Course Name: Master of Science

Discipline : Microbiology

CHOICE BASED CREDIT SYSTEM

(For those who joined in June 2024 and after)

Course Objectives:

The objectives of postgraduate training are orienting the students for research towards higher degrees, or in the field of development of industrial processes. The expectations and opportunities available for Masters Students are responsible positions in technical production, planning and policy making, both in research and industry. Though all postgraduate students do not undertake research career, but all the researchers necessarily come from postgraduates in the subject and therefore postgraduate curriculum in all its different aspects such as design, implementation and evaluation needs necessarily to be research oriented. Imparting in-depth fundamental knowledge of the diverse areas of the discipline, combined with acquaintance with front-line research trends and developments in related field is the aim of postgraduate curricula. The curriculum should be designed in such a way, that after their postgraduate studies, students should be able to work directly in the applied field (industry or research institute) without any additional special training. After completing this curriculum the students should be able to take up the following responsibilities:

1. Research at national, international level.
2. Higher positions in biotech production units
3. Planning and policy making for Microbiology/ Biotechnology
4. Teaching at undergraduate / postgraduate level courses in Microbiology Biotechnology

To keep the syllabus relevant to national needs, the guidelines from CSIR and UGC curricula for research fellowship were taken into account. Syllabus reforms involved discussions with experts from educational institutes, research and industry as well as few past and present students.

Eligibility for Admission:

Candidate who has passed the B.Sc. degree in (any Life Sciences) Microbiology / Applied Microbiology/ Industrial Microbiology/ Botany/ Plant Sciences and Plant Biotechnology/ Zoology/ Animal Science/ Applied Animal Science and Animal Biotechnology/ Biochemistry/ Bioinformatics/ Biology/ Life Sciences/ Home Science/Food Science & Nutrition/ Chemistry with Botany or Zoology and B.Voc. degree in Food Safety and Quality Management/ Environmental Sciences as Allied Subjects of this University or any other University accepted by the Syndicate as equivalent there to shall be eligible for admission to M.Sc. Degree Course in Microbiology.

Duration of the Course:

The course for the degree of Master of Science in Microbiology shall consist of two academic years divided into four semesters.

Core Practicals (100 marks) the duration of Practical Examination for M.Sc. (Microbiology) exam shall be 9 Hrs; 2 Consecutive days (6+3=9 Hours).

Programme – Master of Microbiology

Programme Outcomes

Postgraduate (M.Sc. Microbiology) is 2-year degree programme with 4 semesters consisting the following Programme Outcomes (POs) under various criteria including critical thinking, problem solving, effective communication, societal/ citizenship/ ethical credibility, sustainable growth and employable abilities.

PO1: Disciplinary Knowledge: Capable of demonstrating detailed knowledge and expertise in all the disciplines of the subject.

PO2: Communication Skills: Able to express thoughts, ideas, concepts, scientific information, experiments and its significance effectively in writing and verbal, communicate with confidence to different groups, using appropriate media.

PO3: Moral and Ethical Awareness: Ability to employ values in conducting one's life, use ethical practice at work, avoiding fabrication, misinterpretation and plagiarism, adhering to intellectual property rights and appreciate ethical solutions for environmental sustainability.

PO4: Analytical Reasoning: Ability to evaluate the reliability and relevance of evidence, identify flaws, analyze and synthesize data from different sources.

PO5: Contribution to Society: Solve public issues concerned with public health and safety for the welfare of the society.

PO6: Scientific Reasoning: Ability to identify, analyze, interpret and draw conclusions from qualitative and quantitative data, critically evaluate ideas, evidences and experiences, with an open mind and reasoned perspective.

PO7: Employability Skill: Equip with skills, based on current trends and future expectations for career development and placements.

PO8: Entrepreneurial Skill: To create efficient entrepreneurs by accelerating critical thinking, problem solving, decision making and leadership qualities to facilitate start-ups.

PO9: Research Related Skill: A sense of inquiry and capability for questioning, problem arising, synthesizing and articulating. Ability to recognize cause and effect relationships, define problems, formulate and test hypothesis, analyze, interpret and draw conclusions from data, establish hypothesis, predict cause and effect relationships, ability to plan, execute and report the results of an experiment or investigation.

PO10: Lifelong Learning: Identify the need for skills necessary to be successful in future, through self- paced and self - directed learning aiming at personal development, meeting economic, social and cultural objectives, adapting to changing trends and demands of work place.

PO11: Instrumentation Skill: Able to handle conventional and sophisticated instruments thereby acquiring employability skills.

