Dhanalakshmi Srinivasan College of Arts & Science for Women (Autonomous)

(Affiliated to Bharathidasan University, Trichirappalli) (Nationally Re-accredited with 'A' Grade by NAAC)

Perambalur- 621 212

(For the candidates admitted from the academic year 2020-2021 onwards)

M.Sc., MICROBIOLOGY COURSE STRUCTURE UNDER CBCS

Sem	Course	Course Title	Sub.Code	Periods/ week	Credit	Exam hrs	Internal	External	Total
I	Core Course-I (CC)	General Microbiology	20PMB1C1	6	5	3	25	75	100
	Core Course-II (CC)	Microbial Metabolism	20PMB1C2	5	4	3	25	75	100
	Core Course-III (CC)	Microbial Biochemistry	20PMB1C3	5	4	3	25	75	100
	Core Course-IV(CC)	Practical I-Pertaining CCI,CCII & CCIII	20PMB1C4P	6	3	6	40	60	100
	Elective Course-I (CE)	A) Biopharmaceuticals	20PMB1E1A	5	4	3	25	75	100
		B) Biosafety,Bioethics and IPR	20PMB1E1B						
	Application Oriented Course	Bioinstrumentation	20PMB1A1	3	3	3	25	75	100
			Total	**30**	**23**				**600**
II	Core Course-(CC) V	Advanced virology	20PMB2C5	6	5	3	25	75	100
	Core Course-VI(CC)	Microbial Genetics	20PMB2C6	5	4	3	25	75	100
	Core Course-VII(CC)	Environmental and Agricultural Microbiology	20PMB2C7	5	5	3	25	75	100
	Core Course-VIII (CC)	Practicals II- Pertaining CCV,CC VI&CCVII	20PMB2C8P	6	3	6	40	60	100
	Elective Course-II(CE)	A)Advanced Molecular biology	20PMB2E2A	5	4	3	25	75	100
		B) Nanotechnology	20PMB2E2B						
	Application Oriented Course	Mushroom Technology	20PMB2A2	3	3	3	25	75	100
			Total	**30**	**24**				**600**
III	Core Course-IX (CC)	Immunology and Medical Microbiology	20PMB3C9	6	5	3	25	75	100
	Core Course-X(CC)	Food and Dairy Microbiology	20PMB3C10	5	4	3	25	75	100
	Core Course-XI (CC)	Recombinant DNA Technology	20PMB3C11	6	5	3	25	75	100
	Core Course-XII (CC)	Practical III- Pertaining CCIX,CCX &CCXI	20PMB3C12P	8	5	6	40	60	100
	Elective Course-III (CE)	A) Fermentation Technology	20PMB3E3A	5	4	3	25	75	100
		B) Marine Microbiology	20PMB3E3B						
			Total	**30**	**23**				**500**
IV	Core Course-XIII(CC)	Research Methodology	20PMB4C13	6	5	3	25	75	100
		Project work	20PMB4PW	24	15	3	40	60	200
	Total			**30**	**20**				**300**
	Grand Total			**120**	**90**				**2000**

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AND SCIENCE FOR WOMEN (AUTONOMOUS)
PERAMBALUR - 621 212

LIST OF ELETIVE COURSES FOR PG MICROBIOLOGY

I	20PMB1E1A	BioPharmaceuticals
	20PMB1E1B	Biosafety, Bioethics and IPR
II	20PMB2E2A	Advanced Molecular biology
	20PMB2E2B	Nanotechnology
III	20PMB3E3A	Fermentation Technology
	20PMB3E3B	Marine Microbiology

PROGRAMME OUTCOME

1. Students will be able to acquire, articulate, retain and apply specialized language and knowledge relevant to microbiology
2. Students will acquire and demonstrate competency in laboratory safety including accurately reporting observations and analysis
3. Students will communicate scientific concepts, experimental results and analytical arguments clearly and concisely
4. Students will inculcate involvement in Research and internship activity
5. Graduates develop a broad range of scientific knowledge to meet the current and future expectation of industries at the national and global level

CORE COURSE : I

GENERAL MICROBIOLOGY

Semester: I **Max Marks:** 75

Course Code: 20PMB1C1 **Credit** : 5*

Total Period: 75 **Exam Hrs**: 3

Objectives

To provide the fundamental knowledge on microorganism

To acquire ideas on isolation and preservation of microbes

UNIT I Microbial Origin (15 Period)

Origin of life: Oparin theory – Urey miller experiment. Fossil evidence for protobiont and cyanobacteria-introduction to evolution. Mechanism of the process of evolution-micro evolution - speciation - macro evolution. Evidence of evolution. Evolutionary theory – Lamarckism - Darwinism- natural selection - and mutation theory-Neo Darwinism.

UNIT II Overview of Microbiology (15 Period)

Scope and history of Microbiology. A biogenesis vs biogenesis. General properties and principles of classification of microorganisms. Classification of microbes – Kingdom concept, Bergey's systematic classification of bacteria. Numerical taxonomy and phylogenetic classification.

UNIT III Sterilization and Staining (15 Period)

Physical methods: principle of Dry heat and moist heat sterilization. Sterility indicator organisms for oven and autoclave. UV in sterilization. Chemical methods: disinfection (ethanol), sanitization (chlorine), antisepsis (cholorohexidine and iodine), sterility and fumigation (formaldehyde and glutaraldehyde). staining techniques: auxochrome, chromophores, dyes, classification of stains- simple and differential staining- mechanism of gram staining, acid fast staining, negative staining , capsule staining , flagella staining and endospore staining.

UNIT IV Kingdom Fungi and Algae (15 Period)

General characteristics and outline classification of fungi by Alexopoulos (1979). Heterokaryon-dimorphic fungi and imperfcti fungi. Cell wall of fungi. Lifecycle of fungi- sexual and parasexuality. Algae - general characteristics, classification of algae by smith (1955). Nature of cell wall - pigmentation and photosynthetic apparatus. Reproduction of algae chlorophyta, diatoms, rhodophyta. Economic importance of fungi and algae.

UNIT V Cultivation and Preservation (15 Period)

Microbiological media - Autotrophic media, defined synthetic mineral media, heterotrophic media. The concept of prototrophs and auxotrophs, prototrophic (minimal media) complex media (undefined media).Cultivation of Bacteria, Fungi and Algae: Routine and special culture methods. Isolation of pure cultures. Preservation and Maintenance of Microbial Cultures: Routine methods and Liquid nitrogen preservation, freeze-drying (lyophilization).

REFERENCES

1. Ingraham, J. L. and Ingraham, C. A. 2004. Introduction of Microbiology: A Case History Approach. 3rd Edition. Thomson Brooks/Cole, Pacific Grove.
2. Madigan, M.T. and Martinko, J.M. 2006. Brocks Biology of Microorganisms. 11th Edition. Pearson Education Inc.
3. Pelczar, M. J., Chan, E.C.S. and Krieg, N. R. 1993. Microbiology. 5th Edition. Tata MacGraw Hill Press.
4. Prescott, L.M., Harely, J.P. and klein, D.A. 2005. Microbiology. 6th Edition. MacGraw Hill Companies Inc.
5. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. 2013. Prescott's Microbiology. 8th Edition. McGraw-Hill Higher Education.
6. Salle, A. J. 1971. Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Hill Publishing Co.

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Know the Oparin theory and Evolutionary theory	K1
CO 2	Overview of Microbiology	K2
CO 3	Understand Sterilization and Staining	K3
CO 4	Understand the Kingdom concept	K5
CO 5	Understand the Classification of Fungi and Cyanobatceria	K4

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**M**	**S**	**S**
CO 2	**M**	**S**	**S**	**M**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**M**	**S**

S- Strong, M- Medium, L- Low

CORE COURSE : II

MICROBIAL METABOLISM

Semester: I **Max Marks: 75**

Course Code: 20PMB1C2 **Credit : 4***

Total Period: 75 **Exam Hrs : 3**

Objectives

To provide knowledge on nutritional requirement for bacteria

To make the students to understand the metabolism of microbes

UNIT I: Ultra structure of Bacteria (15 Period)

Cell theory- structure of cell wall, plasma membrane, outer membrane, mitochondria, chloroplast, golgi complex, PHB, gas vesicles, ribosome, endoplasmic reticulam, nuclus. pili, fimbriae, microtubules and flagella-chemotaxis.

UNIT II: Microbial Growth (19 Period)

Microbial nutrition - autotroph, phototroph, heterotroph, organotroph, lithotrophs and Winogradsky column. Nutrient transport mechanisms - uniport, symport and antiports - active, passive, facilitated diffusions and group translocation - siderophore in iron transport. Phases of growth - synchronous growth, diauxic growth and continuous growth. Factors influencing microbial growth- Cell division - mechanisms involved in formation of Z-ring. Sporulation and vegetative cell formation in Bacillus sp.

UNIT III: Microbial Metabolism (11 Period)

Carbon assimilation- oxygenic and anoxygenic photosynthesis - Calvin cycle. Metabolism - catabolism-fermentation and respiration-EMP pathway-Pasture effect, ED pathway, Glyoxalate pathway, Krebs cycle. Anabolism- gluconeogenesis and reverse TCA cycle. Law of thermodynamics and free energy.

