DEPARTMENT OF BIOTECHNOLOGY
RAJAH SERFOJI GOVERNMENT COLLEGE (Autonomous)
THANJAVUR-613005
BOARD OF STUDIES MEETING

The board of studies meeting for the Department of Biotechnology was conducted on **Tuesday (05.01.2021)** at **2:00 pm** during the academic year 2020-2021 in the presence of the following board members under the chairmanship of **Dr. K. RAMESH KUMAR**

S. No	Name		Address	Signature
1	**Dr. K. RAMESH KUMAR**	Chairperson	Head, Department of Biotechnology	5/1/2021
2	**Dr. M. MANIKAVASAGAM**	University Nominee	Assistant Professor Dept. of Biotechnology Bharathidasan University Tiruchirappalli-620024	ABSENT
3	**Dr. S. ACHIRAMAN**	Subject Expert	Associate Professor Dept. of Environmental Biotechnology Bharathidasan University Tiruchirappalli-620024	5/1/2021
4	**Dr. S. MEENAKSHI SUNDARAM**	Subject Expert	Assistant Professor Dept. of Biotechnology Nehru Memorial college, Puthanampatti - 621007	ABSENT
5	**Mr. A. PANDIKUMAR**	Industrialist	Boeringer Ingeheim India Pvt. Ltd Business development manager, Woraiyur, Tiruchirappalli-620003	ABSENT
6	**Dr. J. RAJESH SINGH**	Faculty Member	Assistant Professor, Dept of Biotechnology	5/1/21
7	**Dr. K. GIRIJA**	Faculty Member	Guest Lecturer, Dept of Biotechnology	05/01/21
8	**Dr. A. SATHYA**	Faculty Member	Guest Lecturer, Dept of Biotechnology	05/01/21

The syllabi for B.Sc. Biotechnology (Major) under CBCS system were discussed and necessary corrections/modifications were made in the paper and finalized. The finalized syllabi are approved and appended herewith

CHAIRMAN

5/1/2021

(K.RAMESHKUMAR)

CONTROLLER OF EXAMINATIONS,
RAJAH SERFOJI GOVERNMENT COLLEGE (AUTONOMOUS),
THANJAVUR 613 005.

Head, Dept. of Biotechnology
Rajah Serfoji Govt College (Auto)
Thanjavur - 613005 Tamilnadu

Credits	5	Hours/Week	6	Sub Code	S1BT1	Semester	I
Medium of Instruction : English						Core Course : 1	

GENERAL MICROBIOLOGY

Objectives:

1. To offer a sense of the history of microbial science, its methodology and its many contributions to humanity
2. To impart the knowledge on microbiology and microbial diseases.

Unit I: History of Microbiology, classification, and nomenclature of microorganisms. Microscopy: Light and Electron microscopy. Microscopic examination of microorganisms- morphology and fine structure of bacteria.

Unit II: Sterilization Methods - Principles and applications - Physical and chemical methods. Staining techniques - Principle and types; Negative and Differential Staining.

Unit III: Culture medium, growth cycle, impact of environmental factors on growth of microbes, nutritional classification of microbes, Energy production; oxidation and reduction reactions, aerobic and anaerobic processes.

Unit IV: Sources of microbial infection: Portals of entry and exit of pathogenic microbes. Bacterial diseases of man- tetanus, tuberculosis, pneumonia and cholera. Viral Disease- AIDS (HIV).

Unit V: Applications of microbes in medicine- antibiotics; penicillin and streptomycin. In Agriculture - Biofertilizer –bacteria and cyanobacteria. In food and diary industries. Microbial bio-products (SCP, Bio-pigments, yeast –products and enzymes)

Learning Outcomes:

1.Students acquainted the historical account and development of microbiology as a scientific discipline.
2.They also gained knowledge on different types of sterilization and staining techniques.
3.They acquired an overview of growth requirements of microorganisms.
4.They attained detailed information on sources of microbial infection.
5.Students gained detailed information about applications of microbes in various fields.

Text Books:

1. Michael J. Pelczar, Chan, E.C.S and Noel R. Kreig, (2011). Microbiology, 7th edition, McGraw Hill.
2. Joaenne Wille, Linda Sherwood and Christopher Woolverton, (2011). Prescott Microbiology, 11th edition, Mc Graw Hill.

Reference Books:

1. Jawetz, Melnick and Adelbergs Geo F. Brooks, (2012). Medical Microbiology, 26th edition, Lange Med.
2. Roger Stainer, (1986). General Microbiology, 5th edition, Prentice Hall.
3. Hans Zinnser, Wolfgang K. Joklik, (2010). Zinsser's Microbiology, 11th edition, McGraw-Hill Professional.
4. Michael T. Madigan, John M. Martinko, Paul V. Dunlap, David. P clark, (2009) Brock Biology of microorganisms, 12th edition, Prentice Hall.

Web links:

1. https://www.britannica.com/science/microbiology/The-study-of-microorganisms
2. https://milnepublishing.geneseo.edu/suny-microbiology-lab/chapter/differential-staining-techniques/
3. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=5209
4. https://www.medicalnewstoday.com/articles/196271#causes
5. https://vikaspedia.in/agriculture/agri-inputs/bio-inputs/bioinputs-for-nutrient-management/biofertilizers

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A:	Two Questions from each Unit (No choice)	(10x 2 = 20 Marks)
Part - B:	Either or Questions (One pair from each Unit)	(5 x 5 = 25 Marks)
Part - C:	Three out of Five Questions (One from each Unit)	(3x10 = 30 Marks)

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Credits	4	Hours/Week	3	Sub Code	S1BTP1	Semester	I
Medium of Instruction : English						Core Course : 2	

MAJOR PRACTICAL – I

GENERAL MICROBIOLOGY

1. Laboratory rules and regulations of microbiology.
2. Staining Techniques - Ssimple, Gram's, spore and capsule.
3. Fungal staining - Wet Mount technique
4. Microscope and its functions.
5. Media preparation and sterilization (Bacteria and Fungi).
6. Enumeration of microorganism from soil, water and air - serial dilution technique.
7. Pure culture technique - Pour plate, Spread plate and Streak plate methods.
8. Biochemical characterization of selected bacteria.

Spotters:

1. Autoclave
2. Hot air oven
3. Incubator
4. pH meter
5. EMB agar
6. Blood agar plate
7. Capsule structure
8. Inoculation loop
9. Laminar flow
10. Petri plate
11. *Aspergillus*
12. *Saccharomyces cerevisiae*

Learning outcomes:

1. Students able to isolate micro organisms from different sources.
2. They know the procedure for morphological and cultural characterization of bacteria and fungi.
3. They also gained knowledge on different types of staining methods.

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Credits	5	Hours/Week	6	Sub Code	S2BT2	Semester	II
Medium of Instruction : English						Core Course : 3	

CELL BIOLOGY AND GENETICS

Objectives:

1. To understand the concept of cell, their organelles and functions.
2. To know the basics of genetics and mutation.

Unit I: Cell as a basic Unit. Cell theory. Classification of cell types, specialized cells such as motile, nerve and muscle cells. Ultrastructure of prokaryotic and eukaryotic cells. Comparison of microbial, plant and animal cell.

Unit II: Cellular organization - plasma membrane, cell wall, their structural organization, transport of nutrients, ions and macromolecules across the membranes. Cellular energy transactions - Role of mitochondria and chloroplast. Cellular organelles (Cytosol, nucleus, endoplasmic reticulum, golgi bodies, cytoskeleton, ribosomes, vacuoles, peroxisomes and lysosome).

Unit III: Cell division (Eukaryotic and Prokaryotic) - Cell cycle, Mitosis and Meiosis. Specialized chromosomes – Salivary gland and Lampbrush chromosomes.

Unit IV: Mendelism – Mendels work, laws of heredity, Test cross, incomplete dominance. Genome organization – Solenoid model. DNA replication - chromosomal theory of inheritance.

Unit V: Mutation – Types. Spontaneous and induced. Mutagens - Physical and chemical. Transposable elements in prokaryotes and eukaryotes.

Learning Outcomes:

1 Students gained knowledge about the features of cell wall, plasma membrane, cell transport mechanisms and cytoskeleton
2.Students know the structures and functions of the nucleus and different cell organelles.
3.They learned the mechanisms of cell division/cell cycle and its regulation
4. Students know about Mendelism and inheritance.
5.They acquainted basic and applied aspects of mutations and mutagenesis and their importance

Text Books:

1. E. D. P. De Robertis and E. M. F. De Robertis, Jr, (2006) Cell Biology and Molecular Biology, 8th edition. Lippincott Williams and Wilkins.
2. Verma and Agarwal, 1991, Cytology, S. Chand and company.

Reference Books:

1. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Kreiger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin, (2018). Molecular cell biology, 8th edition. W. H. Freeman publishers
2. E. J. Gardener, M. J. Simmons and D. P. Snustad, (2006) Principles of Genetics, 8th edition, John Wiley & Sons Publications.
3. S.C. Rastogi, (2006) Cell and Molecular Biology, 3rd edition, New Age International Publishers, New Delhi.