PO12: Leadership Readiness and Qualities: Capability for building a team, identifying the tasks, setting direction, formulating an inspiring vision, employing skills to reach the right destination, smoothly.

PO13: Information/ Digital Literacy: Ability to use software for interpretation and analysis of data in a variety of learning situations.

PO14: Cooperation and Team Work: Ability to work effectively with diverse teams, facilitate cooperative or coordinated effort on the part of a group and act together as a group or as a team in the interest of a common cause and work efficiently as a member of a team.

Programme Specific Outcomes

PSO-1: Placement: Prepare the students in varied disciplines like agriculture, industry-medical, pharma, dairy, hotel, food and food processing, immunological, cosmetics, vermitechnology and water treatment for effective and respectful placement.

PSO-2: Entrepreneurship: To create effective entrepreneur by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate start-ups and high potential organizations.

PSO-3: Research and Development: Design and implement HR systems that comply with good laboratory practices, following ethical values, leading the organization towards growth and development. .

PSO-4: Contribution to Society: To contribute to the development of society and produce microbiological products, by collaborating with stake holders, related to the betterment of environment and mankind at the national and global level.

I year M.Sc. MICROBIOLOGY

Semester	Part	Subject Name	Hours	Credit	Int + Ext =Total	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject Code	Revised / New / No Change / Interchanged & Percentage of Revision
I	Core I	**General Microbiology and Microbial Diversity**	5	4	25+75=100			✔						✔			**P24MBC11**	**Revised 50%**
	Core II	**Microbial Physiology**	5	4	25+75=100			✔						✔			**P24MBC12**	**New**
	Core III	**Microbial Biochemistry**	4	3	25+75=100	✔										✔	**P24MBC13**	**Interchanged (moved from II Semester)**
	Core IV	**LAB: General Microbiology and Microbial Diversity & Microbial Physiology**	6	5	40+60=100			✔								✔	**P24MBCP11**	**Revised 30%**
	Core V	**LAB: Microbial Biochemistry**	6	5	40+60=100			✔								✔	**P24MBCP12**	**Revised 50%**
	Elective 1	**Microalgal Technology**	4	3	25+75=100	✔										✔	**P24MBE11**	**Revised 10%**
	Total		**30**	**24**														
II	Core IV	**Immunology**	5	4	25+75=100			✔						✔			**P24MBC21**	**Revised 10%**
	Core V	**Medical Microbiology**	4	4	25+75=100			✔						✔			**P24MBC22**	**Revised 40%**
	Core VI	**Molecular Biology & Recombinant DNA technology**	5	4	25+75=100	✔								✔			**P24MBC23**	**Revised 30%**
	Core VII	**LAB: Immunology & Medical Microbiology**	6	4	40+60=100			✔								✔	**P24MBCP21**	**Revised 30%**
	Core VIII	**LAB: Molecular Biology & Recombinant DNA technology**	6	4	40+60=100	✔										✔	**P24MBCP22**	**Revised 40%**
	NME	**Personal Health & Hygiene**	4	4	25+75=100	✔										✔	**P24MBN21**	**Revised 10%**
	Total		**30**	**24**														

*For II Year PG Microbiology, **Internship/Industrial** training should be carried out for 60 hours during II semester vacation. **2 extra credits** will be awarded on completion of the internship with report.

III SEMESTER

Part	Course code	Course Title	Hours	Credit	Marks			Focus on Employability/ Entrepreneurship/ Skill Development
					I	E	Total	
Core 11		Environmental & Agricultural Microbiology	5	4	25	75	100	Skill Development
Core 12		Food Microbiology	5	4	25	75	100	Skill Development
Core 13		Research Methodology and Biostatistics	4	4	25	75		
Core 14 Lab		Lab: Environmental & Agricultural Microbiology	6	4	40	60	100	Focus on Employability
Core 15 Lab		Lab: Food Microbiology	6	4	40	60	100	Focus on Employability
Elective 2		Bioinformatics	4	4	25	75	100	Skill Development
Total			30	24				

IV SEMESTER

Part	Course Code	Course Title	Hours	Credit	Marks			Focus on Employability/ Entrepreneurship/ Skill Development
					I	E	Total	
Core 16		Industrial Microbiology	5	4	25	75	100	Skill Development
Elective 3		Marine Microbiology	5	4	25	75	100	Entrepreneurship
Core 17		Project/Internship	20	10	40	60	100	Focus on Employability
Total			30	18				

CORE 1 - GENERAL MICROBIOLOGY AND MICROBIAL DIVERSITY

Contact Hours per semester: 75 **Credits: 4**
Contact Hours per week: 5 **Subject code: P24MBC11**

Course Outcomes:

COs	CO Statement
CO1	Provide an idea about the major types of microbes
CO2	Evaluate the importance of the contributions to microbiology
CO3	A basic knowledge of the biology and growth of microorganisms
CO4	The extent knowledge on the major concepts related to prokaryotic diversity and to develop key quantitative skills.
CO5	An overview of microbial diversity and the need to explore on identification of new microorganisms with potential applications in biotechnology.