UNIT IV:Microbial Pigments (17 Period)

Brief account of photosynthetic and accessory pigments. Fluorescence and phosphorescence in bacteria. Bacterial chlorophyll, rhodospsin, carotenoids, phycobiliproteins, Pulcherrimin, indigoidin, vioalecin. Defensive role of pigments. Bioluminescence mechanism - advantages.

UNIT V: Extremophiles Physiology (13 Period)

Effect of oxygen toxicity, pH, osmotic pressure and heat shock. Bacterial adaptations in thermophiles, halophiles, alkaliphiles, acidophiles. Osmolarity porin regulation (Omp system) and Pho system in E.coli. Extremophiles-adaptations and significance in biotechnology.

REFERENCES

1. Murray, R.K. Granner, M. D., Mayes, P.A. and Rodwell, V.W. 1990. Biochemistry.

Prentice Hall International Inc., London.

2. Stryer, L. 1990. Biochemistry, 4th Edition. Freeman, W.H. & company, New York.

3. Madigan, M.T., Mrtinko, J. M. and Parker, J. 2000. Brock Biology of Microbiology. 9th Edition. Prentice Hall International, USA.

4. Moat, A .G., Foster, J.W. and Spector, M.P. 2009. Microbial Physiology. 4th Edition.

Wiley Publication, India.

5. Pelczar,M.J.R., Chan, E.C.S. and Kreig, N.R. 1993. Microbiology. 5th Edition.

McGraw Hill. Companies Inc. New York.

7. Prescott, L.M., Harley, J.P. and AKlein, D. 2007. Microbiology. 7th Edition. McGraw Hill. Companies Inc. New York.

6. Caldwell, D.R. Microbial Physiology and Metabolism. 1995. WM. C. Brown Publishers, (USA Edition). LPE-Pearson Education, Inc.

7. John, Ingraham and Catherine,Ingraham. 2004. Introduction to Microbiology. 3rd Edition. Thomson Brooks/cole publication.

8. Gottychalk, G. Bacterial Metabolism. 2nd Edition. Springer - Verlag, Berlin. Hissar, Agricultural University, Prentice Hall of India Pvt. Ltd., Delhi, 1986.

9. Doelle, H.W. Bacterial Metabolism 2nd Edition. Elsevier Publication, Academic press,

New Delhi, India.2005.

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Understand the Cell theory	K4
CO 2	Know the Microbial nutrition and Factors influencing microbial growth	K3
CO 3	Outline the Carbon assimilation, Metabolism and catabolism	K3
CO 4	Discuss the Microbial Pigments	K2
CO 5	Understand Extremophiles Physiology	K4

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**M**	**M**	**S**	**M**
CO 2	**S**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**M**	**S**

S- Strong, M- Medium, L- Low

CORE COURSE: III

MICROBIAL BIOCHEMISTRY

Semester: I **Max Marks : 75**

Course Code: 20PMB1C3 **Credit : 4***

Total Period : 75 **Exam Hrs : 3**

Objective

To provide a solid foundation on biomolecules

To understand the importance of biomolecules

To gain knowledge on enzymes and signaling pathway.

UNIT I : Carbohydrates and Proteins **(15 Period)**

Properties and classification- monosaccharides - isomerism and anomerism. Disaccharides and polysaccharides - structures of starch and glycogen.. Protein - properties of aminoacids. Classification of proteins. Structure of protein - primary, secondary, tertiary and quaternary structure.

UNIT II: Lipids and Nucleic acids **(15 Period)**

Biological importance and classification of lipids. properties and types of fats and fatty acid - □ oxidation. Biosynthesis of cholesterol. Nucleic acid - biosynthesis and degradation (de novo and salvage pathway)

UNIT III:Vitamins **(13 Period)**

Discovery, role and chemistry of fat soluble vitamins A, D, E and K. Water soluble vitamins - Pantothenic acid, niacin, pyridoxine, biotin, riboflavin, cyanocobalamine, folic acid and ascorbic acid.

UNIT IV:Enzymes **(20 Period)**

Enzyme - classification , specificity, active site and isozymes. Factors affecting enzyme efficiency, enzyme activators, coenzymes and cofactors. Enzyme kinetics - Michaelis - Menton equation, determination of kinetic parameters, multi-step reactions and enzyme inhibition. Allostersim - kinetic analysis and principles of allosteric regulation.

UNIT V:Bio Signaling **(14 Period)**

Molecular mechanism of signal transduction - gated ion channel, cell surface receptor and hormones. Signaling through G protein coupled receptor and second messengers. Protein kinase in signal transduction. Regulation of signaling pathways and programmed cell death.

REFERENCES

1. Deb, A. C. 2001. Fundamentals of Biochemistry. 7th Edition. New central book agency (p)ltd. India

2. Thomas M. Deblin. 1997. Textbook of Biochemistry With Clinical Correlations. 4th Edition. A John Wiley and sons, Inc., publications, New York.

3. Sathyanarayana, U. 2002. Biochemistry. 2nd Edition. Arun Ba Sen books and allied pvt ltd. Kolkata

4. AmbikaShanmugam, 2003. Fundamental of Biochemistry for Medical Students. Revised Edition.

Published by the Author, 17. III Cross street, west CIT Nagar, Chennai-35

5. Chatterjea, M.N. and Shindea, R. 2007. A Text Book of Medical Biochemistry. Jaypee Brothers Medical Publishers (P) Ltd., New Delhi.

6. Murray, R.K., Grannes, D.K. and Rodwell, V.W. 2006. Harper's Illustrated Biochemistry. 27th Edition. McGraw Hill Companies, New York.

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Understand the Propertics and classification of carbohydrates	K3
CO 2	Know more about lipids and nucleic acids	K2
CO 3	Discuss the role and chemistry fat of soluble vitamins	K3
CO 4	Understand classification and specificity of enzymes	K5
CO 5	Outline the bio signaling	K6

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**M**	**S**	**S**
CO 2	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**M**	**S**

S- Strong, M- Medium, L- Low

CORE COURSE : IV

Practical I: General Microbiology, Microbial Metabolism and Microbial Biochemistry

Semester: I **Max Marks: 75**

Course Code: 20PMB1C4P **Credit : 4***

Total Period: 75 **Exam Hrs: 3**

GENERAL MICROBIOLOGY

Objective: To impart hands on training in isolation and staining procedure

1. Enumeration of Bacteria and Fungi - Viable plate count. (5 Period)
2. Pure culture techniques- Streak plate method (5 Period)
3. Measurement of size of microbes - micrometry method. (5 Period)
4. Motility determination - Hanging drop method and stab method (5 Period)
5. Staining methods -Gram staining, Endospore, PHB and Capsule staining. (5 Period)

MICROBIAL METABOLISM

Objective: To learn the principles on biochemical characterization of microorganism

6. Measurement of growth curve - Direct and indirect methods. (10 Period)
7. Effect of pH and Temperature on microbial growth. (5 Period)
8. Biochemical tests: IMViC, Catalase, Oxidase, TSI test, Gelatin, casein, starch Hydrolysis, and Urease test. (10 Period)

MICROBIAL BIOCHEMISTRY

Objective: To know the concepts pertaining to biomolecules estimation

9. Acid base Titration and PKa determination (5 Period)
10. Estimation of total Carbohydrate by Anthron method (5 Period)
11. Estimation reducing sugar (5 Period)
12. Separation of amino acid by Thin layer chromatography (5 Period)
13. Total protein estimation – Lowery et al method (5 Period)

REFERENCES

1. Aneja, K.R. 2003. Experiments in Microbiology, Plant pathology and Biochemistry. 4th Edition. New age International publishers, India.

2. Cappuccino and James, G. 1996. Microbiology a Laboratory Manual. 4th Edition.

Addison Wesley Publishing Company Inc. England, California

3. Wilson, K. and Walker. Practical Biochemistry, Principles and Techniques. 1995.Cambridge University Press.

4. Jayaraman, J. 2011. Laboratory Manual in Biochemistry 2nd Edition. New age International publishers, India.

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Enumerate of Bacteria and Fungi	K3
CO 2	Know micrometry method.	K4
CO 3	Perform the Stainingtechniques	K5
CO 4	Understand Measurement of growth curve	K4
CO 5	Estimate the of total Carbohydrate	K6

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**M**	**S**	**S**
CO 2	**S**	**S**	**S**	**M**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**M**	**S**

S- Strong, M- Medium, L- Low

ELECTIVE COURSE: I

BIOPHARMACEUTICALS

Semester: I **Max Marks: 75**

Course Code: 20PMB1E1A **Credit : 4***

Total Period: 75 **Exam Hrs: 3**

Objective

Upon completion of this course the student should be able to describe the properties of drug and quality measures in pharmaceutical industry

Unit I: Drug discovery and development **(15 Period)**

Introduction to drug discovery and development, sources of drugs, approaches to new drug discovery, role of molecular recognition in drug design, enzymes and receptors as drug targets, prodrug design and applications, computer aided drug design, preclinical and clinical trials Biopharmaceuticals. Plant and algal compounds as anticancer, antiviral and antibacterial agents.