Web links:

1. https://courses.lumenlearning.com/boundless-biology/chapter/studying-cells/
2. https://www.bioexplorer.net/cellular-organization
3. https://askabiologist.asu.edu/cell-division
4. https://en.wikipedia.org/wiki/Mendelian_inheritance
5. https://geneticeducation.co.in/mutagen-definition-types-and-effect/

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A:	Two Questions from each Unit (No choice)	(10x 2 = 20 Marks)
Part - B:	Either or Questions (One pair from each Unit)	(5 x 5 = 25 Marks)
Part - C:	Three out of Five Questions (One from each Unit)	(3x10 = 30 Marks)

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Credits	4	Hours/Week	3	Sub Code	S2BTP2	Semester	II
Medium of Instruction : English						Core Course : 4	

MAJOR PRACTICAL – II

CELL BIOLOGY AND GENETICS

1. Measurement of cells - Micrometry
2. Structure observation – Prokaryotic & Eukaryotic cell
3. Motility determination - Hanging drop method
4. Identification of Polytene chromosome in Chironomous larvae.
5. Identification of Barr body in buccal cells.
6. Identification of various stages of mitosis in Onion root tip.
7. Identification of various stages of meiosis in Grasshopper testis.

Spotters:

1. Plant cell
2. Animal cell
3. Mitochondria
4. Chloroplast
5. Mitosis
6. Meiosis
7. Chromosome
8. Cell cycle
9. Transposons
10. Karyotype

Learning Outcomes:

1. Students know the procedure to measure the size of the cell.
2. They able to identify various stages of mitosis and meiosis
2. Students have the knowledge on different types of cell structures

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Credits	5	Hours/Week	6	Sub Code	S3BT3	Semester	III
Medium of Instruction : English						Core Course : 5	

MOLECULAR BIOLOGY

Objectives:

1. To learn about the nucleic acid structures and functions.
2. To understand the DNA repair mechanisms, promoter functions and its importance.
3. To study gene expression in prokaryotes and eukaryotes and gene organization.

Unit I: Nucleic Acids Structure and functions (DNA and RNA). Watson and Crick model of DNA and other forms of DNA (A and Z). Functions of DNA and RNA. DNA Replication in Prokaryotic and Eukaryotic.

Unit II: DNA Repair mechanisms; photo-reactivation, excision repair, mismatch repair, SOS repair. Recombination in prokaryotes Transformation, Conjugation and Transduction.

Unit III: Transcription in Prokaryotes and Eukaryotes. Mechanism of Promoters and RNA polymerase and transcription factors.

Unit IV: Translation. Mechanism of translation in Prokaryotes and Eukaryotes. Post translational modifications of proteins. Regulation of Gene expression in Prokaryotes - Operon concept (Lac and Tryp) and in Eukaryotes (galactose metabolism in yeast).

Unit V: Gene organization and expression in Mitochondria and Chloroplasts. Transposable elements in maize and *Drosophila.*

Learning outcomes:

1. Students acquired knowledge on nucleic acid structures, the definition of a gene and organization the genome.
2. They gained in-depth knowledge of DNA replication mechanism in prokaryotes and eukaryotes.
3. They have knowledge on the fundamental principles of transcription in prokaryotes and eukaryotes including RNA polymerase and transcription factors involved.
4. Students know the translational mechanism in both prokaryotes and eukaryotes.
5. They learned various mechanisms involved in regulation of gene expression in prokaryotes as well as eukaryotes.

Text Book:

1. David Freifelder, (1986). Molecular biology, 2nd edition, Jones and Bartlett learning.

Reference Books:

1. Benjamin Lewin, (2007). Gene IX, 9th edition, Jones and Bartlett publishers.
2. Rigby, P.W.J. (1987). Genetic Engineering, Academic Press Inc. Florida, USA.
3. T.A. Brown, (2011). Introduction to Genetics -A Molecular approach, 3rd edition, Garland Science.

Web links:

1.https://www.sciencedaily.com/terms/molecular_biology.htm

2. https://www.easybiologyclass.com/molecular-biology-online-tutorials-lecture-notes-study-materials

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A:	Two Questions from each Unit (No choice)	(10x 2 = 20 Marks)
Part - B:	Either or Questions (One pair from each Unit)	(5 x 5 = 25 Marks)
Part - C:	Three out of Five Questions (One from each Unit)	(3x10 = 30 Marks)

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Credits	4	Hours/Week	3	Sub Code	S3BTP3	Semester	III
Medium of Instruction : English						Core Course : 6	

MAJOR PRACTICAL – III

MOLECULAR BIOLOGY

1. Ames test for mutagenic agents

2. Isolation of bacteriophage from sewage water

3. Bacterial Conjugation - Demonstration

4. Estimation of DNA by DPA method.

5. Estimation of RNA by Orcinol method.

6. Extraction and estimation of protein from plant animal tissues.

7. Separation of protein by SDS- PAGE

Spotters

1. DNA
2. PAGE
3. Spectrophotometer
4. Conjugation
5. RNA polymerase
6. Ribosome
7. Lac operon
8. Tryp operon
9. IS elements
10. Transduction

Practical Out comes: Students

1. can follow general safety routines for laboratory work in molecular biology
2. can plan experimental work based on a protocol
3. can use instrumentation and gene technology methods for separation and analysis of proteins and nucleic acids.
4. can prepare DNA and RNA from various samples then interpret and report data both qualitatively and quantitatively

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Credits	2	Hours/Week	2	Sub Code	S3SB1D	Semester	III
Medium of Instruction : English						Skill Based : 1	

AQUACULTURE

Objectives:

1. To learn the history and scope of aquaculture.
2. To understand the different culture and breeding techniques used in aquaculture.

Unit I: Introduction and scope of aquaculture, aquaculture practices in India- Cultivable organisms Feed in intensive aquaculture – feed development, feed ingredients. Feed types and uses - wet feeds wet and moist formulated feeds, dry feeds and commercial feed types. Feed handling and storage.

Unit II: Preparation of fish pond- selection of site- construction of fish farm- liming irrigation- fertilization- water quality management.

Unit III: Types of culture- Monoculture, composite fish culture, monosex culture, Pen culture, cage culture. Culture of carp, milk fish and sea bass. Culture of fresh water prawn *Macrobrachium* spp, lobsters and crabs.

Unit IV: Production and economics of aquaculture in extensive and semi-intensive systems. Natural seed resources- seed production –seed grounds –methods of collection of seed for culture practices – quarantining – acclimatization of seeds.

Unit V: Collection and transportation of brood stock. Breeding under controlled conditions, brood stock management. Integrated fish farming – Paddy cum fish culture- fish cum poultry farming- fish cum dairy farming – fish cum pig farming

Outcomes:

1. Students know the historical and current status of aquaculture in India.
2. They also well versed in current culture system and associated basic engineering aspects
3. Students know about the types of aquaculture and formation of culture ponds
4. They identify the important macro and micro nutrients relevant to fish nutrition and feed formulation
5. They able to know feeding techniques, brood stock collection and transporation practices in aquaculture

Text Book:

1. Reddy S. M. (2004). A text Book of Aquaculture, Discovery Publishing Pvt. Ltd.

Reference Books:

1. Pillay. T. V. R., 1972. Coastal Aquaculture in the Indo-pacific Region, Fishing News Book Ltd., London.
2. Pillay, T.V.R., 1990. Aquaculture principles and practices. Fishing News (Book) Ltd., London
3. Shigueno, K., 1976. Shrimp culture in Japan. Association for international technical promotion, Tokyo.
4. Bardach, J.E., J.H.Ryther and W.O.McLarney, 1972. Aquaculture: Farming and Husbandry of Freshwater and Marine Organisms. Wiley interscience, New York.

Web links:

1. https://www.notesonzoology.com/india/aquaculture/aquaculture-characters-types
2. https://www.brainkart.com/article/Fish-Pond---Types-and-Preparation-of-pond,-Management-and-Feeding_815/
3. https://www.fao.org/3/t8598e/t8598e05.htm
4. https://www.ncrac.org/files/page/files/Chapter3.pdf

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A:	Two Questions from each Unit (No choice)	(10x 2 = 20 Marks)
Part - B:	Either or Questions (One pair from each Unit)	(5 x 5 = 25 Marks)
Part - C:	Three out of Five Questions (One from each Unit)	(3x10 = 30 Marks)

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Credits	5	Hours/Week	6	Sub Code	S4BT4	Semester	IV
Medium of Instruction : English						Core Course : 7	

INDUSTRIAL BIOTECHNOLOGY

Objectives:

1. To understand the utility of microbes in industries for the production commercially important products.
2. To learn about strain improvement, metabolic products and media formulations.
3. To study about different types of fermentation process and sterilization process.

Unit I: Isolation, screening and maintenance of industrially important microbes. Strain improvement for increased yield and other desirable characteristics. Microbial metabolic products – Primary and secondary metabolites.

Unit II: Media preparation for fermentation. Sterilization methods – Batch and continuous sterilization. Sterilization of air. Basic modes of fermentation (Batch, fed batch and continuous fermentation). Microbial growth kinetics.

Unit III: Basic design, parts of a typical fermentor/bioreactor. Types of fermentor -Air - lift, stirred tank, tower, fluidized bed, packed bed, pulsed and photo bioreactors. Different stages of fermentation process.

Unit IV: Measurement and control of bioprocess parameters - temperature, pressure, agitation and aeration, agitation, pH, computers in biocontrol. Downstream processing.

Unit V: Production of primary and secondary metabolites - Alcohol (Ethanol), Acids (Citric acid) Antibiotics (Penicillin), Amino acids (Lysine), Single Cell Protein (Algae / Fungi) and their applications. Biofertilizers. Mushroom cultivation.