Unit I **(15 Hours)**

Introduction – History and Scope of Microbiology – Contributions of Anton Von Leeuwenhoek, Robert Koch, Louis Pasteur, Edward Jenner, Winogradsky and Francesco Redi –Classification of Microorganisms – Whittaker's five kingdom concept, Bergey's Manual of Systemic Classification –Morphology of bacteria – structure and functions of cellular components of bacteria – Capsule, Golgi apparatus, Mesosomes, Endoplasmic reticulum, Ribosomes - Bacterial locomotion and sporulation mechanisms.

Unit II **(15 Hours)**

Microscopy – Bright field microscopy, Dark field microscopy, Phase contrast microscopy and electron microscopy (SEM and TEM) – Sterilization techniques: Physical and chemical methods – Principles & Application of autoclave, Hot air oven, centrifuge (refrigerated and ultra centrifuge), colorimeter, spectrophotometer, lyophilizer.

Unit III **(15 Hours)**

Microbial Taxonomy – overview - Hierarchy – Taxonomic rank – Classification systems: binomial nomenclature, phenetic, numerical and phylogenetic – Characteristics in taxonomy: Classical, molecular and chemotaxonomy – Assessing microbial taxonomy – Molecular chronometers – Phylogenic trees: rRNA, DNA and proteins as indicators of phylogeny – Polyphasic taxonomy.

Unit IV **(15 Hours)**

Fungal taxonomy – Alexopolus system – General characteristics and reproduction of Vegetative reproduction (Aspergillus), Asexual reproduction (Rhizopus), Sexual reproduction (Agaricus) and life cycle of Saccharomyces – Classification of algae – Fritsch system – General characteristics and reproduction of Chlamydomonas, Dianoflagellates and Blue green algae.

Unit V **(15 Hours)**

General features of Protozoans – life cycle of *Giardia lamblia* and *Trypanosoma gambiense*. General Properties of viruses - Classification of viruses – General characteristics and life cycle of hepatitis B virus, Swine flu virus and HIV.

Text Books:

1. J. M. Willey, L. M. Sherwood, C. J. Woolverton, "Prescott's Microbiology"Published by McGraw-Hill Education, 10th edition, 2017.
2. M. J. Pelczar, E.C.S. Chan and N. R. Kreig, "Microbiology", Tata McGraw Hill Publication, 5th edition, 2001.
3. R. C. Dubey and D. K. Maheshwari, D.K, "A text book of Microbiology", Chand publications, 4th edition, 2015.
4. Prescott, Harley and Klein. 2006. Microbiology (6th Edition). The McGraw-Hill Publishing Co., Ltd., New Delhi.
5. Schlegel, H.G.1993.The text book of General Microbiology. Cambridge University Press,Cambridge.

References Books:

1. Atlas, R.M., 2001. Principles of Microbiology (2nd Edition), Moshby year Book Inc., UnitedStates.
2. Schlegel, H.G.1993.General Microbiology. Cambridge University Press, Cambridge.
3. Stainer, R.Y., Ingraham, Wheelis, M.G. and Paintor, P.R.1986. The Microbial World. PrenticeHall, New Jersey.
4. Tauro, P., Kapoor, K.K. and Yadav, K.S. 1989. An Introduction to Microbiology. WilleyPublications. New Delhi.

CORE 2 – MICROBIAL PHYSIOLOGY

Contact Hours per semester: 75 **Credits: 4**
Contact Hours per week: 5 **Subject Code: P24MBC12**
Course Outcomes:

COs	CO Statement
CO1	The students will gain knowledge about role of macronutrients and micronutrients in growth of microbes.
CO2	Acquire knowledge on prokaryotic and eukaryotic cell structure and its function
CO3	To develop the techniques in involved in microbial growth
CO4	Concern the regulation of metabolism by various pathways.
CO5	Understand about the various pigments essential for photosynthesis

Unit I **(15 Hours)**

Common nutrient requirements of Bacteria – Major Nutritional types of microorganisms: Sources of Carbon, Energy, Electrons - Growth factors (vitamins) - Metabolite Transport – Diffusions: passive and facilitated diffusions – Active transport: Primary active transport and

Secondary active transport – Symport, antiport and uniport — Group translocation (Phosphotransferase system) – Iron uptake.