Unit II: Concepts of pharmaceuticals **(15 Period)**

Biologics and biopharmaceuticals, sources of biopharmaceuticals, biopharmaceuticals in production and research, cytokines, heamopoetic growth factors, hormones, blood products, therapeutic enzymes (Asparaginase, Streptokinase, beta lactamases), bacterial and viral vaccines, New vaccine production (DNA vaccines, synthetic, peptide vaccines, multivalent subunit vaccines, edible vaccines and their trials), Case studies.

Unit III: Radiopharmaceuticals **(15 Period)**

Radio activity, Measurement of radioactivity, Properties of α, β, γ radiations, Half life, radio isotopes and study of radio isotopes - Sodium iodide I131 , Storage conditions, precautions & pharmaceutical application of radioactive substances.

Unit IV: Spoilage of pharmaceutical products **(15 Period)**

Regulatory practices and policies in pharmaceutical industries Microbial production contamination and spoilage of pharmaceuticals products (sterile injectables, ophthalmic preparations and implements) and their sterilization, FDA, govt. concept of R & D, quality control and market planning. Significance of IP, BP and USP. Reimbursement of drugs, biological and legislative aspects, patenting of drugs and biological products.

Unit V: Quality Assurance and Validation **(15 Period)**

Regulatory aspects of QC, QA, and QM. GMP , GLP and CMP in Pharma Industry. ISO, WHO, USFDA certification. Microbial Limit test of Pharma products. Sterility testing , pyrogen testing and LAL test of Sterile Pharma products. Sterilization- heat, D- value, Z-value and survival curve, radioactive, gaseous and filtration. Chemical and biological indicators.

REFERENCES

1. W.B. Hugo, A.D. Russel 2010. Pharmaceutical Microbiology. 6th Edition. Blackwell scientific Publications.

2. Frederick Kavanagh. 1972. Analytical Microbiology. Vol. I & II. Academic Press, New York.

3. David, C., Hooper John S. and Wolfson, A.S.M. 1989. Quinolinone antimicrobial agents. Washington, D.C: American Society for Microbiology.

4. Murray, S. Cooper.1972. Quality control in the Pharmaceutical Industry. Vol. 2. Academic Press, New York.

5. Rehm, H. and Reed, J. Biotechnology. Vol. 4. VCH Publications, Federal Republic of Germany.

6. Vyas, S.P. and Dixit, V.K. Pharmaceutical Biotechnology. 2007. CBS Publishers & Distributors, New Delhi.

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8. Paine Webber. 1994. Advances in Applied Biotechnology Series Vol. 10 – Biopharmaceuticals in transition. Industrial Biotechnology Association, Gulf Publishing Company, Houston.

9. Gregory Gregoriadis. 1979. Drug Carriers in biology and Medicine. Academic Press, New York.

10. Rajesh Bhatia. 1994. Vaccine and Immobilization against Infectious Disease. Jaypee Brothers Medical Publishers (P) Ltd. New Delhi

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Understand the Introduction to drug discovery and development	K3
CO 2	Understand the Biologics and biopharmaceuticals	K4
CO 3	Understand Radio activity, Measurement of radioactivity, Properties of α, β, γ radiations	K3
CO 4	Understand the Spoilage of pharmaceutical products	K4
CO 5	Understand the Regulatory aspects of QC, QA, and QM. GMP , GLP and CMP in Pharma Industry	K5

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**S**	**S**	**S**
CO 2	**M**	**S**	**S**	**S**	**M**
CO 3	**S**	**S**	**S**	**M**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**M**	**S**

S- Strong, M- Medium, L- Low

ELECTIVE COURSE : I

BIOSAFETY, BIOETHICS AND IPR

Semester: I **Max Marks: 75**

Course Code: 20PMB1E1B **Credit : 4***

Total Period: 75 **Exam Hrs: 3**

Objectives

To understand the salient features of ethical guidelines

To impart knowledge about Property rights and laws of biotechnological inventions

UNIT I Biosafety **(10 Periods)**

Introduction - biosafety issues in biotechnology - historical background. Biological safety cabinets, Primary containment for biohazards. Biosafety levels - levels of specific microorganisms, infectious agents and infected animals.

UNIT II Biosafety Guidelines **(15 Periods)**

Guidelines and regulations (National and International including Cartegana Protocol) - operation of biosafety guidelines and regulations of Government of India; Definition of GMOs & LMOs. Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture. Environmental release of GMOs - Risk - analysis, assessment, management and communication.

UNIT III Bioethics **(17 Periods)**

Introduction to ethics and bioethics, framework for ethical decision making. ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research. Ethical implications of GM crops, GMO's, human genome project, human cloning, designer babies, biopiracy and biowarfare. Eugenics and its possible approaches. Animal right activities - Blue cross in India- society for prevention of cruelty against animals. Ethical limits of animal use. green peace - human rights and responsibilities.

UNIT IV Intellectual Property Rights **(20 Periods)**

Introduction to IPR, types of IP - patents, trademarks, copyright & related rights, industrial design, traditional knowledge and geographical indications. Importance of IPR – patentable and non patentables, patenting life, legal protection of biotechnological inventions. Agreements and treaties - history of GATT & TRIPS agreement, madrid agreement, Hague agreement, WIPO treaties; budapest treaty; PCT, Indian patent Act 1970 & recent amendments. IPR and WTO regime - consumer protection and plant genetic resources.

UNIT V Patents and Patent Laws **(15 Periods)**

Objectives of the patent system - basic, principles and general requirements of patent law. Biotechnological inventions and patent law - Legal development - Patentable subjects and protection in Biotechnology. Patent filing

procedures - National & PCT filing procedure, time frame and cost, Status of the patent applications, precautions while patenting, disclosure/ nondisclosure, financial assistance for patenting, introduction to existing schemes. Patent licensing and agreement. Patent infringement - meaning, scope, litigation, case studies.

REFERENCES

1. Beier, F.K., Crespi, R.S and Straus, T. 1986. Biotechnology and Patent protection, Oxford and IBH Publishing Co. New Delhi.
2. Jeffrey M. Gimble, 2005. Academia to Biotechnology, Elsevier Academic Press.
3. Rajmohan Joshi. 2006. Biosafety and Bioethics. Isha Books, New Delhi.
4. Sasson, A, 1988. Biotechnologies and Development, UNESCO Publications.
5. Senthil Kumar, S. and Mohammed Jaabir M. S. 2008. IPR, Biosafety and Biotechnology Management, Jasen Publications, India

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Understand biosafety issues in biotechnology and historical background	K1
CO 2	Understand the Biosafety Guidelines	K2
CO 3	Analyse ethical and professional issues which arise in the intellectual property law context	K3
CO 4	Apply intellectual property law principles (including copyright, patents, designs and trademarks) to real problems and analyse the social impact of intellectual property law and policy	K4
CO 5	Understand the Patents and Patent Laws	K4

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**M**	**S**	**S**
CO 2	**S**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**M**	**S**
CO 4	**S**	**S**	**M**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**

S- Strong, M- Medium, L- Low

APPLICATION ORIENTED COURSE

BIOINSTRUMENTATION

Semester: I **Max Marks: 60**

Course Code: 20PMB1A1 **Credit : 3***

Total Period: 75 **Exam Hrs: 3**

Objectives

To know the various types of instruments used in research

To impart the knowledge on working principle

UNIT I Centrifugation (15 Periods)

Principle of centrifugation- rpm and sedimentation co efficient- types of rotors and its advantages. High speed centrifugation, differential centrifugation, density gradient centrifugation. Separation of intracellular components by differential centrifugation.

Unit II Chromatography Techniques (15 Periods)

Chromatographic techniques: General principles of chromatography. Principles, operational procedure and applications of paper, thin layer, ion exchange, gel permeation and gas-liquid chromatography. High performance liquid chromatography (HPLC and HPTLC).

UNIT III Electrophoresis and Filtration Techniques (15 Periods)

Principles, procedure, types and application of electrophoresis. Types – Polyacrylamide gel electrophoresis, SDS-PAGE, 2DElectrophoresis, isoelectric focusing. Agarose gel electrophoresis, staining, fluorescence, pulsed field electrophoresis, high voltage electrophoresis, capillary electrophoresis. Filtration - Theory of filtration, Batch and continuous filters, filter media. Classification of filters - filter press, leaf filters, filter candles, sintered filters, membrane filters.

UNIT IV Spectroscopic method (15Periods)

Beer-lamberts Law, absorption and its transmittance. UV Spectrophotometry principle, instrumentation and application. Flamephotometry: atomic absorbance and emission spectra. AAS, FTIR and NMR

UNIT V Radio Isotope Techniques (15 Periods)

Atomic structure, radiation, type of radio active decay, half- life and units of radioactivity. Detection and measurement of radioactivity- methods based upon ionization GM counter, excitation (scintillation counter). Auto radiography and isotope dilution techniques. radio immuno assay.

REFERENCES

1. Keith Wilson and John Walker. 1994. Principle and Techniques of Practical Biochemistry. 1994. Cambridge Press.

2. Shawney and Randhirsingh, 2001. Introduction to Practical Biochemistry. Narasa publications, New Delhi.

3. Turner, R.B. 1977. Analytical biochemistry. Elsevier, New York.

4. Arumugam, M. 2002. Biomedical instrumentation. Anuradha agengies, Chennai.

5. Bryan, L. 1992. Principles and Techniques of Practical Biochemistry. Williams and Keith Wilson, Cambridge University Press.