Learning outcomes:

1.Students gained the knowledge in the techniques of isolation, screening, preservation and maintenance of industrially important microbial strains.
2. Students can able to explain the steps involved in the production of bioproducts and media used in fermentation process to improve modern biotechnology.
3.They gained proficient knowledge on design and operation of fermentor.
4.They learned the downstream processing
5.They attained in-depth knowledge on the principles of techniques used for production, extraction purification of industrial products.

Text Books:

1. Patel, A.H, (2007). Industrial Microbiology, Macmillan India Limited, New Delhi.
2. U. Satyanarayana, 2005, Biotechnology, Books and allied (P) Ltd, Kolkata

Reference Books:

1. Stanbury, P.F., Whitaker, A., and Stephen H., (Eds), (1995). Principles of Fermentation Technology, 2nd edition, Pergamon Press, Oxford.
2. Frazier, W.C. and Dennis C. Westhoff, (1995). Food Microbiology, Tata McGraw Hill Publishing Company, New Delhi.
3. Casida, L.E, (2003). Industrial Microbiology, New Age International (P) Ltd., New Delhi.
4. Michael Shuler and Fikret Kargi, (2002). Bioprocess Engineering: Basic Concepts, 2nd edition, Prentice Hall, Englewood Cliffs, NJ.

Web Links:

1.https://www.technicalsymposium.com/newbiotech_iiisem.html
2.http://www.gupshupstudy.com/classnotes/btech-31/biotechnology-3135/bioprocess-principles-353336
3. https://byjus.com/biology/metabolites/

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A:	Two Questions from each Unit (No choice)	(10x 2 = 20 Marks)
Part - B:	Either or Questions (One pair from each Unit)	(5 x 5 = 25 Marks)
Part - C:	Three out of Five Questions (One from each Unit)	(3x10 = 30 Marks)

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Credits	4	Hours/Week	3	Sub Code	S4BTP4	Semester	IV
Medium of Instruction : English						Core Course : 8	

MAJOR PRACTICAL – IV

INDUSTRIAL BIOTECHNOLOGY

1. Isolation of industrially important organisms for the production of amylase enzyme - *E. coli* on EMB Agar.
2. Amylase production test – Demonstration of starch hydrolysis
3. Cellulose production test – Degradation of cellulose.
4. Production of alcohol from grape juice.
5. Determination of quality of raw milk by methylene blue reductase test.
6. Determination of population growth by turbidometry (Spectrophotometric method)
7. Immobilization of Yeast cells.
8. Cultivation of paddy straw mushroom.
9. Process Control of Fermentor – Demonstration.

Spotters:

1. Yeast
2. Starch hydrolysis
3. Batch culture
4. Fermentor
5. Antifoaming agents
6. pH sensor
7. Agitator
8. *Spirulina*
9. Penicillin
10. Biofertilizer

Practical outcomes: Students have

1. gain hands-on experience and to learn the principles behind bioprocess technology
2. know the process involved in isolation, separation, manipulation of bioprocessing
3. Developing and assessing the conditions for efficient and sustainable design of bioprocesses and fermenter
4. apply the technology in pharmaceutical and any other industries

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Credits	2	Hours/Week	2	Sub Code	S4SB2B	Semester	IV
Medium of Instruction : English						Skill Based : 2	

BIOFERTILIZER

Objectives:

1. To learn the basics of biofertilizers and the valuable organisms involved.
2. To study the role of bacteria, Mycorrhiza in enriching the soil as biofertilizers.

Unit-I: Biofertilizers - Introduction, scope. A general account of Biofertilizers organisms - Cyanobacteria (BGA), Bacteria and Mycorrhizae – Cyanobacteria (BGA) as biofertilizers - *Anabaena, Cylindrospermum, Gloeocapsa, Lyngbya, Nostoc, Plectonema* and *Tolypothrix. Algalization, Azolla - Anabaena* as biofertilizers.

Unit II: Isolation of cyanobacteria. Formation of Fogg's medium – Mass cultivation of *Azolla* - Cyanobacterial biofertilizers - Symbiotic association of Cyanobacteria - Field application of Cyanobacterial inoculants.

Unit-III: Isolation - *Azotobacter* - Ashby's mannitol agar. *Azospirillum* - Semisolid medium (Bulow and Dobereiner, 1975). Rhizobium - Yeast Extract Mannitol Agar medium - Culture characteristics. Mass production of *Azospirillum, Azotobacter* and *Phosphobacteria*.

Unit IV: Bacterial biofertilizers - Introduction, scope. Bacterial biofertilizers organisms - *Azospirillum, Azotobacter, Frankia, Phosphobacteria* and *Rhizobium*. Vermicompost.

Unit V: Mycorrhizal fungi as biofertilizers - Introduction, scope. A general account of Ecto, Endo and *Arbuscular mycorrhizae* (AM). Legume - AM interactions - National and Regional Biofertilizers Production and Development Centres.

Learning outcomes:

1. Students acquired knowledge regarding biofertilizers and its consequences in the environment.
2. They developed skill regarding isolation, identification and mass production of bacterial biofertilizers, on blue green algal biofertilizer production and its application
3. They are familiar with the commonly used bacterial, fungal and cyanobacterial biofertilizers for different crops.
4. Students gained knowledge on biofertilizers and chemical fertilizers in increasing crop productivity.
5. Students get awareness to mitigate the usage of synthetic fertilizers.

Text Book:

1. Dubey, R. C. (2008). A Textbook of Biotechnology. S. Chand & Co., New Delhi.

Reference Books

1. Subba Rao, N. S. (2002). Soil Microbiology. 4th ed. Soil Microorganisms and Plant Growth. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Verma, A. (1999). Mycorrhiza. Springer Verlag, Berlin.
3. Wallanda, T. *et al*. (1997). Mycorrhizae. Backley's Publishers, The Netherlands.

Web Links:

1.https://www.onlinebiologynotes.com/biofertilizer-advantages-types-methods-of-application-and-disadvantages/
2. https://www.k-state.edu/fungi/Greeting/Publications_files/2006%20Handbook.pdf
3. https://www.bio-fit.eu/upload/Bio-Fit-Book/EN/Bio-FIT_Book_EN.pdf

Question Paper Pattern (Time: 3 Hours) (Marks: 75)

Part - A:	Two Questions from each Unit (No choice)	(10x 2 = 20 Marks)
Part - B:	Either or Questions (One pair from each Unit)	(5 x 5 = 25 Marks)
Part - C:	Three out of Five Questions (One from each Unit)	(3x10 = 30 Marks)

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Credits	5	Hours/Week	6	Sub Code	S5BT5	Semester	V
Medium of Instruction : English						Core Course : 9	

rDNA TECHNOLOGY

Objectives:

1. To learn about the molecular tools for gene cloning, gene manipulation techniques.
2. To give an insight into vectors for cloning and construction of gene libraries.

Unit I: Molecular tools for gene cloning: Nucleases: exonucleases and endonucleases, restriction enzymes (Type I, II, III, IV & V). Polymerases: DNA pol I, Klenow fragments, reverse transcriptase, Taq & pfu polymerases. Ligases: *E. coli* DNA ligase, T4 RNA ligase. Topoisomerases: Type I (A, B) & Type II (A, B). End modifying enzymes: Terminal transferases, T4 polynucleotide kinase, alkaline phosphatases.

Unit II: Vectors: Introduction and properties - plasmids, bacteriophage, phagemids, cosmids, Ti plasmids, BAC, YAC, shuttle vectors and expression vectors, viral vectors.

Unit III: Transfer of DNA into Cells - transformation, CaCl2 mediated, Ultra-sonication, Electroporation, Micro-injection, Macro-injection, Particle bombardment system and Liposome mediated gene transfer.

Unit IV: Cloning methods: Cloning in *E. coli*, Selection and screening of recombinants. DNA amplification- PCR. Blotting techniques - Southern, Western and Northern blot.

Unit V: Construction of genomic libraries and cDNA library, DNA sequencing methods - chemical degradation, chain termination. Application of rDNA Technology in animals - Production of Vaccine, Insulin, gene therapy.

Learning outcome:

1. Learn the available genetic engineering tool-box for manipulating genes
2. Our students have the capability to construct vectors
3. Students are familiar with various gene transfer mechanisms
4. Students able to handle the blotting techniques.
5. Students know to construct genomic and cDNA libraries.

Text Book :

1. Brown T.A. (2010). Gene Cloning and DNA Analysis: An Introduction, 6th Edition, Wiley Blackwell.

Reference Books :

1.Old, R.W and S.B. Primrose. (1996). Principles of Gene Manipulation: An Introduction to Genetic Engineering, Blackwell Scientific Publications, Oxford.
2. Glover, DM. and B.D. Hames. (1995). DNA Cloning: A Practical Approach, IRL Press, Oxford, Innis, Persing, D.H., K T.F Smith, F.C. Teower and T.J. While. (1993). Diagnostic Molecular Microbiology, ASM Press, Washington, D.C.