Unit II **(15 Hours)**

Microbial growth – Growth curve – balanced and unbalanced growth, generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxic growth curve – Measurement of microbial growth: Total count, viable count and turbidity method – Environmental effects on microbial growth: Temperature, pH, Osmotic pressure and Oxygen.

Unit III **(15 Hours)**

Microbial photosynthetic pigments: Chlorophyll, bacteriochlorophyll, rhodopsin, carotenoids, phycobiliproteins – Photosynthesis – Oxygenic and anoxygenic photosynthesis – Carbon fixation – Calvin (C_3) and Hatch-Slack (C_4) pathways – Bioluminescence and its advantages – Sporulation – Endospore formation in bacteria.

Unit IV **(15 Hours)**

Bacterial cell division: Cell division in Gram-negative rods (*E.coli*) – Cell division in Gram-positive rods (*Bacillus*) – Cell division in Gram-negative cocci (*Neisseria*) – Cell division in Gram-positive cocci (*Staphylococci*).

Unit V **(15 Hours)**

Chemolithotrophy: sulphur, iron, hydrogen, nitrogen oxidations and methanogenesis – Biosynthesis of polysaccharides: Patterns of cell wall formation – Hyphae vs. Yeast forms and their significance – Multicellular organization of microbes (*Cyanobacteria).*

Text Books:

1. Madigan,M.T., Mrtinko, J.M. and Parker, J. 2000. Brock Biology of Microbiology (9^{th} Edition). Prentice Printing Hall, New Jersey.
2. Prescott, L.M., Harley, J.P. and Klein, D.A. 2007. Microbiology(8^{th} Edition).Mc Grow Hill, New Delhi.
3. Talaro, K.P. and Talaro, A. 1999. Foundations in Microbiology. Mc Graw Hil. Pub. New Delhi.
4. Davis R.Y. E.A. Adeberg and Ingram, J.L. 1991. General Microbiology. Mc Grow Hill, New Delhi.
5. Ronald M. Atlas. 1997. Principles of Microbiology(2^{nd} Edition). Mc Graw Hill Pub., New Delhi.

References:

1. Doelle H.W. 1969. Bacterial Metabolism. Academic Press, London.
2. Caldwell, D.R. 1995. The Microbial Physiology and metabolism, Wm. C. Brown Publishers, USA.
3. Lansing, Prescott John, M., Harley, P. and Donald, Klein, A. 2003. Microbiology (5^{th} Edition). McGraw Hill Company, New York.
4. Sneath, P.H.A. and Sokal, R.R. 1973 Numerical taxonomy .The Principles and Practice of Numerical Classification. W.H. Freeman, San Francisco.

MICROBIAL BIOCHEMISTRY

Contact Hours per semester: 60 Credits: 3
Contact Hours per week: 4 Subject Code: **P24MBC13**

Course Outcomes:

Cos	CO Statement
CO1	To enable students to acquire a specialized knowledge and understanding the concept of buffer and enzymes.
CO2	To give the knowledge about the metabolism of carbohydrates and their

	participation in bacterial cell wall synthesis.
CO3	To make the students to understand the concept of protein metabolism
CO4	To enable students to acquire a specialized knowledge on lipids metabolism
CO5	To make the awareness to the students about vitamin role and diseases due to the lack of vitamins.

Unit I **(12 Hours)**

Chemistry of life- pH and Buffers; Laws of thermodynamics - First law, second law; Free energy concept - ATP as an energy source; cellular foundations – structural hierarchy in the molecular organization of cells; Enantiomers. Weak interactions in Aqueous Systems; Osmolarity.

Unit II **(12 Hours)**

Carbohydrates - Classification, biological significance; Structure and biological importance of glucose, lactose, maltose, starch and cellulose. Metabolism of carbohydrates - Glycolysis, gluconeogenesis, citric acid cycle; Electron transport chain and oxidative phosphorylation. Glycoconjugates – proteoglycans.

Unit III **(12 Hours)**

Amino acids - Classification and properties; Protein Structure (primary, secondary, tertiary and quaternary) and properties; Protein metabolism – Synthesis of amino acids (α – ketoglutarate precursor family, 3- phosphoglycerate precursor family); Breakdown of amino acids to pyruvate; Globular and structural proteins; Protein misfolding and diseases - alzheimer's disease, sickle cell anemia.

