(As per the guidelines of NPTEL)*

- Average assignment score = 25% of average of best 6 assignments out of the total assignments given in the course.
- Exam score = 75% of the proctored certification exam score out of 100
- Final score = Average assignment score + Exam score
- Please note that assignments encompass all types (including quizzes, programming tasks, and essay submissions) available in the specific week.
- A certificate will be awarded only if an average assignment score of at least 10/25 and an exam score of at least 30/75 are obtained. If either of the two criteria is not satisfied, the certificate will not be awarded even if a final score of 40/100 or more is secured.
- The certificate will contain the name, photograph, and the score in the final exam along with the detailed breakup. The logos of NPTEL and IIT Madras will also be displayed on it.

ABOUT THE COURSE:

Drug discovery and development is a time consuming and expensive process., taking about 10 years and costing about US 1.0 B dollars. Several candidates that enter clinical trials fail because of several reasons. Computer assisted drug design can speed up the process, reduce surprises and predict the properties, thereby reduce the cost of R&D. The course will cover structure and target based design, molecular modeling, quantum mechanics, drug likeness properties, QSAR and pharmacokinetic and dynamics using several softwares that are freely available.

INTENDED AUDIENCE: Biotech/Pharmaceuticals/Bioinformatics /Chemistry and allied programmes and research scientists in biotechnology and pharma industries and clinicians/medical practioners

PREREQUISITES: Prior knowledge of biochemistry, bioinformatics

Content of Course: Theory: Computer Aided Drug Design	**8 weeks**
Unit 1	**Week 1**
Introduction to drug discovery	
Unit 2	**Week 2**
Structure and property	
Unit 3	**Week 3**
ADME-rules	
Unit 4	**Week 4**
Force field/MM/QM	
Unit 5	**Week 5**
Boundary conditions/Conformation	

Unit 6	**Week 6**
QSAR/Pharmacophore	
Unit 7	**Week 7**
Enzymes/proteins structures/docking	
Unit 8	**Week 8**
PK/PD	

References:

- Voit E (2012) A First Course in Systems Biology. Garland Science, 1/e. ISBN 0815344678
- Klipp E (2009) Systems biology: a textbook. Wiley-VCH, 1/e. ISBN 9783527318742
- Newman MEJ (2011) Networks: an introduction. Oxford Univ. Press. ISBN 9780199206650

Further details on instructor and course can be accessed at :
https://onlinecourses.nptel.ac.in/noc25_bt62/preview

Course Title: Data Analysis For Biologists (January - March)	
Total Contact Hours: **8 weeks**	Course Credits: 0**2**

CRITERIA TO GET A CERTIFICATE ***(As per the guidelines of NPTEL)***

- Average assignment score = 25% of average of best 6 assignments out of the total assignments given in the course.
- Exam score = 75% of the proctored certification exam score out of 100
- Final score = Average assignment score + Exam score
- Please note that assignments encompass all types (including quizzes, programming tasks, and essay submissions) available in the specific week.
- A certificate will be awarded only if an average assignment score of at least 10/25 and an exam score of at least 30/75 are obtained. If either of the two criteria is not satisfied, the certificate will not be awarded even if a final score of 40/100 or more is secured.
- The certificate will contain the name, photograph, and the score in the final exam along with the detailed breakup. The logos of NPTEL and IIT Guwahati will also be displayed on it.

ABOUT THE COURSE:

Analysis of data is an integral part of biology, both in academic research and the Industry. With the advent of high-throughput techniques, biological data analysis has crossed the realm of classical statistical techniques and now involves techniques used by the wider data analytic and machine learning community. It is now expected that every biology student is acquainted with the key concepts and tools of data analysis. This course is designed specifically for biology students to learn the key concepts, applications, and limitations of commonly used data analysis techniques. This course emphasizes visualization and analysis of higher-dimensional data, like clustering, classification, and dimensionality reduction.