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Understand the Principle of centrifugation	K4
CO 2	Understand the General principles of chromatography	K3
CO 3	Understand Principles, procedure, types and application of electrophoresis	K5
CO 4	Understand the UV Spectrophotometry principle	K4
CO 5	Understand the Detection and measurement of radioactivity	K6

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**S**	**S**	**S**
CO 2	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**S**	**M**	**S**	**S**
CO 5	**S**	**S**	**S**	**M**	**S**

S- Strong, M- Medium, L- Low

CORE COURSE : V

ADVANCED VIROLOGY

Semester: II **Max Marks: 60**

Course Code: 20PMB2C5 **Credit : 5***

Total Period: 75 **Exam Hrs: 3**

Objectives

To provide basic idea about viral structure and its significance on immunity.

Create the awareness about viral infection

Acquire skills to viral diagnosis

UNIT I: General Virology **(15 Periods)**

Brief outline on discovery of viruses (origin and evoluation), terminology. Nomenclature and classification of viruses. Morphology and structure of viruses. Chemical composition of viruses. Assay of viruses.

UNIT II: Virus Replication Strategies **(15 Periods)**

Principal events involved in replication: Adsorption, penetration, uncoating nucleic acid and protein synthesis, intracellular trafficking, assembly, maturation and release, viral-host interaction, Host response to viral infection. Cellular interactions—clathrin coated pits, lipid rafts, endocytosis and virus uncoating mechanisms.

UNIT III: Viral vectors **(15 Periods)**

Recombination in phages, multiplicity reactivation and phenotypic mixing General account of Tumor virus (RNA and DNA). Baculovirus System for insect cell lines and its importance Silver lining: viruses as therapeutic agents, viruses for gene delivery, viruses to destroy other viruses

Unit IV: Bacterial viruses **(15 Periods)**

Bacteriophages - structural organization; life cycle (extra cellular phase;attachment, penetration of nucleic acid, transcription, translation, replication, maturation and release of phage particles) of ϕX174,T4, lambda, M13 and Mu Phages. Bacteriophage - typing, one step growth curve.

UNIT V: Pathogenicity and Prophylaxis **(15 Periods)**

Lifecycle, pathogenesis, Diagnosis of HIV, CORONA virus, Hepatits, rabies, EBOLA, influenza virus, H1N1, HTLV virus., Viderabine, Acyclovir, Ganciclovir, Ribavirin, NNRTIS (Non - Nuleoside RT inhibitors) - Nevirapine, Delavirdine and Efavirenz. Protease inhibitors - Saquinavir, Indinavir and Ritonavir. viral vaccines and developments

REFERENCES

1. Dimmock, N.J. and Primrose, S.B.1994. Introduction to Modern Virology. 4th Edition. Science Ltd.

2. Dimmock, N.J., Eatson, A.L, Leppard, K.N. 2007. Introduction to Modern Virology.6th Edition. Blackwell Publishing Ltd.

3. Carter, J. and Saunders, V. 2007. Virology: Principles and Applications. John wiley and Sons publications.,

4. Alan, J. Cann. 1997. Principles of Molecular virology. 2nd Edition. Academic press.

5. Conrat, H.F, Kimball, P.C. and Levy, J.A. 1988. Virology. 2nd Edition. Prentice Hall, Englewood Cliff.

6. Flint, S.J., Enquist, L.W., Krung, R. Racaniello, V.R. and Skalka, A.M. 2000. Principles of Virology, Volume 2, Pathogenesis and Contorl. 3rd Edition. Bookholders.

7. Nicklin, J. Greame, C. and Killington, R. 2003. Instant Notes in Microbiology. 2nd Edition. Viva Books private limited.

8. Saravanan, 2006.Virology. J.C Pillai, MJP publishers.

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Outline on discovery of viruses	K2
CO 2	Understand the Principal events involved in replication	K2
CO 3	Understand the Viral vectors	K3
CO 4	Discuss the Bacterial viruses	K5
CO 5	Know the Pathogenicity and Prophylaxis	K6

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**S**	**S**	**S**
CO 2	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**S**	**M**	**S**	**M**
CO 5	**S**	**S**	**S**	**S**	**S**

S- Strong, M- Medium, L- Low

CORE COURSE : VI

MICROBIAL GENETICS

Semester: II **Max Marks: 60**

Course Code: 20PMB2C6 **Credit : 4***

Total Period: 75 **Exam Hrs: 3**

Objectives

To Impart basic knowledge on genetics

To gain knowledge on gene expression

To Know the principles of gene regulation

UNIT I: Genome and Genetic Material (15 Periods)

Organization of gene- nucleus- chromosome- gene- DNA structure and types. DNA as genetic material – Griffith, Hershey-Chase and Avery experiments. RNA as genetic material. Types and structure of RNA. Genetic code discovery and wobble hypothesis.

UNIT II: DNA replication and Expression (15 Periods)

Replication- general principles, enzymes involved, and methods of replication, Proof-reading and Meselson and Stahl experiment. Inhibitors of DNA replication. Transcription and translation of prokaryotic and eukaryotic gene

UNIT III: Gene Regulation (15 Periods)

Operon concept, co-ordinated control of structural genes, stringent response, catabolite repression, instability of bacterial RNA, inducers and repressors, Lac Operon system. Regulation by attenuation by trp operon. Gene expression - transcription - maturation and processing of RNA - Methylation, capping, polyadenylation and splicing of mRNA, Translation.

UNIT IV : Bacterial Recombinations (15 Periods)

Discovery, gene transfer, molecular mechanism. Bacterial transformation- Competency and resistance. Bacterial conjugation – Sex factor in bacteria, F and HFR transfer, linkage mapping . transduction Bacterial transduction – transduction phenomenon, methods of transduction, co- transduction, generalized, specialized and abortive transduction, sex-ductions.

UNIT V: Mutations (15 Periods)

Spontaneous and induced, basis pair changes, frame shifts, deletions, inversions, tandem duplications, insertions, useful phenotypes (auxotyphic, conditional lethal, resistant), reversion vs. suppression, Ames test - fluctuation test and its significance - complementation. Mutagens- chemical and physical mutagens - UV, NTG and hydroxylamine- mode of action- isolation of auxotroph and drug resistance mutants- DNA damage and repair.

REFERENCES

1. Snyder, L. and Wendy, W. Molecular Genetics of Bacteria, 2/e, ASM press, Washington David Freifelder 1987. Microbial Genetics, Jones & Bartlett, Boston.
2. Watson, J.D., Hoppkins, N.H., Roberts, J.W., Steitz, J.A. and Weiner, A.M. 1987. Molecular Biology of the Gene. 4th Edition. The Benjamin / Cummings Publications Co. Inc. California.
3. Robert, H. Tamarin and William, C. Brown. 1995. Principles of Genetics, 5th Edition, WMC Brown Publishers. Unites States.
4. Lewin, B. 1990. Genes, 6th Edition, Oxford University Press, England.
5. Gardner, E. J., Simmons, M .J and Snustard, D. P. 1991. Principles of Genetics, 8th Edition. John Wiley &Sons. New York.
6. Philip and Gerhardt. 1993. Methods of General and Molecular Bacteriology. ASM Publications.
7. Maloy et al., 1994. Microbial Genetics. Jones and Bartlett Publishers. USA.
8. Dale, J. W. 1994. Molecular Genetics of Bacteria. John Wiley and Sons.
9. Klug, W.S. and Cummings, M.R. 1996. Essentials of Genetics, Mentics Hail. NewJerse
10. Errol, C. Friedberg, Graham, C. Walker and Wolfram Siede. 1995. DNA repair and mutagenesis. ASM Publications. US.
11. Larry, Snyder and Wendy. 1997. Molecular Genetics of Bacteria. ASM Publications. US.
12. Robert, L. Charlebois. 1999. Organization of Prokayotic Genome. ASM Publications. US.
13. James, D. Watson, Tania, A. Baker, Stephen, P. Bell, Alexander Gann, Michael Levin and Richard Losick. 2004. Molecular Biology of the Gene, 5th Edition. Pearson, Benjamin Cummings and CSHL press.
14. Brown, T. A. 2010. Gene Cloning and DNA analysis, 6th Edition, Wiley and Blackwell publishers.

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Understand the DNA and RNA as genetic material	K3
CO 2	Outline the Replication	K2
CO 3	Understand the Gene Regulation	K4
CO 4	Understand the gene transfer, molecular mechanism. Bacterial transformation	K4
CO 5	Understand the Mutations	K6

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**M**	**S**	**S**
CO 2	**S**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**M**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**

S- Strong, M- Medium, L- Low

CORE COURSE : VII

ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

Semester: II **Max Marks: 60**

Course Code: 20PMB2C7 **Credit : 5***

Total Period: 75 **Exam Hrs: 3**

Objectives

To understand the vital role of microorganisms in our ecosystem

To gain knowledge on production of biofertilizer and biopesticides

UNIT I Soil Microbiology **(15Periods)**

Soil - structure, types, physical and chemical properties. Weathering and humus formation, soil pollution. Soil microbes - Microbial flora of soil and factors affecting them. Types of microbial interaction. Outline biogeochemical cycles - carbon, nitrogen, oxygen, hydrogen, phosphorous, sulfur and iron.