Web links:

1. https://www.brainscape.com/flashcards/chapter-20-recombinant-dna-technology-le-2936495/packs/4588677
2.https://nptel.ac.in/courses/102/103/102103013/
3.https://facultystaff.richmond.edu/~lrunyenj/bio554/
4.http://www.discoveryandinnovation.com/BIOL202

Question Paper Pattern (Marks: 75) (Time: 3 Hours)

Part - A:	Two Questions from each Unit (No choice)	(10x 2 = 20 Marks)
Part - B:	Either or Questions (One pair from each Unit)	(5 x 5 = 25 Marks)
Part - C:	Three out of Five Questions (One from each Unit)	(3 x10 = 30 Marks)

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Credits	4	Hours/Week	6	Sub Code	S5BTP5	Semester	V
Medium of Instruction : English						Core Course :10	

MAJOR PRACTICAL – V

rDNA TECHNOLOGY, BIOINSTRUMENTATION AND IMMUNOLOGY & IMMUNOTECHNOLOGY

I. rDNA TECHNOLOGY

1. Isolation of Genomic DNA from Bacteria
2. Isolation of Plasmid DNA
3. Agarose gel Electrophoresis
4. Isolation of RNA.
5. Restriction Digestion of DNA
6. Competent cell preparation, transformation and selection

II. BIOINSTRUMENTATION

1. SDS-PAGE
2. Southern blotting
3. PCR
4. UV- Spectrophotometer
5 UV- transilluminator
6. Centrifuge
7. pH meter

III. IMMUNOLOGY AND IMMUNOTECHNOLOGY

1. Haemagglutination – ABO blood grouping – Slide Method.
2. Bacterial agglutination – WIDAL – Slide method
3. Latex agglutination – ASO and pregnancy test – Slide method
4. Immunodiffusion (ODD)
5. Blood cell count (WBC, RBC and DC)

SPOTTERS

1. ELISA, 2) MAbs 3) *Taq* polymerase 4) pBR322 5) Haemocytometer 6) tRNA
7) Phagemids 8) Cosmid 9) Immunoglobulin 10) EcoR1

Practical Outcomes:

1. Students can plan and organize laboratory activities and develop further experimental strategies.
2. They learned working principles of laboratory equipment's - centrifuges; colorimeter; UV transilluminator, pH meter and electrophoresis,.
3. They acquired a practical methodology and goal-oriented working skills in recombinant DNA technology independently and in a team.
4. They know how to use the main methodologies and instruments that characterize serological test for the diagnosis of human diseases.

Credits	4	Hours/Week	6	Sub Code	S5BTEL1A	Semester	V
Medium of Instruction : English					Major Elective Course :1		

ENZYMOLOGY AND ENZYME TECHNOLOGY

Objectives:

1. To understand the basics of enzyme technology which includes structure, function and importance of enzymes and its wide industrial applications.
2. To obtain knowledge on enzyme kinetics and enzyme regulation

Unit I: Enzymes - history and general characteristics, definition and IUB enzyme classification. Properties of enzymes. Isozymes, abzymes, synzymes, holoenzyme, apoenzyme, coenzyme, cofactors, activators, inhibitors, active site, metallo enzymes.

Unit II: Enzyme kinetics - effect of pH, temperature, activator, enzyme and substrate concentration - Michaelis Menten plot and inhibitor kinetics (competitive, uncompetitive and non- competitive). Lineweaver Burk plot, Eadie-Hofstee plot and Hanes Woolf equation. Significance of Km and Vmax, Kcat, turnover number.

Unit III: Enzyme regulation - allosteric modification of enzymes, reversible covalent modification and proteolytic activation, enzymes in membranes, feedback inhibition and forward simulation. Irreversible inhibition- sucide inhibition.

Unit IV: Mode of enzyme action - lock and key hypothesis and induced fit hypothesis. Enzyme catalysis - acid base catalysis, bond catalysis, strain, proximity and orientation effects. Mechanism of action of lysozyme, chymotrypsin, enzyme substrate complex formation - bisubstrate (random and ping pong mechanism).

Unit V: Applications of enzyme technology- industrial enzymes- thermophilic enzymes, amylases, lipases, proteolytic enzymes. Clinical enzymes - thrombolytic agents, anti-inflammatory agents. immobilization of enzymes- advantages and disadvantages of immobilization techniques

Learning Outcomes:

After studying this paper, students will be able to:

1.Distinguish the fundamentals of enzyme properties, nomenclatures, characteristics and mechanisms

2.Apply biochemical calculation for enzyme kinetics

3.Compare methods for production, purification, characterization and immobilization of enzymes

4. Discuss various mechanisms of enzyme action

5.Discover the current and future trends of applying enzyme technology for the ommercialization purpose of biotechnological products.

Text Books:

1. Nooralabetu and Krishna Prasad, (2011). Enzyme technology. Eastern economy edition.
2. Palmer T. (2004). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, West Press Edition.

Reference Books:

1. Geoffrey L. Zubey., William. W. Parson and Dennis E. Vance. (1995). Principles of Biochemistry, W.M.C. Brown Publisher.
2. Stanbury, P.F., A. Whitaker and S.J. Hall. (1997). Principles of Fermentation Technology, Aditya Books Pvt. Ltd., India.

Web Links:

1. https://nptel.ac.in/courses/102/102/102102033/
2. https://microbenotes.com/enzyme-technology/
3. http://www.biologymad.com/studentswork/12%20-%20etnotes.pdf
4. https://www.kth.se/dib/enzyme-technology-1.783173
5. http://www1.lsbu.ac.uk/water/enztech/whither.html
6. https://bmcbiotechnol.biomedcentral.com/articles/sections/protein-and-enzyme-technology
7. http://www.odofin.com/enzyme%20technology.htm
8. https://www.thesciencenotes.com/enzyme-technology/
9. https://application.wiley-vch.de/books/sample/3527329897_c01.pdf

Question Paper Pattern (Marks: 75) (Time: 3 Hours)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)
Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)
Part - C: Three out of Five Questions (One from each Unit) (3 x10 = 30 Marks)

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Credits	4	Hours/Week	6	Sub Code	S5BTEL1B	Semester	V
Medium of Instruction : English					Major Elective Course :1		

BIOINSTRUMENTATION

Objectives:

1. To study the basics of analytical, physical chemistry for understanding instrumentation.
2. To understand the principles and applications of various analytical tools and techniques used in the field of Biotechnology.

Unit I: pH meter, Buffer of biological importance, Centrifuge- Preparative, Analytical and Ultra, Laminar Air Flow, Autoclave, Hot Air Oven and Incubator.

Unit II: Spectroscopic Techniques: Colorimeter, Ultraviolet and visible, Infra red and Mass Spectroscopy

Unit III: Chromatographic Techniques: Paper, Thin Layer, Column, HPLC and GC. Electrophoresis Techniques: Starch, Gel, AGE, PAGE.

Unit IV: Immunological Methods: Precipitation reaction based assays. Radial Immuno Diffusion, Immunoelectrophoresis, Counter Current.

Unit V: Complement Fixation Test, Radio Immuno Assay, ELISA, PCR, Immunoblotting and Hybridization, Autoradiography.

Learning outcome:

1. This enables the students to apply their acquired knowledge in isolation and separation of biomolecules for analysis.
2.Students have gained an in-depth knowledge of principles and applications of chromatography, spectrophotometry.
3.They comprehend details of working principle and outline of all biological techniques
4.Students know the procedures to operate all instruments for clinical diagnosis.
5.Students able to explain the importance of immunological methods

Text Books:

1. Keith Wilson, john walker, (2000). Practical Biochemistry, Cambridge university press
2. Kuby, J. (1997). Immunology, 3rd Edition, W.H. Freeman and Co.

Reference Books:

1. S. K. Sawhney and Randhir Singh, (2009). Introductory Practical Biochemistry, Narosa Publishing House.
2. Gedder A and L. E. Balsar, (1991). Principles of Applied Biomedical Instrumentation, 3rd edition, John Wiley and Sons.
3. Boyer, Rodney F. Benjamin and Cummins, (2000). Modern Experimental Biochemistry, 3rd edition, Pearson publisher.

Web links:

1. https://microbenotes.com/centrifuge-and-centrifugation/
2. https://www.biochemden.com/spectrophotometer-instrumentation-principle/
3. https://microbenotes.com/chromatography-principle-types-and-applications/
4. https://thebiologynotes.com/immunological-techniques/

Question Paper Pattern (Marks: 75) (Time: 3 Hours)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)
Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)
Part - C: Three out of Five Questions (One from each Unit) (3 x10 = 30 Marks)

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Credits	4	Hours/Week	6	Sub Code	S5BTEL1C	Semester	V
Medium of Instruction : English					Major Elective Course :1		

DEVELOPMENTAL BIOLOGY

Objectives:

1. To learn the reproductive cycles in mammals.
2. To study and gain insight in the developmental stages observed in plants and animals.

Unit I: Reproductive cycle in mammals, their hormonal control, gametogenesis – spermatogenesis and oogenesis. Fertilization, Artificial insemination, *in vitro* fertilization and Embryo Transfer.

Unit II: Types of eggs and patterns of cleavage, Blastulation, Gastrulation, Fate of germ layers, metamorphosis – retrogressive and progressive changes in insects and amphibians.

Unit III: Microsporogenesis, megasporogenesis, Pollen development, Gametrophytic amphimixis; Polyploidy; methods and application; Seeds – types, germination, Organogenesis.

Unit IV: Plant embryogenesis – techniques to study embryology, Embryo sacs in Anther Leptomenia, Calotis; Hyacinthus, Unusual embryological features – Loranthacease, Endosperimal embryos; Gynospermic characters in angiosperms, Types of embryos.

Unit V: Genetic control of development – Early experiments, Pattern determination, Bithorax Complex, Genes Controlling – Flower development and development of Drosophila.