Unit IV **(12 Hours)**

Lipids - Storage lipids and structural lipids; Classification of fatty acids; properties and biological importance of phospholipids, sphingolipids and triglycerides; Lipid metabolism - β- oxidation pathway, biosynthesis of fatty acid (palmitic acid); Lipids as signals; Cofactors, and pigments; Lipid bilayer – peripheral and integrated protein.

Unit V **(12 Hours)**

Nucleic acid metabolism; Vitamins - Dietary sources, biochemical functions and deficiency diseases. Enzyme - Definition, classification, nomenclature, active site, activity unit, isozyme, ribozyme, abzyme; Enzyme kinetics - Michaelis-Menton equation, enzyme inhibition, regulatory enzyme - Allostearism.

Text Books:

1. Jain, J.L., Sunjay Jain and Nithin Jain. 2014. Fundamentals of Biochemistry (7th Edition). S. Chand & Company (P) Ltd., New Delhi.
2. Anusha Baskar and Vidya, V.G. 2009. Enzyme Technology. MJPublications, New Delhi.

Reference Books:

1. Nelson, D. and Cox, M. 2005. Lehninger Principles of biochemistry (4th Edition), W.H. Freeman and Company, New Delhi.

2. Donald Voet., Judith G. Voet. and Charlotte, W. Pratt., 1999. John Wiley & Sons, Inc., New York.
3. Robert K. Murray., Daryl K. Granner., Peter A. Mayes. and Victor W. Rodwell. 2003. Harper's Illustrated Biochemistry (26th Edition), Lange Medical Books/McGraw-Hill, New Delhi
4. Ambika Shanmugam. 2012. Fundamentals of Biochemistry for Medical Students (7th Edition). New Central Agency, Calcutta.

LAB: GENERAL MICROBIOLOGY AND MICROBIAL DIVERSITY & MICROBIAL PHYSIOLOGY

Contact Hours per semester: 90 **Credits: 5**
Contact Hours per week: 6 **Subject Code: P24MBCP11**

Course Outcomes:

Cos	CO Statement
CO1	Demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures
CO2	Know various Culture media and their applications and also understand various physical and chemical means of sterilization
CO3	Know General bacteriology and microbial techniques for isolation of pure cultures of bacteria and fungi
CO4	Know the various Physical and Chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement.
CO5	Comprehend the various methods for identification of unknown microorganisms

1. Staining methods to study morphological and structural characteristics of bacteria and fungi: Gram, Capsule, Negative, Acid-fast, Flagella staining, Spore staining and Fungal staining (Lacto-phenol cotton blue).
2. Pure culture techniques - Streak plate, Spread plate and Pour plate techniques
3. Measurement of bacterial cell size by micrometry method.
4. Catalase & Oxidase test.
5. Hydrolysis of casein
6. Hydrolysis of Starch.
7. Carbohydrate fermentation test
8. Hydrolysis of gelatin
9. Urease test
10. TSI test
11. Determination of bacterial growth by turbidity measurements and to plot bacterial growth curve.
12. Motility of Microorganisms by hanging drop and semi solid agar methods
13. Effect of pH, temperature and osmotic pressure on growth of bacteria.
14. Anaerobic culture techniques
15. Culture preservation techniques (Agar slants, stabs and glycerol stocks)
16. Industrial visit and Report (Visiting R & D Laboratories)

Text Books:

1. Cappuccino, J.G. and Sherman, N. 2002. Microbiology: A laboratory manual (7th Edition), Addison Wesley, New York.
2. Kannan, N. 2002.Laboratory Manual in General Microbiology, Panima Publishers, New Delhi.
3. David R Brooke. Bergey's Manual of systematic bacteriology (Vol 1), Eastern Halz, Springer publication, US. 2007.
4. Gunasekaran P. Laboratory Manual in Microbiology. New Age International Pvt. Ltd. Publishers. New Delhi; 2005.ISBN:81-224- 0783-8

References Books:

1. Kanika Sharma. Manual of Microbiology – Tools and Techniques. 2nd Edition, Ane Books Pvt. Ltd. New Delhi. 2009.ISBN13:978-81-8052- 143-0.
2. Keith Wilson and John Walker. Principles and Techniques of Practical Biochemistry. 5th edition. Cambridge University press, Britain;2005.
3. Nizhny Novgorod. Laboratory manual on Biochemistry: Publishing House of Nizhny Novgorod State medical academy. 2008.