UNIT II : Water and Air Microbiology **(15 Periods)**

Water pollution BOD, COD and water borne pathogens. bacteriological examination of water, indicator organisms(MPN). Purification and disinfection of water. Biofouling. Microbes in Air droplet nuclei and air sampling techniques.

UNIT III Recycling of Liquid and Solid Wastes **(12 Periods)**

Composting, biogas, biodegradation, bioremediation, bioleaching, xenobiotic degradation. Microbial corrosion - biofilms degradation of petroleum products . Microbes in mineral leaching and metal concentration, microbial enhanced oil recovery.

UNIT IV Agro Ecosystem **(15 Periods)**

Definition, structure and functioning of agro ecosystems. Microbes in soil formation, role of microorganism in soil fertility, role of microbes in crop production, harmful role of microbes in agro ecosystem. Energy flow in agro ecosystems. System approach, constraints and strategies of IPM implementation. Important role of trees and soil. Characteristics and fertility, microclimate, hydrology associated biological components and productivity.

UNIT V Bioinoculants **(17 Periods)**

Diazotrphs and Plant growth promoting Microbes (PGPM). Biological nitrogen fixation. Mechanism and nif gene regulation. Nitrogenase enzyme complex - azoferredoxin and molybdo ferrodoxin. mechanism of nitrogen reduction. Role of hydrogenase enzyme in nitrogen fixation. Phosphate solublizing bacteria. Production and application of Rhizobium, Azospirillum, Azotobacter, Phosphate solubilizing and utilizing bacteria - Blue green algae, Frankia and Mycorrhizae. Bt-toxin and Trichoderma- mode of action and applications, Integrated pest management. GM crops and its importance.

REFERENCES

1. Michell, R. 1974. Introduction to Environmental Microbiology. Prentice – Hall, Englewood Cliffs.

2. Compbell, R.E. 1983. Microbial Ecology. 2nd Edition. Blackwell Scientific Publications, Oxford.

3. Rheinherimer, G. 1991. Aquatic Microbiology. 4th Edition. John Wiley and Sons publications

4. Dart, R.K.1980. Microbiological aspect of pollution control. 2nd Edition. Elsevier Scientific, Amsterdam.

5. Alexander, M. 1977. Introduction to Soil Microbiology. 2nd Edition. Wiley Black well Publishers, New York, London.

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Understand the Soil - structure, types, physical and chemical properties	K1
CO 2	Know the Microorganisms responsible for water pollution especially Water-borne pathogenic microorganisms	K3
CO 3	Comprehend the various methods to determine the Sanitary quality of water and sewage treatment methods employed in waste water treatment	K3
CO 4	Understand the Agro Ecosystem	K4
CO 5	Understand the Bioinoculants	K5

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**M**	**S**	**S**
CO 2	**S**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**S**	**M**	**S**	**S**
CO 5	**S**	**S**	**S**	**M**	**S**

S- Strong, M- Medium, L- Low

CORE COURSE : VIII

PRACTICAL -II ADVANCED VIROLOGY, MICROBIAL GENETICS, ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

Semester: II **Max Marks: 60**

Course Code: 20PMB2C8P **Credit : 3***

Total Period: 75 **Exam Hrs: 3**

ADVANCED VIROLOGY

Objective: To provide technical skill on viral isolation

1.	Isolation of bacteriophage from sewage	(5 Periods)
2.	Isolation of lambda DNA and their characterization	(5 Periods)
3.	Cultivation and assay of viruses using embryonated egg	(3 Periods)
4.	Microscopic study on Cytopathic effect of viral infected plant leaves	(2 Periods)

MICROBIAL GENETICS

Objective: To impart hands training on microbial genetics

5.	Isolation of Genomic DNA	(5 Periods)
6.	Isolation of Auxotrophic mutant by replica plate method	(5 Periods)
7.	Isolation of drug resistant mutants by gradient plate method	(5 Periods)
8.	Isolation of plasmid DNA by alkaline lysis method	(5 Periods)
9.	Restriction digestion and agarose gel electrophoresis of DNA	(5 Periods)

ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

Objective: To acquired the knowledge about the techniques of agricultural microbiology

10.	Determination of indices of pollution by measuring BOD	(4 Periods)
11.	Determination of COD different effluents.	(4 Periods)
12.	Estimation of chlorides in soil and water sample	(4 Periods)
13.	Algae as indicator of water pollution	(4 Periods)
14.	Isolation of nitrogen fixing bacteria from root nodules of legumes	(4 Periods)
15.	Localization of AM fungi	(5 Periods)
16.	Screening of antagonistic fungi against plant pathogen	(5 Periods)
17.	Determination of phosphate solubulizing bacteria	(5 Periods)

REFERENCES

1. Morag, C. and Tim bury, M.C .1994. Medical Virology. 10th Edition. Churchil Livingstone, London.

2. Dimmock, N.J., Primrose, S.B. 1994. Introduction to Modern Virology 4th Edition.

Blackwell Scientific Publication. Oxford.

3. Topley and Wilsons 1995. Text Book of Principles of Bacteriology, Virology and Immunity. Hodder Arnold.

4. Maloy et al., 1994. Microbial Genetics. Jones and Bartlett Publishers.

5. Dale, J.W. 1994. Molecular Genetics of Bacteria. John Wiley and Sons

6. Streips and Yasbin. 1991. Modern Microbial Genetics. Niley Ltd.

7. Trivedy, R.K. 1998. Advances in Waste Water Treatment Technologies. Volumes I and

II. Global Science Publications.

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Isolate of bacteriophage from sewage	K3
CO 2	Isolate of Genomic DNA	K4
CO 3	Isolate of plasmid DNA by alkaline lysis method	K3
CO 4	Understand the Screening of antagonistic fungi against plant pathogen	K5
CO 5	Determine of phosphate solubulizing bacteria	K5

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**S**	**S**	**S**
CO 2	**M**	**S**	**S**	**M**	**S**
CO 3	**S**	**S**	**S**	**M**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**

S- Strong, M- Medium, L- Low

ELECTIVE COURSE : II

ADVANCED MOLECULAR BIOLOGY

Semester: II **Max Marks: 75**

Course Code: 20PMB2E2A **Credit : 4***

Total Periods: 75 **Exam Hrs: 3**

Objectives:

To educate the students with the advanced tools, technique and methods employed in DNA/ gene cloning and expression as well as in protein Engineering.

UNIT I Gene Expression in Eukaryotes (13 Periods)

Eukaroytic genome organization, Proteins involved in the control of transcription, Protein, protein interactions, Post-translational control, DNA methylation, Cell Signaling, Ligand binding to membrane receptors and its role in regulating transcription, phosphorylation cascade and amplification of signal. Role of chromatin in regulating gene expression and gene silencing.-

UNIT II Genomics (13 Periods)

Physical structure and genetic content of Human genome, Nature of genetic variations: Single nucleotide polymorphism, Large scale variations, conserved and variable domains, Methods for studying variation: RFLPs, VNTR and mini satellites, SSCP and direct Sequencing. Genetic and physical maps of human genome: chromosome maps and markers, clone libraries and Expressed sequence Tag.

UNIT III: Recent Trends in Molecular biology (13 Periods)

Targeted genome editing: ZFNs, TALENs, CRISPRs - Gene targeting: Knock-ins & Knock- out- DNA finger printing- microarrays- RNA interference as a reverse genetic approach.

UNI IV: Applications of Recombinant DNA (15 Periods)

In Medicine: Molecular diagnostics, and gene therapy. In Agriculture: Transgenic plants, insecticide, herbicide resistant plants and antisense technology. In Industry: Commercially available recombinant products, transgenic animals

UNIT V -Social Issues in Molecular Technologies (16 Periods)

Public opinion against the molecular technologies. Legal issues – legal actions taken by countries for use of the molecular technologies. Ethical issues- ethical issues against the molecular technologies. Bioethics, different paradigms of bioethics-national and international. Intellectual Property Rights- Why IPR is necessary, TRIPS &IPR, IPR national and international scenario, IPR protection of life forms.

REFERENCES

1. Principles of gene manipulation and genomics (link is external) -7th Edition-Sandy B. Primorse, Richard Twyman –Blackwell publishing

2. Gene cloning DNA analysis: An introduction (link is external) -6th Edition –T.A. Brown- John Wiley & Sons

3. An introduction to Genetic Engineering (link is external) – 3rd Edition Desmond S.T. Nicholl- Cambridge University Press

4. Molecular Biotechnology: Principles and Applications of Recombinants DNA (link is external)- 4th Edition –Bernad R. Glick, Jack J.Pasternak, Cheryl L. Patten-ASM Press.