Learning outcomes

1. On completion of this subject, the student should be able to use the developmental biology concepts in various fields.
2.Students have also well versed in the foundational knowledge that defines the fields of developmental biology.
3. They are able to understand the concepts clearly and effectively about developmental biology at the graduate level.
4. Students can able to explain the techniques of developmental biology to professional scientists, students and to a lay audience
5. The students can also able to explain the development process and its genetic control

Text Book:

1. B.I Balansky, (1981). An introduction to Embryology, 5th edition, W.B Saunders and co, Philadelphia.

Reference Books:

1. Bhojwani S. S., Bhatnagar S. P and Dantu P. K, (2014).The embryology of Angiosperms, 6th edition. Vikas publishing House.
2. Werner A. Mueller, (2008). Developmental Biology, Springer.
3. Verlec and Jhori B.M., (1982). The embryology of Angiosperms, Springer
4. Maheswari. P, (1981). Introduction to the embryology of Angiosperms, McGraw Hill.

Web links:

1. https://embryology.med.unsw.edu.au/embryology/index.php/Reproductive_Cycles
2. https://en.wikipedia.org/wiki/Human_fertilization
3. http://nsdl.niscair.res.in/jspui/bitstream/123456789/820/3/Metamorphosis
4. https://opentextbc.ca/biology/chapter/13-2-development-and-organogenesis/
5. https://en.wikipedia.org/wiki/Plant_embryogenesis
6. http://www.hhmi.ucla.edu/derobertis/teaching/lecture_1.pdf

Question Paper Pattern (Marks: 75) (Time: 3 Hours)

Part - A:	Two Questions from each Unit (No choice)	(10x 2 = 20 Marks)
Part - B:	Either or Questions (One pair from each Unit)	(5 x 5 = 25 Marks)
Part - C:	Three out of Five Questions (One from each Unit)	(3 x10 = 30 Marks)

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Credits	4	Hours/Week	6	Sub Code	S5BTEL2A	Semester	V
Medium of Instruction : English					Major Elective Course :2		

IMMUNOLOGY AND IMMUNOTECHNOLOGY

Objectives :

1. To study the organs of the immune system, types of immunity, hypersensitivity.
2. To impart knowledge into Immunodiagnostic techniques.
3. To learn about the auto immunity and cancer.

Unit I: Introduction - History and scope of Immunology. Haematopoiesis. Organs of the immune system: bone marrow, thymus, spleen, lymph nodes, MALT, peyer's patches, tonsils.

Unit II: Types of immunity - innate, acquired immunity, cells involved in innate and acquired immunity. Structure and functions of cytokines. Antigen - types, immunoglobulins - types, distribution and functions. T & B Cells - receptors, activation and function.

Unit III: Cellular interactions in immune response, hypersensitivity reactions- Type I, II, III and IV. HLA Tissue typing, transplantation immunity, monoclonal antibody production.

Unit IV: Autoimmune disorders and immunology of infectious diseases including AIDS. Introduction to tumor immunology - Immune evasion - Immune suppression. Cancer genetics- oncogenes, tumor suppressor genes, cancer and cell cycle, metastasis

Unit V: Immunodiagnostics - precipitation, agglutination, Widal test, pregnancy test. Immuno blotting techniques - ELISA and FISH.

Learning outcomes

1. The students after successfully completing this subject would be aware of immune system structure and functions.
2. Students well explain the concepts of innate and adaptive immune response and techniques for clinical diagnosis..
3. Students can understand the roles of immunology in protection against disease and autoimmune disorders to choices in their daily lives
4. The students would be aware of the concepts and mechanism behind tumor development, allergy and hypersensitivity reactions.
5. The students would be aware of the principles behind the production of therapeutic/ diagnostic molecules

Text Books:

1. Kuby, J., (1997). Immunology, 3rd Edition, W.H. Freeman and Co.
2. Nandhini Shetty, (2017). Immunology - An introductory textbook, Rev 2nd edition, New age international publishers

Reference Books:

1. Male, D., Brostoff, J., Roth D, and Roitt, I (2006). Immunology, 7th edition, Elsevier.
2. Richard Coico and Geoffrey Sunshine, (2015). Immunology - A Short Course,7th edition, Willey - Blackwell
3. Gabrial Virella. (1993). Introduction to Medical Immunology, Marcel Dekker Inc.
4. Donald M. Weir and John Steward, (1993). Immunology, 7th Edition. ELBS, London.

Web links:

1. https://en.wikibooks.org/wiki/Immunology/Organs_of_the_Immune_System
2. https://www.medicalnewstoday.com/articles/320101#immunity
3. https://teachmephysiology.com/immune-system/immune-responses/hypersensitivity-reactions/
4. https://www.healthline.com/health/autoimmune-disorders#common-autoimmune-diseases
5. https://www.abcam.com/kits/elisa-principle

Question Paper Pattern (Marks: 75) (Time: 3 Hours)

Part - A:	Two Questions from each Unit (No choice)	(10x 2 = 20 Marks)
Part - B:	Either or Questions (One pair from each Unit)	(5 x 5 = 25 Marks)
Part - C:	Three out of Five Questions (One from each Unit)	(3 x10 = 30 Marks)

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Credits	4	Hours/Week	6	Sub Code	S5BTEL2B	Semester	V
Medium of Instruction : English					Major Elective Course :2		

MOLECULAR DIAGNOSTICS

Objectives:

1. To make a study on principles and applications of various techniques used for diagnosis of diseases.
2. To learn about the techniques in prenatal diagnosis.

Unit I: Blood examination – anticoagulant, hemoglobin, RBC, Packed cell volume, ESR, WBC total, differential normal and abnormal hematopathies – anemia, bone marrow smear, leukemia and myelodysplastic syndromes, diagnostic significance of PB smear, hemorrhagic disorder, L.E. cell phenomenon.

Unit II: Urine analysis – collection – physical, chemical and microscopic examination of urine – CSF Parasite analysis.

Unit III: Biochemical analysis of Blood, Blood banking, Transplantation, AIDS, ELISA, RIA, Computers in lab. Quality control.

Unit IV: Lab safety – Biosafety levels I, II, III,IV , FACS, PCR- types of PCR, quantitative and semi-quantitative PCR.

Unit V: Artificial blood, detecting chromosomal abnormalities using molecular techniques, amniocentesis, immunodiffusion techniques.

Learning Outcome:

On completion of the course, the student should be able to:

1. Explain the layout of different molecular analysis methods
2. Able to analyze the urine and blood samples
3. Explain how these methods are applied in current research and diagnostics
4. Evaluate the advantages and disadvantages of the methods
5. Independently select appropriate molecular methods for a given application

Text Book:

1. Talib, V.H, (2012). Handbook of medical lab technology, 2nd edition, CBS publication.

Reference Books:

1. William J. Marshall., Marta Lapsley, Andrew Day (2016). Clinical Chemistry, 8th edition, Elsevier.
2. Allen Gaw, Robert A.Cowan (1999). An Illustrated color text of Clinical Biochemistry, illustrated by Robert Britton, second edition, Churchill Living stone press.
3. Allan D. Marks., Colleen M. Smith, Dawn B. Marks, and Michael A. Lieberman, (2006). Marks' Basic Medical Biochemistry: A Clinical Approach, 2nd Edition), Lippincott Williams and Wilkins.

Web links:

1.https://geneticeducation.co.in/what-is-nested-pcr/
2. https://www.gene-quantification.de/hrm-beginners-guide.pdf
3. https://www.ncbi.nlm.nih.gov/books/NBK2263/
4. https://www.statpearls.com/articlelibrary/viewarticle/28286/
5. https://www.dovemed.com/common-procedures/procedures-laboratory/ketone-bodies-urine-test/
6. https://microbenotes.com/radial-immunodiffusion/

Question Paper Pattern (Marks: 75) (Time: 3 Hours)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)
Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)
Part - C: Three out of Five Questions (One from each Unit) (3 x10 = 30 Marks)

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Credits	4	Hours/Week	6	Sub Code	S5BTEL2C	Semester	V
Medium of Instruction : English					Major Elective Course :2		

NANOBIOTECHNOLOGY

Objectives:

1. To study the basics of nanobiotechnology and different types of nanomaterials.
2. To gain knowledge on the techniques used in analysis of nanomaterials.

Unit I: Biological Inspired Concepts: Biological Networks – Biological Neurons – The Function of Neuronal Cell – Biological neuronal cells on silicon – Modelling of Neuronal cells by VLSI circuits.

Unit II: Biological and Quantum Mechanical Computers: DNA Computer – Information Processing with Chemical reaction – Nanomachines – Parallel Processing – Quantum Computer.

Unit III: Nanobiometrics: Introduction – lipids as nano-bricks and morter- Self assembled nanolayers - the bits that do things - proteins – DNA Computer

Unit IV: Natural nanocomposites: Introduction – natural nanocomposite materials – biologically synthesized nanostructures – protein based nanostructure formation – Nanotechnology in Agriculture.

Unit V: Nanoanalytics: Quantum dot Bio labelling – Nano particle Molecular labels – Analysis of Biomolecular Structure by AFM.

Learning outcome:

On successful completion of this paper,
1. Our students can explain the fundamental principles of nanotechnology and their application to biomedical engineering.
2. They can understand the synthesis of nanomaterials and their application
3. They know the impact of nanomaterials on environment
4. Students can apply their learned knowledge to develop nanomaterials.
5. Our students have the technical knowledge on the analysis of biomolecular structure by AFM.

Text Book:

1. Baldav Raj, Budaraju srinivasa murty, James Murday and P. Shankar (2012). Textbook of Nanoscience and Nanotechnology, Springer.