LAB: MICROBIAL BIOCHEMISTRY

Contact Hours per semester: 90 **Credits: 5**
Contact Hours per week: 6 **Subject Code: P24MBCP12**

Course Outcomes:

Cos	CO Statement
CO1	To understand and perform the agglutination reactions.
CO2	To understand the salient features of antigen antibody reaction & its uses in diagnostics and various other studies.
CO3	To understand the concepts of immunohematology
CO4	To estimate the biomolecules.
CO5	To understand the immunotechniques

1. Preparation of buffers: Acetate and phosphate buffer.
2. Buffer: Determination of pKa of a mono protic weak organic acid.
3. Verification of Beer – Lambert's law using $CuSo_4$.
4. Estimation of Carbohydrate (Glucose) – Anthrone method.
5. Estimation of Protein – Lowery's Method.
6. Estimation of DNA – Diphenylamine
7. Estimation of RNA – Orcinol Method.
8. Separation of amino acids by paper chromatography
9. Separation of amino acids by thin layer chromatography.
10. Estimation of SGOT - Demo
11. Estimation of SGPT - Demo
12. DEMO - ELISA, SDS PAGE,
13. Industrial visit and reporting (Visiting nearby R & D Laboratories)

Text Books:

1. Balows, A., Hausler, W.J., Ohashi, M. and Turano.A. (Eds).1988. Laboratory Diagnosis of Infectious Diseases: Principles and Practice. Vol: 1. Springer-Verlag, New York.
2. Holt, J.S., Krieg, N.R., Sneath, P.H.A. and Williams, S.S.T. 1994. Bergey's Manual of Determinative Bacteriology (9th Edition). Williams & Wilkins, UK.
3. Finegold, S.M. 2000. Diagnostic Microbiology (10th Edition). C.V. Mosby Company, St. Louis.
4. Boyer, R. 2001. Modern Experimental Biochemistry(3 rd edition). Benjamin / Cummings Publishing Company Inc., USA.
5. Jayaraman, J. 1981. Laboratory manual in Biochemistry. New Age Int. Publishers, New Delhi.

Reference Books:

1. Betstir, L. 1996. The Microbiology in Practice (6th Edition). Adeland Wesley, Langman, New York.
2. Benson, J.H. 1996. Microbiological applications: A laboratory Manual in General Microbiology (6th Edition). En. C.Brown Publication IOWK, USA.
3. James G.C. and Sharman, N. 1996. Microbiology: A laboratory Manual (4th Edition). The Benjamin/Cummings Publishing Company, USA.
4. Atlas R.M. 2001. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.

e- Resources:

1. URL of the resource 1 – Protein estimation - https://www.youtube.com/watch?v=7o65va089S4
2. URL of the resource 2 – SDS PAGE- https://www.youtube.com/watch?v=i_6y6Z5UvwE
3. URL of the resource 3 – Beer Lamberts Law - https://www.youtube.com/watch?v=0fBSBG8f6VU

Course Title : Elective - Microalgal Technology	**Total Hours : 60**
Course Code : P24MBE11	**Total Credits :3**

Course Outcomes:

COs	CO Statement
CO1	Acquire knowledge in the field of microalgal technology and their characteristics.
CO2	Identify the methods of algal cultivation and harvesting.
CO3	Recognize and recommend the use of microalgae as food, feed and fodder.
CO4	Promote microalgae in phycoremediation.
CO5	Compare and critically evaluate recent applied research in these microalgal applications.

Unit I **12 Hours**

Introduction to Algae - General characteristics. Classification of algae according to Fritsch. Salient features of different groups of algae. Distribution -Freshwater, brackish water and marine algae. An overview of applied Phycology. Economically important microalgae.

Unit II **12 Hours**

Cultivation of freshwater and marine microalgae – Growth media. Isolation and enumeration of microalgae. Laboratory cultivation and maintenance. Outdoor cultivation - Photobioreactors - construction, types and operation; raceway ponds - Heterotrophic and mixotrophic cultivation - Harvesting of microalgae biomass.

Unit III **12 Hours**

Microalgae in food and nutraceutical applications – Algal single cell proteins. Cultivation of *Spirulina* and *Dunaliella*. Value-added products from microalgae. Pigments - Production of microalgal carotenoids and their uses. Phycobiliproteins – production and commercial applications.