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Understand the Eukaroytic genome organization and Proteins involved in the control of transcription	K3
CO 2	Outline the Physical structure and genetic content of Human genome	K2
CO 3	Understand Recent Trends in Molecular biology	K3
CO 4	Understand the Applications of Recombinant DNA	K5
CO 5	Understand the Social Issues in Molecular Technologies	K6

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**S**	**S**	**S**
CO 2	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**S**	**M**	**S**	**S**
CO 5	**S**	**S**	**S**	**M**	**S**

S- Strong, M- Medium, L- Low

ELECTIVE COURSE : II

NANOTECHNOLOGY

Semester: II **Max Marks: 60**

Course Code: 20PMB2E2B **Credit : 4***

Total Period: 75 **Exam Hrs: 3**

Objectives

To acquire the knowledge about role of microorganisms in nanoparticle biosynthesis

UNIT I Basic Concepts in Nanotechnology (15 Periods)

Nanotechnology - Classification of nanostructures, nanoparticles, nano-clusters, nanotubes, nanowires and nanodots, liposomes, cubosomes and hexosomes, lipid based nanoparticles-liquid nanodispersions- solid lipid nanoparticles (SLP), effects of the nanometre length scale - nanoscale dimensions affect properties.

UNIT II Synthesis of Nanoparticles (15 Periods)

Chemical - pyrolysis - inert gas condensation, biological methods of nanoparticle synthesis - silver, zinc oxide, gold and titanium; intracellular synthesis and extracellular synthesis, mechanism of synthesis of nanoparticles, properties; assembly. Inorganic, organic and hybrid nanomaterials.

UNIT III Characterization Techniques (15 Periods)

Structural studies of Nanoparticles - XRD and FT- IR. Microscopic techniques- electron Microscopy- SEM, TEM, biological sample preparation for TEM- scanning probe microscopy- STEM- AFM- confocal Microscopy- Scanning Near Field Microscopy- Spectroscopic and Electrochemical techniques- UV-Vis Spectroscopy- Energy Dispersive X-ray spectroscopy, Mass spectroscopy-types- Nuclear Magnetic Resonance (NMR) spectroscopy.

UNIT IV Biomedical Applications (13 Periods)

Antimicrobial activity of nanoparticles- antibacterial, antifungal, antiviral, antiparasitic, antihelmenthic, mosquito larvicidal, bacterial sporicidal, insecticidal activity, herbicidal activity. mechanism; mode of action of nanoparticles on microbial growth- changes in membrane permeability, oxygen consumption measurement, protein leakage analysis.

UNIT V Biocomputational Approach (17 Periods)

Assembly and characterization of biomolecule–gold nanoparticle conjugates and their use in intracellular imaging - whole-blood immunoassay facilitated by gold nanoshell–conjugate antibodies - assays for selection of single-chain fragment variable recombinant antibodies to metal nanoclusters - surface-functionalized. Nanoparticles for controlled drug delivery - structural DNA nanotechnology - nanostructured DNA templates - probing DNA structure with nanoparticles.

REFERENCES

1. Banerjee, P., Satapathy, M., Mukhopahayay, A. and Das, P. 2014. Leaf extract mediated green synthesis of silver nanoparticles from widely available Indian plants: synthesis, characterization, antimicrobial property and toxicity analysis. Bioresources and Bioprocessing, 1(1), 3.
2. Balaji, S., Mukunthan, K. S. and Kannan, N. 2014. Bio-Nanomaterials: Structure and Assembly. Reviews in Advanced Sciences and Engineering, 3 (3), 250-260.
3. Batley, G.E., Kirby, J.K. and McLaughlin, M.J. 2013). Fate and risks of nanomaterials in aquatic and terrestrial environments. Accounts of Chemical Research; 46 (3), 854–862.
4. Poonam, T. and Sheefali, M.T. 2011. In vitro methods for nanotoxicity assessment: advantages and applications. Archives of Applied Science Research; 3 (2):389-403.
5. Johnston , H. J, Hutchison, G., Christensen, F.M., Peters, S., Hankin, S. and Stone, V. 2010. A review of the in vivo and in vitro toxicity of silver and gold particulates: Particle attributes and biological mechanisms responsible for the observed toxicity. Critical Reviews in Toxicology; 40(4): 328–346.

WEB REFERENCE

6. https://www.coursera.org/learn/stem/lecture/9ZN3W/nanotechnology-around-the-world
7. https://www.coursera.org/learn/nanotechnology/lecture/apP2j/welcome-to-the-course
8. https://fr.coursera.org/learn/stem/lecture/iSFJP/the-burning-of-fossil-fuels

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Understand the Basic Concepts in Nanotechnology	K3
CO 2	Outline the Synthesis of Nanoparticles	K2
CO 3	Understand Structural studies of Nanoparticles	K3
CO 4	Outline the Antimicrobial activity of nanoparticles	K5
CO 5	Understand the whole-blood immunoassay facilitated by gold nanoshell	K6

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**S**	**M**	**S**	**S**
CO 5	**S**	**S**	**S**	**M**	**S**

S- Strong, M- Medium, L- Low

APPLICATION ORIENTED COURSE

MUSHROOM TECHNOLOGY

Semester: II **Max Marks: 60**

Course Code: 20PMB2A2 **Credit : 3***

Total Period: 75 **Exam Hrs : 3**

Objectives

To provide knowledge on application of mushroom

UNIT I Scope and Development of Mushroom (15 Periods)

Classification of edible mushrooms - medicinal value of mushrooms - Edible mushroom cultivation -Types of edible mushroom available in India - Calacybe indica, Volvariella Volvacea, Pleurotus sp., Agaricus bisporus.

UNIT II Nutritive Value and Spawn Production (15 Periods)

Protein, vitamins, minerals, carbohydrates, fibre, fat - Nutritive values and medicinal values - Pure culture-preparation of media (PDA and Oatmeal agar media) sterilization - Preparation of test tube slants to store mother culture - culturing of Pleuretus mycelium on petriplates - Preparation of mother spawn in bottles and polypropylene bags and their multiplication.

UNIT III Cultivation Technology (15 Periods)

Infra structure, substrates (locally available) polythene bag, vessels, inoculation hood - low cost stove -sieves - Cultural rack mushroom unit (Thatched house) - Mushroom bed preparation - Paddy straw, sugarcane trash, maize straw, banana leaves- post harvest technique - packing- transport- storage- short term storage - long term storage- Cultivation of button mushroom.

UNIT IV Pests and Diseases of Edible Mushroom (15 Periods)

Fungal diseases - dry bubble, wet bubble, cob web disease, green moulds, competitor moulds - bacterial diseases - bacterial blotch - viral diseases – insect - sciarid flies, phorid flies, cecid files-mushroom mites – beetles - Nematodes.

UNIT V Economics of Mushroom Cultivation (15 Periods)

Fixed assets, recurring expenditure, labour, and economics of cultivation throughout the year and seasonal growing. Formulation of project report for getting finance from funding agencies. Precautions in mushroom cultivation. Mushroom recipes- western and indian recipes, pickles, powders, jams. Medicinal properties of mushroom.

REFERENCES

1. Baumberg, S., Hunter, I.S. and Rhodes, P.M. 1989. Microbial Products –New approaches. Cambridge University Press, Cambridge.

2. Demain, A.L. and Davies, J.E. 1999. Manual of Industrial Microbiology and Biotechnology. ASM press.

3. Marimuthu.1991. Oyster Mushrooms, Dept. of Plant pathology, TNAU, Coimbatore.

4. Nita Bahl. 1988. Hand book of Mushrooms. 2nd Edition, Vol. I & II.

5. Paul Stamets, J.S. and Chilton, J.S. 2004. Mushroom Cultivator: A practical guide to growing mushrooms at home, Agarikon Press.

6. Swaminathan, M. 1990. Food and Nutrition, Bappco. The Bangalore Printing and Publishing Co. Ltd., Bangalore.

7. Tewari and Pankaj Kapoor S.C. 1988. Mushroom cultivation, Mittal Publications, Delhi.

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Understand the Scope and Development of Mushroom	K2
CO 2	Discuss the Nutritive Value and Spawn Production	K3
CO 3	Outline Cultivation Technology	K3
CO 4	Understand the Pests and Diseases of Edible Mushroom	K5
CO 5	Understand the Economics of Mushroom Cultivation	K6

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**S**	**S**	**S**
CO 2	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**M**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**

S- Strong, M- Medium, L- Low

CORE COURSE : IX

IMMUNOLOGY AND MEDICAL MICROBIOLOGY

Semester: III **Max Marks: 60**

Course Code: 20PMB3C9 **Credit : 5***

Total Period: 75 **Exam Hrs: 3**

Objectives:

To provide idea on immune system

To impart the knowledge immunological reaction

UNIT I-Immunity **(15 Periods)**

Types of immunity-innate and acquired immunity. Mechanism of cell mediated and humoral immunity. Antigens: Definition, Types of antigens, factors influencing antigenicity. Immunoglobulin and immunozymes. Monoclonal antibodies-production and applications. Complement cascade activation.

UNIT II: Hypersensitivity **(15 Periods)**

Allergens and Allergic reactions: Types (I, II, III, IV), Mediators of hypersensitivity reactions, mechanism of mast cell degranulation and detection of type I hypersensitivity. Mechanism of Erythroblastosis fetalis. Arthus reaction and contact dermatitis. Delayed type Hypersensitivity- Tuberculin reaction. RIST and RAST.

UNIT III Immune Tolerance **(15 Periods)**

Clonal selection- positive and negative selection. Self and non self antigen recognition. Auto immunity and disorders. MHC and antigen presentation. HLA antigen and transplantation. graft rejection and prevention by HLA typing. Tumor immunology.