INTENDED AUDIENCE: Students of different areas of Biology, Biotechnology, and allied subjects

Content of Course: Theory: Data Analysis For Biologists	**8 weeks**
Unit 1	**Week 1**
Basic concepts of probability and statistics	
Unit 2	**Week 2**
Basic concepts of linear algebra	
Unit 3	**Week 3**
Basics of R	
Unit 4	**Week 4**
Data visualization	
Unit 5	**Week 5**
Correlation and regression	
Unit 6	**Week 6**

Clustering and classification, Correlation and regression	
Unit 7	**Week 7**
Clustering and classification	
Unit 8	**Week 8**
Analysis of higher-dimensional data	

References:

Reading materials, links for online resources, Excel files and R codes will be provided by the instructor and will be adequate enough for this course.

Reference books:

- Whitlock, Michael C.; Schluter, Dolph. The Analysis of Biological Data (2nd edition). Freeman, W. H. & Company, 2014.
- Yang, Zheng R.; Machine Learning Approaches to Bioinformatics. World Scientific, 2010.
- Moses, Alan; Statistical Modeling and Machine Learning for Molecular Biology. Chapman and Hall/CRC, 2016.
- Hartvigsen, Gregg. A Primer in Biological Data Analysis and Visualization Using R, (1st Edition). Columbia University Press, 2014.
- Stewart, James; Day, Troy; Biocalculus: Calculus for Life Sciences. Cengage Learning, 2015
- James, Gareth, etal. An introduction to statistical learning with application in R. Vol. 112. New York: springer, 2013.

First edition can be downloaded from the website https://www.statlearning.com/Further details on instructor and course can be accessed at : https://onlinecourses.nptel.ac.in/noc25_bt16/preview

Course Title: Biological data analysis and visualization with R (February – April)	
Total Contact Hours: **8 weeks**	Course Credits: 0**2**

CRITERIA TO GET A CERTIFICATE *(As per the guidelines of NPTEL)*

- Average assignment score = 25% of average of best 6 assignments out of the total assignments given in the course.
- Exam score = 75% of the proctored certification exam score out of 100
- Final score = Average assignment score + Exam score
- Please note that assignments encompass all types (including quizzes, programming tasks, and essay submissions) available in the specific week.
- A certificate will be awarded only if an average assignment score of at least 10/25 and an exam score of at least 30/75 are obtained. If either of the two criteria is not satisfied, the certificate will not be awarded even if a final score of 40/100 or more is secured.
- The certificate will contain the name, photograph, and the score in the final exam along with the detailed breakup. The logos of NPTEL and IIT Kharagpur will also be displayed on it.

ABOUT THE COURSE:

The proposed course aims to provide an understanding of the data analysis techniques and visualization tools for analysis of biological data sets. The course will use the statistical programming language R and introduce requisite packages for such analyses and visualization. The course will cover the theoretical understanding of the methods of analyses and will also provide hands-on demonstration on real biological datasets. The students will thus be able to gain exposure to data analysis and visualization tools which will be directly applicable to real-world datasets.

INTENDED AUDIENCE: UG/PG/PhD students

PREREQUISITES: Introduction to R software

Introduction to R Software: https://nptel.ac.in/courses/111104100

Content of Course: Theory: Biological data analysis and visualization with R	8 weeks
Unit 1	**Week 1**
Introduction and set up for biological data analysis with R	
Unit 2	**Week 2**
Basic statistical analysis and data visualization techniques	
Unit 3	**Week 3**
Bioconductor packages	
Unit 4	**Week 4**
Gene expression analysis and co-expression network	
Unit 5	**Week 5**
Analysis of ChIP-seq data in R	
Unit 6	**Week 6**

Regression models on biological data	
Unit 7	**Week 7**
Dimensionality reduction techniques	
Unit 8	**Week 8**
Decision trees and Random Forest	

References:

- Introduction to Bioinformatics with R: A Practical Guide for Biologists (Chapman & Hall/CRC Computational Biology Series)
- R Programming for Bioinformatics (Chapman & Hall/CRC Computer Science & Data Analysis)
- A Little Book of R for Bioinformatics 2.0 (brouwern.github.io)

Further details on instructor and course can be accessed at :
https://onlinecourses.nptel.ac.in/noc25_bt43/preview