Unit IV **12 Hours**

Microalgae in environmental applications. Phycoremediation - Domestic and industrial waste water treatment. High-rate algal ponds and surface-immobilized systems - Treatment of gaseous wastes by microalgae. Sequestration of carbon dioxide. Scavenging of heavy metals by microalgae. Negative effects of algae. Algal blooms, algicides for algal control.

Unit V **12 Hours**

Microalgae as feed stock for production of biofuels -Carbon-neutral fuels. Lipid-rich algal strains - *Botryococcus braunii*. Drop-in fuels from algae - hydrocarbons and biodiesel, bioethanol and biomethane, from microalgae biomass. Biocrude synthesis from microalgae.

Text Books:

1. Lee R.E. (2008). Phycology. Cambridge University Press.
2. Sharma O.P. (2011). Algae. Tata McGraw-Hill Education.
3. Shekh A., Schenk P., Sarada R. (2021). Microalgal Biotechnology. Recent Advances, Market Potential and Sustainability. Royal Society of Chemistry.
4. Lele. S.S., Jyothi Kishen Kumar (2008). Algal bio process technology. New Age International P(Ltd).
5. Das., Mihirkumar. Algal Biotechnology. Daya Publishing House, New Delhi.

Reference Books:

1. Andersen R.A. (2005). Algal culturing techniques. Academic Press, Elsevier.
2. Bux F. (2013). Biotechnological Applications of Microalgae: Biodiesel and Value-added Products. CRC Press.

3. Singh B., Bauddh K., Bux, F. (2015). Algae and Environmental Sustainability.Springer.
4. Das D. (2015). An algal biorefinery: An integrated approach. Springer.
5. Bux F. and Chisti Y. (2016). Algae Biotechnology: Products and Processes. Springer.

e- Resources:

1. https://www.classcentral.com/course/algae-10442.
2. https://onlinecourses.nptel.ac.in/noc19_bt16/preview.
3. https://freevideolectures.com/course/4678/nptel-industrial-biotechnology/46
4. https://nptel.ac.in/courses/103103207
5. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microalgae

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IMMUNOLOGY

Contact Hours per semester: 75 **Credits: 4**
Contact Hours per week: 5 **Subject Code: P24MBC21**
Course Outcomes:

COs	CO Statement
CO1	Detail the organization of the immune system and their functions
CO2	Illustrate the types of Antigen and Immunoglobulin
CO3	Differentiate cell mediated and humoral immune response
CO4	Analyze the factors responsible for Immunodeficiency and auto immune disease
CO5	Choose the appropriate Immunotechnique for diagnosis

UNIT I **(15 hours)**

Introduction to immune system: Immune cell types- Hematopoises and its regulation- Primary lymphoid organs (Thymus and Bone marrow)- Secondary lymphoid organs (Spleen and lymph nodes) – Types of immunity.

UNIT II **(15 hours)**

Antigen and Antibody: Antigen and its types (Exogenous and Endogenous)- Antigenicity and Immunogenicity- Factors affecting Immunogenicity- Haptens- Adjuvants- B and T cell epitopes- Structure of antibody- Functions and Classification of immunoglobulins (Immunoglobulin domains, concept of variability, isotopes, allotypes)- Antigen antibody interactions (Agglutination and precipitation reactions).

UNIT III **(15 hours)**

Antigen Presentation: Endogenous and Exogenous pathway- Antigen Presenting cells- Antigen processing- Antigen presentation- Activation and differentiation of B cells and T cells- T cell subtypes- Role of cytokines- Major histocompatibility complex (MHC)- General organization of H2 and HLA complexes- Structure and functions of Class I and Class II MHC molecules.

UNIT IV **(15 hours)**

Complement systems and Hypersensitivity: Components of complement system- Pathways (Classical and Alternative)- Hypersensitivity- Types of Hypersensitivity (I, II, III, IV), Immune dysfunction: Autoimmunity and its disorder (Rheumatoid Arthritis)- Immunodeficiency and its disorder (Acquired Immuno deficiency syndrome-AIDS).

UNIT V **(15 hours)**

Immune response and techniques: Immune response and its types (Primary and secondary)- Immune response to bacteria, fungi and viruses- Detection of molecules using Enzyme linked Immunosorbent Assay (ELISA)- Radio Immuno Assay (RIA)- Western blotting- Monoclonal Antibody Production (Hybridoma technology) and its application in cancer treatment – Vaccines and their properties- Types (Live, Attenuated and Heat killed vaccines)- Immunization schedule.