UNIT IV -Medical Microbiology **(15 Periods)**

Host microbe interaction. Infection and route of infection, infectious dose, Pathogenicity and Virulence factors. Mechanisms of microbial pathogenesis. Types of infectious diseases – bacterial diseases (α and β hemolytic Streptococcal infection, Cholera, Typhoid, Tuberculosis, meningitis, gonococci infection), Fungal diseases (Cutaneous mycoses, systematic mycoses, opportunistic mycoses), and Protozoan diseases – Amoebiasis, Giardiasis, Malaria, W.branchrafti.

UNIT V -Diagnosis and Control of Microbial Diseases **(15 Periods)**

Collection processing of different specimen. Detection of antigen from the agent by immunologic assay (enzyme immunoassay [EIA], fluorescein-labeled (or peroxidase-labeled) antibody stains). DNA-DNA or DNA-RNA hybridization to detect pathogen- specific genes in specimens. Detection and amplification of nucleic acid in specimens. Principle and significance of chemotherapy and susceptibility testing. Mode of action of antiviral and antifungal drugs. components of vaccine and Vaccines under trail.

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Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Understand the innate and acquired immunity, Mechanism of cell mediated and humoral immunity	K4
CO 2	Understand the Allergens and Allergic reactions	K5
CO 3	Discuss the Immune Tolerance	K4
CO 4	Understand the Types of infectious diseases	K5
CO 5	Outline the Diagnosis and Control of Microbial Diseases	K6

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**S**	**S**	**S**
CO 2	**M**	**S**	**S**	**S**	**M**
CO 3	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**S**	**M**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**

S- Strong, M- Medium, L- Low

CORE COURSE: X

FOOD AND DAIRY MICROBIOLOGY

Semester: III **Max Marks: 60**

Course Code: 20PMB3C10 **Credit : 4***

Total Period: 75 **Exam Hrs: 3**

Objectives:

The subject aims to provide concept on important food microbes

To create knowledge on food fermentation and food preservation,

To provide idea on food spoilage and food safety

UNIT I Food Microbiology (15 Periods)

Microbial flora of fresh foods: Milk as a growth medium of bacteria, normal micro flora of milk, undesirable microorganisms in milk and normal micro flora of meat, poultry, eggs, fruits and vegetables. Intrinsic and extrinsic factors that affect growth and survival of microbes in foods.

UNIT II Food Spoilage and Contamination (15 Periods)

General principles underlying food spoilage and contamination. Microbial spoilage of food- Fresh food, fresh milk, canned food and stored grains. Microbiological examination of food: microscopic examination and culture, phosphatase test of Pasteurized milk.

UNIT III Fermented Food and Food Preservation (15 Periods)

Microbiologically fermented food- Curd, cheese, idli, yogurt, acidophilic milk, microorganisms as food SCP- food borne diseases. Food preservation methods principles of food preservation– asepsis, removal of microorganisms, anaerobic conditions, high and low temperatures, drying, radiation. Chemical preservatives-food additives.

UNIT IV Microbiology of Milk and Dairy Products (15 Periods)

Bacteriological examination of milk. Preservation of milk, pasteurization –different methods and advantages, sterilization, dehydration, bacteriological standards and grading of milk. fermented dairy products- cheese, cultured buttermilk, ice cream, condensed and dry milk products, yoghurt, low lactose milk.

UNIT V Food Borne Diseases and Sanitation (15 Periods)

Food borne diseases: food spoilage and Food intoxications: Staphylococcus aureus, Clostridium botulinum and mycotoxins; Food infections: Bacillus cereus, Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes and Campylobacter jejuni. White gut disease of shrimp (Vibrio parahaemolyticus). Hazard Analysis Critical Control Points (HACCP).

REFERENCES

1. Casida, L.E.1968.Industrial Microbiology.Wiley,New York, London.

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4. Rose,A.H. 1983. Food Microbiology. Academic press, London.

5. Garbutt,J.H. 1997. Essential of Food Microbiology. Arnold, London.

6. Wood,B.J.B.1998. Microbiology of fermented foods.2nd Edition. blackie academic and professional London.

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Understand the Microbial flora of fresh foods	K3
CO 2	Outline General principles underlying food spoilage and contamination	K4
CO 3	Understand the Fermented Food and Food Preservation	K4
CO 4	Discuss Microbiology of Milk and Dairy Products	K5
CO 5	Understand the Food Borne Diseases and Sanitation	K6

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**S**	**S**	**S**
CO 2	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**M**	**S**

S- Strong, M- Medium, L- Low

CORE COURSE: XI

RECOMBINANT DNA TECHNOLOGY

Semester: III **Max Marks: 60**

Course Code: 20PMB3C11 **Credit : 5***

Total Period: 75 **Exam Hrs: 3**

Objectives:

To understand the role of enzymes in genetic engineering

To provide knowledge on vectors in cloning

To create awareness on molecular techniques.

UNIT I: Enzymes in Rdna **(15 Period)**

Developments in recombinant DNA technology. Enzymes used in recombination: restriction endonucleases (type I, II, III), properties, nomenclature. DNA ligase: Properties and specificity, alkaline phosphatase, polynucleotide kinase, DNA polymerase, reverse transcriptase and its mode of action. Cohesive and blunt end ligation, linkers, adaptors and homopolymeric tailing. Labeling of DNA – nick translation, random priming, radioactive and non-radioactive probes.

UNIT II: Vectors in Genetic Recombination **(15 Period)**

Properties, incompatibility, isolation and purification techniques, plasmid vectors and their properties, PBR322 – its construction and derivatives, Bacteriophage lambda (λ) as a vector: essential features, organization of λ genome, λ EMBL vectors. Phagemids, insertion and replacement vectors, cosmids , Expression vectors – pMal and pET based vectors.

UNIT III: Cloning Methodologies **(15 Period)**

Cloning strategies. Insertion of foreign DNA into host cells, isolation of mRNA and total RNA, cDNA and genomic libraries , cDNA and genomic cloning, short gun cloning, directed cloning, phage display. Expression of gene cloning and screening methods-Insertional inactivation, colony hybridization-blotting techniques.

UNIT IV: Gene Transfer Techniques **(15 Period)**

.Physical methods: Electroporation, Micro injection, Genegun method. Chemical: Calcium phosphate mediated, DMSO and liposome. Bacterial:Agrobacterium mediated. Viral:Baculovirus and Herpes and adeno virus mediated

UNIT V: Sequencing Methods **(15 Period)**

DNA sequencing (Enzymatic, chemical & automated sequencing), Chemical synthesis of oligonucleotides, Gene silencing techniques - introduction to siRNA, siRNA technology, micro RNA, principle and application of gene

silencing , cDNA and intragenic arrays, differential gene expression and protein array# and Next generation sequencing (NGS).

REFERENCES

1. Watson, J.D., M.Gillman, J.Witknow Ski and M.Zoller. Recombinant DNA (2nd Ed), Scientific Americans books, New York. 1992.

2. Innis, M.A., D.H. Gelfant&J.J.Sninskey.. PCR Strategies,. IRL Press. 1995.

3. Watson, JD. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner. Molecular Biology of the Gene. 6th Edition. Benjamin Cummings Publishing Company Inc. 2007.

4. Brown TA., Gene cloning and DNA Analysis. 6th edition, Wiley Blackwell Publishing. 2010. T.B.2. 2. Primrose S.B., R.M. Twyman.. Principles of Gene Manipulation and Genomics. S.B.University Press. 2013.

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Understand the Developments in recombinant DNA technology	K4
CO 2	Discuss the Vectors in Genetic Recombination	K4
CO 3	Understand Cloning strategies	K4
CO 4	Outline the Gene Transfer Techniques	K5
CO 5	Understand the DNA sequencing and method	K6

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**S**	**M**	**S**	**S**
CO 5	**S**	**S**	**S**	**M**	**S**

S- Strong, M- Medium, L- Low

CORE COURSE: XII

Practical-III Immunology and Medical Microbiology, Microbial Food Technology and Recombinant DNA Technology

Semester: III **Max Marks: 60**

Course Code: 20PMB3C12P **Credit : 5***

Total Period: 75 **Exam Hrs: 6**

IMMUNOLOGY AND MEDICAL MICROBIOLOGY (P)

Objectives: To provide skills on Immunology and Medical Microbiology diagnosis

1.	Bacterial agglutination WIDAL test	(5 Periods)
2.	Haem agglutination blood grouping	(5 Periods)
3.	precipitation – ouchterlony double diffusion	(5 Periods)
4.	Isolation and identification of pathogen from urine	(5 Periods)
5.	Isolation and identification of pathogen from pus	(5 Periods)
6.	Antibiotic sensitivity testing – E test	(5 Periods)
7.	Determination of MIC	(5 Periods)

MICROBIAL FOOD TECHNOLOGY (P)

Objectives: Understand the importance of safe handling of food and the role of microorganisms in environment, Industry and in maintenance of health.