Reference Books:

1. Goser, K., Glosekotter, P, and J. Dienstuhl, (2004). Nanoelectronics and Nanosystems: From transistors to molecular devices, Springer.
2. Mick Wilson, Kamali Kannagara, Geoff Smith and Michelle Simmons, Burkhard Raguse, (2005). Nanotechnology: Basic science and emerging technologies, First Indian Edition, Overseas Press.

Web sites:

1. https://en.wikipedia.org/wiki/Biological_neuron_model
2. https://www.nanowerk.com/spotlight/spotid
3. https://en.wiktionary.org/wiki/nanobiometrics
4. https://www.biologydiscussion.com/nanotechnology.

Question Paper Pattern (Marks: 75) (Time: 3 Hours)

Part - A:	Two Questions from each Unit (No choice)	(10x 2 = 20 Marks)
Part - B:	Either or Questions (One pair from each Unit)	(5 x 5 = 25 Marks)
Part - C:	Three out of Five Questions (One from each Unit)	(3 x10 = 30 Marks)

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Credits	2	Hours/Week	1	Sub Code	S5SB3C	Semester	V
Medium of Instruction : English						Skill Based : 3	

MUSHROOM CULTIVATION AND VALUE ADDITION

Objectives:

1. To acquire knowledge in differentiating edible and poisonous mushrooms.
2. To teach cultivation, harvesting and storage methods.
3. To learn the nutritional and beneficial aspects of mushroom in food and pharma industry.

Unit I: Mushroom Technology - Introduction, History and Scope - Edible and Poisonous Mushrooms. Vegetative characters - Formation and development of Basidiocarp, structure of basidiocarp - *Agaricus*. Importance and nutritive value of edible mushrooms. Mushroom research centres in India.

Unit II: Morphological and Microscopical identification of mushrooms. Nutrient Profile of Mushroom: Protein, aminoacids, calorific values, carbohydrates, fats, vitamins & minerals.

Unit III: Cultivation of button mushroom (*Agaricus bisporus*), milky mushroom (*Calocybe indica*), oyster mushroom (*Pleurotus sajorcaju*) and paddy straw mushroom *(Volvariella volvcea*). Isolation and culture of spores, culture media preparation. Production of mother spawn, multiplication of spawn.

Unit IV: InoculationTechnique - Cultivation technology - Substrates, composting technology, bed, polythene bag preparation, spawning - casing - Cropping – Mushroom production - Harvest - Storage methods and marketing.

Unit V: Nature, Medicinal and nutritional value, Health benefits: Microbicidal effects. Therapeutic Aspects: Antitumour effect. Identification of Mushroom compounds: Antimicrobial, Flavonoids, Pharmaceutical compounds. Separation and Purification of Compounds.

Learning outcomes:

On successful completion of this paper, students can

1. Identify edible types of mushroom
2. Gain the knowledge of cultivation of different types of edible mushrooms and spawn production
3. Manage the diseases and pests of mushrooms
4. Learn a means of self-employment and income generation.

Text Books:

1. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.
2. Kannaiyan, S. Ramasamy, K. (1980). A hand book of edible mushroom, Today & Tomorrows Printers &Publishers, New Delhi.

Reference Books:

1. Pandey, B. P. 1996. A textbook of fungi. Chand and Company New Delhi.
2. Tripathi, D.P.(2005). Mushroom Cultivation, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
3. PathakYadav Gour (2010). Mushroom Production and Processing Technology, Published by Agrobios (India).

Web links:

1. http://pubs.cas.psu.edu/PubTitle.asp?varTitle=mushroom.
2. http://www.mushworld.com/home/
3. http://ohioline.osu.edu/for-fact/0043.html

Question Paper Pattern (Marks: 75) (Time: 3 Hours)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)
Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)
Part - C: Three out of Five Questions (One from each Unit) (3 x10 = 30 Marks)

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Credits	5	Hours/Week	6	Sub Code	S6BT6	Semester	VI
Medium of Instruction : English					Core Course :11		

PLANT & ANIMAL BIOTECHNOLOGY

Objectives:

1. To understand the different types of culturing techniques used in plant and animal biotechnology.
2. To learn about the media formulations, establishment of cell lines, transformation techniques
3. To give an insight into Stem cells culture and hybridoma technology for MAB production.

Unit I: Introduction to plant cell and tissue culture. Concept of cellular totipotency. Laboratory organization. Sterilization techniques. Plant tissue culture media (Composition, types and preparation). Role of plant growth hormones (auxin, cytokinins, gibberlins) in tissue culture.

Unit II: Establishment and maintenance of callus culture. Micropropagation. Organogenesis and somatic embryogenesis. Protoplast isolation and fusion. Production of somatic hybrids and cybrids. Synthetic seed technology. Somoclonal variation.

Unit III: Plant transformation techniques. *Agrobacterium* mediated gene transfer. General features of Ti plasmid. Organization of Vir genes. Mechanism of T-DNA transfer. Ti plasmid as vectors – Binary and Co-integrative vectors. *Agrobacterium rhizogenes* and Ri plasmid. Production of transgenic plants. Delay of fruit ripening.

Unit IV: Animal cell culture: Structure and organization of animal cells. Animal cell culture: media formulations. Types of cell culture – primary cell culture, secondary cell culture, cell transformation, cell lines, Stem cell types and culture. Tests: cell viability and cytotoxicity, Cryopreservation.

Unit V: Embryology - Gametogenesis and fertilization in animals. Artificial fertilization- IVF and embryo collection, preservation and transfer. GMO- (Genetically Modified Organisms) transfection methods animal vectors - SV40, Adenovirus, Baculovirus. Transgenic animals production and application.

Learning Outcomes: Students can

1. Support methodologies in plant tissue/cell culture to plant improvement,
2. Become motivated to set goals towards pursuing graduate school and higher level positions, such as lab manager and key scientist in plant biotechnological research institutes and industries.
3. Able to describe gene transfer technologies for plants/animals and animal cell lines/ tissue culture.
4. Able to describe techniques and problems both technical and ethical in animal cloning.
5. Able to describe the contribution 'functional genomics' is making and is likely to make in animal biotechnology now and in the future.

Text Books:

1. Chawla, H.S. (2009). Introduction to Plant Biotechnology, 3rd Edition. New Delhi.
2. Ignachimuthu, S. (1995). Basic Biotechnology, Tata McGraw Hill Publishers, New Delhi.

Reference Books:

1. Grierson, D. and S.N. Covey. (1988). Plant Molecular Biology, Blackie & Sons. Ltd.
2. Ramadas, P. (2008). Animal Biotechnology, MJP Publishers, Chennai.
3. Ranga M.M. (2004). Animal Biotechnology, 2nd Edition, Agrobios, India.

Web links:

1.https://www.intechopen.com/books/recent-advances-in-plant-in-vitro-culture/plant-tissue-culture-current-status-and-opportunities
2. .https://sciencesamhita.com/what-is-plant-tissue-culture/
3. http://americanpregnancy.org/infertility/embryo-transfer/
4. https://www.invitra.com/en/ivf-with-donor-sperm/
5. https://microbenotes.com/stem-cells/
6https://www.embibe.com/study/ti-plasmid-concept

Question Paper Pattern (Marks: 75) (Time: 3 Hours)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)
Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)
Part - C: Three out of Five Questions (One from each Unit) (3 x10 = 30 Marks)

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Credits	5	Hours/Week	6	Sub Code	S6BT7	Semester	VI
Medium of Instruction : English					Core Course :12		

ENVIRONMENTAL BIOTECHNOLOGY

Objectives :

1. To give an insight into ecology, environmental pollution and microbial processes in the environment.
2. To provide knowledge on the use of microbes for a safe environment and in the treatment of hazardous waste using biotechnological processes.

Unit I: Ecology - ecological principles, structural concepts, ecological factors - physical, chemical, biotic and edaphic factors. Ecosystem concepts - types, structure and function - productivity and energy flow, food chains, food web and ecological pyramids.

Unit II: Environment Pollution and its causes: Air pollution, water pollution (heavy metal pollution and thermal pollution) soil pollution (pesticide pollution). Nonconventional energy resources- biogas production, methane and hydrogen production - Recycling of waste products- composting and silaging.

Unit III: Introduction to bioremediation – types, factors influencing bioremediation. Bioremediation techniques: ex situ and in situ bioremediation, Phytoremediation - Types of reactors used in bioremediation.

Unit IV: Characteristics of sewage and objectives in sewage treatment. Biological treatment: attached growth system, biofilm kinetics, trickling filters, rotating biological contactors. Suspended growth system: activated sludge process, anaerobic digestion. Tertiary treatment: nitrogen and phosphorus removal, disinfection, removal of heavy metals and pesticides by biosorption. Removal of oil spills by microbes.

Unit V: Introduction to xenobiotics, degradation of xenobiotics- pathways of phenol, pentachlorophenol and polychlorinated biphenyl degradation.
Pollution by radionuclides - uptake of radionuclides from polluted sites.Purification of polluted air using biofilters - Future prospects.

Learning outcomes

1. Students can apply the concepts of Biotechnology in Environmental Management
2. They can also investigate some examples of different types of environmental pollution and their impacts
3. Students can able to recognize the various global and regional environmental concerns due to natural causes and/or human activities, and the impact of these on various forms of microorganisms in bioremediation.

4 Students can demonstrate an awareness of emerging concerns such as climate change, waste management, sewage treatment, removal of oil spills fuels, and new technologies for addressing these.

5. Students appreciate the scientific, ethical and social issues associated with certain applications of biotechnology for alleviating the environmental concerns

Text Book:

Rana, S.V.S., (2010). Environmental Biotechnology, Rastogi Publications, Meerut, India.

Reference Books:

1. Raina, M. Maier, Ian L. Pepper and Charles P. Gerba, (2000). Environmental Microbiology. Academic Press. UK.
2. Alan Scragg, (1999). Environmental Biotechnology, Pearson Education Limited.
3. Dubey, R.C. (2004). A text book of Biotechnology. S. Chand & Company Ltd. New Delhi.

Web links:

1.https://peda.net/kenya/css/subjects/biology/form-three/ecology2/concepts-of-ecology
2. http://www.sgtbkhalsadu.ac.in/colleges/tutorial/112704042020162813.pdf
3. https://www.researchgate.net/publication/258630253_Chapter_1
4.https://www.researchgate.net/publication/292407057_CHARACTERISTICS_OF_SEWAGE_AND_TREATMENT_REQUIRED/link/
5.https://www.biologydiscussion.com/microbiology-2/bioremediation/xenobiotic-compounds-meaning-hazards-and-biodegradation/55625

Question Paper Pattern (Marks: 75) (Time: 3 Hours)

Part - A:	Two Questions from each Unit (No choice)	(10x 2 = 20 Marks)
Part - B:	Either or Questions (One pair from each Unit)	(5 x 5 = 25 Marks)
Part - C:	Three out of Five Questions (One from each Unit)	(3 x10 = 30 Marks)

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Credits	5	Hours/Week	6	Sub Code	S6BTP6	Semester	VI
Medium of Instruction : English					Core Course :13		

PRACTICAL - VI

PLANT & ANIMAL BIOTECHNOLOGY, ENVIRONMENTAL BIOTECHNOLOGY AND BIOINFORMATICS

I. PLANT & ANIMAL BIOTECHNOLOGY

1. Surface sterilization of explants (leaf, internode and root)
2. Plant Tissue Culture Media Preparation – M.S. Media
3. Isolation of DNA from plant tissue
4. Isolation of DNA from animal tissue
5. Establishment of callus culture from carrot
6. Micro propagation
7. Protoplast isolation
8. Preparation of Animal cell culture media
9. Synthetic seed preparation (Entrapment method)

II. ENVIRONMENTAL BIOTECHNOLOGY

1. Estimation of nitrate in Drinking water.
2. Estimation of COD in water sample
3. Estimation of BOD in water sample
4. Isolation of microorganisms from industrial effluents
5. Staining of bacteriods from root nodules

III. BIOINFORMATICS

1. Retrieval of nucleic acid sequences (DNA & RNA)
2. Performing BLAST for DNA sequences
3. Construction of phylogenetic tree

IV. A field visit to biotechnology related industries

Spotters

1. Callus 2) Protoplast 3) Ti plasmid 4) Plant growth Hormones 5) Food web
6. Activated sludge process 7) BOD bottle 8) Pesticide 9) FASTA 10) Phylogram

Practical Outcomes:

1. Students can demonstrate and employ practical skills with both classical and modern laboratory techniques in plant, animal, environmental biotechnology and bioinformatics, including troubleshooting and problem solving.
2. They have enough knowledge in preparing and maintaining cultures of plants with good viability, minimal contamination and appropriate documentation.
3. Students know to recognize and troubleshoot problems common to routine cell culture.
4. They learned how to use bioinformatics tools in an appropriate way.

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Credits	4	Hours/Week	6	Sub Code	S6BTEL3A	Semester	VI
Medium of Instruction : English					Major Elective Course : 3		

INTRODUCTION TO BIOINFORMATICS

Objectives:

1. To understand the basics of bioinformatics, biological sequence databases, genetic and biochemical interaction networks.
2. To impart knowledge on methods to retrieve and submit biological data in Nucleic acid data bases, protein data bases, structural databases and to understand cell interactions.

Unit I: Bioinformatics - Overview definition and history. Structure and chemical composition of nucleic acids and proteins.

Unit II: Biological resource database - Protein and nucleic acid sequence databases (NCBI, EMBL, GenBank, Swiss-Prot and PIR), Pattern and motif searches (BLOCKS, PRINTS). Structural, classification, Alignment and analysis (SCOP, CATH, FSSP). BLAST, FASTA.

Unit III: Genes and Genomes: Evolution of modularity and transcription networks, riboswitches, metabolite sensing and translational control, non coding sequence and its importance

Unit IV: Pathway bioinformatics: Protein-carbohydrate metabolism, biochemical cycles, interconnection of pathways -metabolic regulation

Unit V: Omics concepts: Genomics, proteomics, metabolomics, transcriptomics- introduction and techniques involved.

Outcomes:

1. Students will be acquired with the chemical composition of nucleic acids and proteins
2. They gained an in-depth knowledge of primary, secondary and composite databases, organization of diverse types of biological databases.
3. Students acquire knowledge to explore domains of genomic technologies
4. Students will able to gain about sequence analysis, metabolism and regulation of protein.
5. Will have learnt the concept of omics concept- genomics and proteomics

Text Books:

1. Attwood, T.K and Parry-Smith. (2006). Introduction to Bioinformatics, 1st Edition, Pearson Education, India.
2. S. Ignacimuthu, (2010). Basic bioinformatics, Narosa publishing house.

Reference Books:

1. David W. Mount, (2005). Bioinformatics sequence and Genome analysis, 2nd edition, CBS.
2. Andreas D., Baxevanis. B.F and Francis Ouellette, (2005). Bioinformatics, 3rd edition, John Willey and Sons.
3. Brayen Bergeron, (2003). Bioinformatics Computing, M.D. Pearson Education.

Web Links:

1.http://apps.iasri.res.in/ebook/win_school_aa/notes/Biological_Databases.pdf
2. https://www.cs.tau.ac.il/~rshamir/algmb/archive/bioinfo_tools.pdf
3. http://web.cs.iastate.edu/~cs544/Lectures/lectures.html

Question Paper Pattern (Marks: 75) (Time: 3 Hours)

Part - A:	Two Questions from each Unit (No choice)	(10x 2 = 20 Marks)
Part - B:	Either or Questions (One pair from each Unit)	(5 x 5 = 25 Marks)
Part - C:	Three out of Five Questions (One from each Unit)	(3 x10 = 30 Marks)

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Credits	4	Hours/Week	6	Sub Code	S6BTEL3B	Semester	VI
Medium of Instruction : English					Major Elective Course : 3		

INTELLECTUAL PROPERTY RIGHTS & BIOETHICS

Objectives:

1. To impart knowledge on IPR & Bioethics
2. To know the benefits and risk factors associated with GE.

Unit I: Introduction to Intellectual Property Types- Patents, Trademarks, Copyright & Related Rights, Design, Draft design, Traditional Knowledge, Geographical Indications- importance of IPR. IP rights in India - IPs of relevance to Biotechnology – few Case Studies.

Unit II: Patent Filing Procedures National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes Patent licensing and agreement Patent infringement- meaning, scope, litigation, case studies.

Unit III: IPR Agreements and Treaties History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments..

Unit IV: Bioethics Introduction to ethics/bioethics – framework for ethical decision making; purpose and principles of bioethics, Bioethics in medical – drug testing, non maleficence, Informed consent and human cloning, Bioethics on religious rules and guidelines,

Unit V: Biotechnology and ethics Benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and biowarfare; Ethical implications of cloning: Reproductive cloning , therapeutic cloning. Ethical implications of human genome project.

Learning outcome:

1. Students have knowledge the concepts of IPR and its protection.
2. They also understand IPR through Patents, Copyright and related rights
3. Students know about the Agreements, Treaties and Acts related to IP protection.
4. Students can know the framework for ethical decision making on science and religious rules and guidelines
5. The students should know to use the ethical aspects in genetic engineering

Text Books:

1. Ellen Frankel Paul, Fred D. Miller, Jeffrey Paul and Fred Dycus Miller (2002). Bioethics, Cambridge University Press.
2. John A. Bryant, Linda Baggott la Velle, John F. Searle, (2002). Bioethics and Science,

Reference books:

1. Jose B. Cibelli, Robert P. Lanza, Keith H. S. Campbell, Michael D.West, (2002). Principles of Cloning, Academic Press, SanDiego, Gurdon.
2. Hoosetti, B.B. (2002). Glimpses of Biodiversity. Daya, New Delhi.

Web links:

1.https://en.wikipedia.org/wiki/Intellectual_property
2. https://www.wto.org/english/tratop_e/trips_e/intel2_e.html
3. https://www.iiprd.com/patent-registration-process-under-patent-cooperation-treaty-pct-2/
4. https://en.wikipedia.org/wiki/Bioethics
5. https://en.wikipedia.org/wiki/Ethics_of_cloning

Question Paper Pattern (Marks: 75) (Time: 3 Hours)

Part - A:	Two Questions from each Unit (No choice)	(10x 2 = 20 Marks)
Part - B:	Either or Questions (One pair from each Unit)	(5 x 5 = 25 Marks)
Part - C:	Three out of Five Questions (One from each Unit)	(3 x10 = 30 Marks)

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Credits	4	Hours/Week	6	Sub Code	S6BTEL3C	Semester	VI
Medium of Instruction : English					Major Elective Course : 3		

GENOMICS & PROTEOMICS

Objectives:

1. To give an insight into various tool used in genome data bases
2. To impart knowledge on Genomics and Proteomics techniques and their importance in predicting the gene and its functional significance.