8.	Isolation of bacteria and fungi from Spoiled bread and tomato	(5 Periods)
9.	Methylene blue reduction tests	(3 Periods)
10.	Coagulation test for milk	(3 Periods)
11.	Alkaline posphatase test	(4 Periods)

RECOMBINANT DNA TECHNOLOGY (P)

Objectives: To improve knowledge and enhance skills to the state- of- Gene technology

12.	Preparation of competent cell	(5 Periods)
13.	Transformation and blue white selection	(5Periods)

14. Demonstration of PCR (5 Periods)

15. Demonstration of RAPD (5 Periods)

16. Demonstration of Blotting techniques (5 Periods)

REFERENCES

1. Labortory manual in microbiology – T .sundararaj

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B.J. and Reddy, G.L.B.(1995) New central book agency (P) Ltd. Calcutta.

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15. Brown TA Gene cloning and DNA Analysis ,7th edition ,Wiley Blackwell.2015.

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Perform the Haem agglutination blood grouping	K4
CO 2	Perform the Antibiotic sensitivity testing – E test	K4
CO 3	Perform Coagulation test for milk	K5
CO 4	Perform Preparation of competent cell	K5
CO 5	Demonstrate the Blotting techniques	K5

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**

S- Strong, M- Medium, L- Low

ELECTIVE COURSE: III

FERMENTATION TECHNOLOGY

Semester: III **Max Marks: 75**

Course Code: 20PMB3E3A **Credit : 4***

Total Period: 75 **Exam Hrs: 3**

Objectives:

To empower the student knowledge on designs of fermentor .

To give Knowledge on fermentation and product recovery

UNIT I-Introduction (15 Periods)

Industrially important microorganism – screening techniques – primary and secondary screening – strain improvement techniques– isolation of auxotrophic mutant and revertant. Development of inoculums for various fermentation process. Preservation of industrial cultures

UNIT II-Media & Sterilization (15 Periods)

Media for industrial fermentation – Crude and synthetic media , components of fermentation – Carbon ,Nitrogen, vitamins and minerals sources , role of buffers, Precursors , inhibitors , Inducers and antifoams. Types of fermentation – solid state and liquid state (stationary & submerged) . Types of Sterilization in fermentation unit-Batch and continuous (spiral heat exchangers) .

UNIT III-Fermentor (15 Periods)

Fermentor- design of fermentor – types of bioreactors –Airlift, tower and stirred bioreactor. Control and monitoring of different parameters in bioreactor (pH, temperature, dissolved oxygen, foaming and aeration) computer applications in fermentation technology.

UNIT IV- Fermented Products (15 Periods)

Starter culture preparation and maintenance. Inoculum size and its impact. Raw material and Microbial production of wine, ethanol, organic acid – citric acid and lactic acid, amino acid – lysine, enzyme – α-amylase, vitamin B12 , Pre and Probiotic .

UNIT V- Downstream Processing (15 Periods)

Recovery and purification of fermentation products (intracellular and extracellular), cell disruption , precipitation , filtration , centrifugation , solvent recovery , chromatography , ultra filtration and drying , quality assurance of finished products . Immobilization of cell and enzymes.

REFERENCES

1. Prescott, S. C., Dunn, C.G. and Reed, G. 1982. Proscott and Dunn's Industrial Microbiology, 4th Edition. AVI pub. Co., Westport, Conn.

2. Waites, M.J. 2001. Industrial Microbiology. Blackwell Science, Oxford.

3. Patel A.H 2005. Industrial Microbiology. Macmillan India Ltd., Chennai.

4. cassida L.E 1996. Industrial Microbiology. New Age International Publishers, Chennai.

5. Stanbury P.F, Whitaker, A and Hall, S.J (2006). principles of fermentation technology 2nd Edition, Elsevier.

Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Understand the Industrially important microorganism	K3
CO 2	Discuss the Media & Sterilization	K4
CO 3	Understand the design of fermentor and its type	K3
CO 4	Outline the Microbial production	K6
CO 5	Understand the Recovery and purification of fermentation products	K6

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**M**	**S**	**S**
CO 2	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**M**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**

S- Strong, M- Medium, L- Low

ELECTIVE COURSE - III

MARINE MICROBIOLOGY

Semester: III **Max Marks: 75**

Course Code: 20PMB3E3b **Credit: 4***

Total Period: 75 **Exam Hrs: 3**

Objectives:

This subject aims to introduce concept of marine adopted microbes and marine microbial products.

UNIT I Introduction to Marine Microbes (20 Periods)

Marine microbial habitats and diversity - marine environment - properties of seawater, chemical and physical factors of marine environment - Ecology of coastal, shallow and deep sea microorganism - significance of marine microflora. Diversity of microorganism - archaea, bacteria, actinobacteria, cyanobacteria, algae, fungi, viruses and protozoa in the mangroves and coral environments - microbial endosymbionts - epiphytes - coral-microbial association, sponge- microbial association.

UNIT II Cultivation of Marine Microbes and Nutrient Cycling (14 Periods)

Methods of studying marine microorganisms - sample collection - isolation and identification. Cultural, morphological, physiological, biochemical and molecular characteristics - preservation methods of marine microbes. Role of microorganisms in carbon, nitrogen, phosphorous and sulphur cycles in the sea under different environments and mangroves.

UNIT III Marine Extremophiles and Bioremediation (15 Periods)

Survival at extreme environments - starvation - adaptive mechanisms in thermophilic, alkalophilic, osmophilic and barophilic, psychrophilic microorganisms - hyperthermophiles, halophiles and their importance. Microbial consortia and genetically engineered microbes in bioremediation of polluted marine sites - heavy metals and crude oil. Biofouling and their control.

UNIT IV Seafood Microbiology (14 Periods)

Resource of seafood and preservation methods. Pathogenic microorganisms, distribution, indicator organisms, prevention and control of water pollution, quality standards, international and national standards. Microbiology of processed finfish and shellfish products. Rapid diagnosis of contamination in seafoods and aquaculture products.

UNIT V Marine Microbial Products (14 Periods)

Marine microbial products - carrageenan, agar-agar, sea weed fertilizers - astaxanthin, β carotene -enzyme - antibiotics - antitumour agents – polysaccharide - biosurfactants and pigments. Preservation methods of sea foods.

Quality control and regulations for microbial quality of fishes, shellfish, marine drugs and Marine living resources used for food and drugs.

REFERENCES

1. Belkin, S. and Colwell, R.R. 2005. Ocean and health: Pathogens in the Marine Environment, Springer.

2. Bhakuni, D.S and Rawat, D.S. 2005. Bioactive marine natural products. Anamaya Publishers, New Delhi.

3. Elay, A.R. 1992. Microbial food poisoning. Chapman and Hall, London.

4. Ford, T.E. 1993. Aquatic microbiology: An ecological approach. Blackwell scientific publications, London.

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7. Krichman, D.L. Microbial Ecology of the Oceans. 2000. Wiley – liss, New York.

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Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Discuss Marine microbial habitats and diversity	K3
CO 2	Understand the Cultivation of Marine Microbes and Nutrient Cycling	K4
CO 3	Understand Survival at extreme environments, hyperthermophiles	K3
CO 4	Understand the Resource of seafood and preservation methods	K4
CO 5	Outline the marine microbial products	K5

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**M**	**S**	**S**
CO 2	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**S**	**M**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**

S- Strong, M- Medium, L- Low

CORE COURSE: XIII

RESEARCH METHODOLOGY

Semester: IV **Max Marks: 75**

Course Code: 20PMB4C13 **Credit: 5***

Total Period: 75 **Exam Hrs: 3**

Objectives:

The aim of the paper thus to strong foundation for the students to understand some basic concepts of research and its methodologies and to write a research report and thesis

UNIT I-Selection of Problem **(15 Periods)**

Stages in the execution of research, choosing a topic to publication - preparation of manuscript – report writing - format of journals-proof reading- sources of information: journals, reviews, books, monographs etc – bibliography.

UNIT II –Literature collection **(15 Periods)**

Research journals - National and International – monographs –Reprints – proof correction – full paper – short communication –Review paper- Citation-h index and impact factor

UNIT III-Biostatistics **(15 Periods)**

Scope – collection – tabulation and classification of data – probability analysis – Graphical diagrammatic representation – mean , median , mode.

UNIT IV-Standard Deviation **(15 Periods)**

Standard error – test of significance – t –test – chi – square test – One way ANOVA table – p value- simple correlation – regression , confidence intervals of regression lines.

UNIT V-National Indian Research centers **(15 Periods)**

Role and research funding government sectors ICMR (JALMA, VCRC,TB research centre) IARI-CFTRI-CPRT-CSIR (CLRI-CECRI)-NCCL-IMTECH-

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Course Outcomes:

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

CO Number	CO STATEMENT	KNOWLEDGE LEVEL
CO 1	Understand the choosing a topic to publication	K1
CO 2	Understand the Research journals	K2
CO 3	Outline tabulation and classification of data	K3
CO 4	Understand the Standard Deviation	K4
CO 5	Discuss the Role and research funding government sectors	K4

Mapping with Programme Outcomes:

Cos/Pos	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**M**	**M**	**S**	**S**
CO 2	**M**	**S**	**S**	**M**	**S**
CO 3	**S**	**S**	**S**	**M**	**S**
CO 4	**S**	**S**	**M**	**S**	**S**
CO 5	**S**	**S**	**S**	**M**	**S**

S- Strong, M- Medium, L- Low