Unit I: Introduction to genome databases - database search - Algorithms issues in databases search - sequence database search - FASTA - BLAST – Types of genomic databases and uses: Polymorphic markers, Cytogenic Maps, LINE, SINE- Amino acid substitution matrices PAM and BLOSUM.

Unit II: Gene Therapy: Concept and Principles of Gene Therapy. Principles of gene Expression - Genome Mapping –physical and genetic mapping techniques, Human Genome Project - Genomes of other organisms. Shotgun DNA sequencing - Sequence assembly - Gene predictions - Molecular prediction with DNA strings.

Unit III: Genomic resources, Gene structure and DNA sequences. EST comparison, gene hunting. Expression analysis- SAGE, cDNA library, ORF prediction, Microarray – DNA sequencing and sequence alignment: RFLP, SNP, RAPD, Application of Comparative Genomics.

Unit-IV: Structural Proteomics: Experimental Techniques for Protein Structure Elucidation, X-ray Crystallography, 2-D Electrophoresis- Sample preparation, pH gradient- MALDI-TOF, Electro plot, Protein Microarrays and Bioseparation.

Unit-V: Metabolomics: Understooding the Metabolic Pathways of Microbes, metabolic pathway databases-KEGG. Structure prediction, active site determination, neural networks. Protein – protein interaction, protein – DNA interaction. Enzyme – Substrate interaction. Applications of Proteomics: Plant breeding and Biomedical.S

Learning outcomes:

1. Students should be able to acquire knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology.
2. Identify and describe the different components in prokaryotic and eukaryotic genomes and proteomes.
3. Identify molecular mechanisms responsible for diseases.
4. Use the different methodologies, techniques and tools commonly used in genome sequencing, assembly and annotation.

Text Books:

1. Irfan Alikhan and Aliya Khanum, (2003). Fundamentals of Bioinformatics, Ukaag publications.
2. Bioinformatics for beginners- K. Mani and N. Vijayaraj, Kalaikathir Atchagam

Reference Books:

1. Parry and Smith, (1999). Bioinformatics, Addition Wesley long ltd.
2. David Mount, (2005). Bioinformatics: sequence and Genome Analysis, 2nd edition, CBS Publishers and distributors Ltd.
3. T. A. Brown, (2006) Genomes 3, 3rd edition, Garland science.
4. Pennigton and Dunn, (2002). Proteomics, Viva books publishers, New Delhi.

Web Links:

1.https://www.illumina.com/techniques/sequencing/dna-sequencing/whole-genome-sequencing.html
2.http://www.genomenewsnetwork.org/resources/whats_a_genome/Chp2_1.shtml
3.https://medlineplus.gov/genetics/understanding/therapy/genetherapy

Question Paper Pattern (Marks: 75) (Time: 3 Hours)

Part - A:	Two Questions from each Unit (No choice)	(10x 2 = 20 Marks)
Part - B:	Either or Questions (One pair from each Unit)	(5 x 5 = 25 Marks)
Part - C:	Three out of Five Questions (One from each Unit)	(3 x10 = 30 Marks)

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Credits	3	Hours/Week	4	Sub Code	S5BTEL01	Semester	V
Medium of Instruction : English					Non Major Elective Course : 1		

HEALTH EDUCATION

Objectives:

1. To understand the concept of biomolecules, their importance and its role in health.
2. To know the basic concept of pollution and its impact on health.
3. To gain knowledge on the basics of mental illness and immunization schedule required for healthy life.

Unit I: Dimensions and Determinants of health, Indicators of health - Characteristics of indicators, Types of indicators, Disease agents - Classification of disease agents.

Unit II: Nutrition - Classification and functions of food, sources and requirement of Carbohydrates, Proteins, Fats, Vitamins and Minerals, Malnutrition - Protein energy Malnutrition (PEM), Balanced diet - Composition of balanced diet

Unit III: Water - Safe and wholesome water, criteria for water quality standards, household purification of water. Air - Health effects of air pollution, prevention and control Ventilation - Standards of ventilation, Light - The requirements of good lighting.

Unit IV: Noise - Effects of noise exposure, Types of mental illness - Major and minor illnesses, Causes of mental ill health - Social pathological causes, Preventive aspects - Primary - Secondary -Tertiary.

Unit V: Immunization - Vaccines and Immunization Schedule, Principles of disease control and prevention.

Learning outcome:

1. Students gained depth knowledge about the spectrum of diseases.
2. They have the clear idea about the composition of balanced diet.
3. Students learned how to keep the environment pollution free
4. They are well versed in the causes of mental ill health
5. They are aware about the vaccines and immunization schedule

Text Books

1. Srilakshmi, B. (2015). Food Science, 6th edition, New Age International publishers.

Reference Books:

1. Murugesh, N. (2002). Health Education and Community Pharmacy, 3rd Edition, Sathya Publishers, Madurai.
2. Srilakshmi, B. (2012). Nutrition Science, 4th revised edition, New Age International publishers.
3. Khurana, S.P.S. (2007). Health Education and Community Pharmacy, S. Vikas Company, India.

Web links:

1.https://www.physio-pedia.com/Determinants_of_Health
2. https://www.worldofmolecules.com/foods/
3. https://en.wikipedia.org/wiki/Water_quality
4. https://medlineplus.gov/mentaldisorders.html
5.https://vikaspedia.in/health/child-health/immunization

Question Paper Pattern (Marks: 75) (Time: 3 Hours)

Part - A:	Two Questions from each Unit (No choice)	(10x 2 = 20 Marks)
Part - B:	Either or Questions (One pair from each Unit)	(5 x 5 = 25 Marks)
Part - C:	Three out of Five Questions (One from each Unit)	(3 x10 = 30 Marks)

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Credits	4	Hours/Week	4	Sub Code	S5BTEL02	Semester	VI
Medium of Instruction : English					Non Major Elective Course : 2		

PHARMACEUTICAL BIOTECHNOLOGY

Objectives:

1. To understand the concept of pharmaceutical biotechnology and its applications.
2. To know the methods of fermentation process used in pharma industries and its advantages in the production of pharmaceutically valuable products.

Unit I: Brief introduction to biotechnology with reference to pharmaceutical sciences, Enzyme biotechnology-methods of enzyme immoblisation and applications, Biosensors-working and applications of biosensors in pharma industries

Unit II: Study of cloning vectors, restriction endonuclease and ligase. Recombinant DNA technology- applications of genetic engineering in medicine-interferons production, vaccines-hepatitis B, hormones-insulin

Unit III: Types of immunity-humoral and cellular,immunoglobulin structure and functions. Hybridoma technology-production of Mabs, purification and application.

Unit IV: Mutation-types of mutation, DNA repair mechanisms, Gene therapy-introduction, types,. Introduction to drug design, evaluation of drugs.

Unit V: Fermentation methods-fermentor design and control, Study of production of penicillin, vitamin B12, griseofulvin. Advantages and disadvantages of phramaceutical biotechnology.

Learning Outcomes:

1. Students can understand the importance of Immobilized enzymes in pharmaceutical industries.
2. Genetic engineering applications in relation to production of pharmaceuticals.
3. Students will be able an outline the production and use of monoclonal antibodies and their importance in industries
4. They have gained in-depth knowledge about the mutation, DNA repair mechanisms and drug designing strategies.
5. They can appreciate the use of microorganisms in fermentation technology and the principles of techniques used for extraction purification of industrial products.

Text book:

1. Daan J.K. chrommelin, Robert D. Sindelar, Bernd Meibohm, (2007). Pharmaceutical Biotechnolgy- Fundamentals and applications 3rd edition, Taylor and Francis publication.

Reference Books:

1. Immunology: Nandhini shetty, (2017). An introductory textbook, Rev 2nd ed, Newage international publishers
2. Brown T.A. (2010). Gene Cloning and DNA Analysis: An Introduction, 6th Edition, Wiley Blackwell.
3. Satoskar, R.S., Bhandarkar, S.D and Rege, N.N, (2006). Pharmacology and Pharmacotherapeutics, Popular Prakashan (P) Ltd.

Web links:

1.https://sites.google.com/site/livescribesmartpennotes/biopharmaceutical-notes
2.https://web.xidian.edu.cn/yqxia/files/20140227_103205.pdf
3.https://www.scribd.com/document/378069330/Pharmaceutical-Biotechnology-Fundamentals-and-Applications-Lecture-Notes-Study-Material-and-Important-Questions-Answers

Question Paper Pattern (Marks: 75) (Time: 3 Hours)

Part - A: Two Questions from each Unit (No choice) (10x 2 = 20 Marks)
Part - B: Either or Questions (One pair from each Unit) (5 x 5 = 25 Marks)
Part - C: Three out of Five Questions (One from each Unit) (3 x10 = 30 Marks)

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SYLLABUS FOR

NON MAJOR ELECTIVE

NMEC1 - for B.Sc., (Statistics) students

NMEC2 - for B.Sc., (Biochemistry) students

DEPARTMENT OF BIOTECHNOLOGY

General Program Outcomes

1 Students will be able to demonstrate their knowledge of biotechnology concepts.

2. Students will possess the technical background knowledge needed to support biotechnology research activity.

3. Students will possess hands-on technical skills necessary for supporting biotechnology research activity.

4. Students describe the structure, classification, staining, culturing and physiology of microorganisms

5. They can restate the various types of gene interactions and genetic recombination

6. Students can explain the basic principles, tools, techniques, applications of Genetic engineering in various fields

7. Students can able to debate on ethical issues concerned with Genetic engineering