Text Book:

1. Kuby, J. 2003. Immunology. W.H. Freeman Co., New York.

Reference Books:

1. Kuby, J. 2003. Immunology. W.H. Freeman Co., New York.
   Roitt, J.M. and Brostaff, J.J. 2004. Immunology (7th edition). C.V. Mosby Publisher, St.Louis, USA.
2. Coleman, R.M., Lambard, M. F. and Siccard. 1992, Fundamental of Immunology (2nd Edition). Tata McGraw Hill Publishing Co., Ltd., New Delhi.
3. Poul, W.E. 1990. Fundamental of Immunology (2nd Edition). Ravar Press, New York
4. Eli Benjamini and Sidney Leskowitz 1994. Immunology- A short course (2nd Edition). Wiley-Liss, USA

e- Resources:

1. http://www.youtube.com/embed/ZoRFcv9WYjs
2. http://www.youtube.com/embed/oqru2Ce8WkI
3. https://www.youtube.com/watch?v=vR1CEAGVMpE
4. https://nptel.ac.in/content/storage2/courses/102103038/download/module3.pdf
5. https://nptel.ac.in/content/storage2/courses/102103038/download/module5.pdf
6. https://nptel.ac.in/courses/104/108/104108055/
7. https://nptel.ac.in/content/storage2/courses/102103038/download/module6.pdf
8. https://nptel.ac.in/content/storage2/courses/102103038/download/module2.pdf
9. https://nptel.ac.in/content/storage2/courses/102103047/PDF/mod5.pdf

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Course Title : Medical Microbiology	**Total Hours : 75**
Course Code : P24MBC22	**Total Credits : 4**

Course Outcomes:

Cos	CO Statement
CO1	Collect, transport and process of various kinds of clinical specimens.
CO2	Analyze various bacteria based on morphology and pathogenesis.
CO3	Diagnose various viral diseases by different methods.(serological, conventional and molecular)
CO4	Educate public about the spread, control and prevention of parasitic diseases.
CO5	Identify the protozoans and helminthes present in stool and blood specimens. Perform serological and molecular diagnosis of parasitic infections.

Unit I **(15 hours)**

Normal microbial flora of Human body. Infection and infection process- routes of transmission of microbes in the body. Collection, transport and Laboratory examination of Specimens:- urine, wounds (pus), sputum, stool, throat and CSF samples.

Unit II **(15 hours)**

Medical bacteriology – General characters, pathogenesis, diagnosis and treatment of *Staphylococcus aureus, Streptococcus pyogenes, Mycobacterium tuberculosis, Mycobacterium leprae, Salmonella typhi, Vibrio cholerae* and *Treponema pallidum*.

Unit III **(15 hours)**

Medical mycology – General characters, pathogenesis, diagnosis and treatment of *Cryptococcus, Candida, Aspergillus ,Mucormycosis, Histoplasma, Coccidioides, Sporothrix, Blastomyces.*

Unit IV **(15 hours)**

Medical virology – General characters, Life cycle, pathogenesis, diagnosis and treatment of HIV, Hepatitis B virus, Polio virus, Ebola virus, Dengue fever virus and SARS (CoV-2).

Unit V **(15 hours)**

Medical Parasitology – General characteristics, Life cycle, Pathogenesis, Epidemiology, Diagnosis, Prevention and Treatments of *Entamoeba histolytica, Plasmodium falciparum, Leishmania donovoni*. Antibacterial, antifungal, antiviral, Anti-protozoan drugs.

Textbooks

1. Prescott, Harley and Klein. 2006. Microbiology (6th Edition). The McGraw-Hill Publishing Co., Ltd., New Delhi.
2. Ananthanarayanan, R. and Jayaram Panicker, C.K. 2005. Text book of Microbiology, orient Long man, London.
3. Jawetz, E., Melnic, J.L. and Adelberg, E.A. 2004. Medical Microbiology(22nd Edition). McGraw Hill companies, New Delhi.
4. Mims, C., Playfair, J., Roitt, Walkelin, D. and Williams, R. 2004. Medical Microbiology (3rd Edition). Mosby publications, US.
5. Greenwood, D. Richard C.B. Salk, John, F. and Peutherer. 2003. Medical Microbiology (5th Edition). Churchill Livingstone, USA.

Course Title : Molecular Biology & Recombinant DNA technology	**Total Hours : 75**
Course Code : P24MBC23	**Total Credits : 4**

Course Outcomes:

Cos	CO Statement
CO1	Describes the Nucleic acids (DNA & RNA) in detail, with respect to both their structure and types.
CO2	Understand the mechanisms of central Dogma (replication, transcription and translation)
CO3	Emphases on gene regulation in prokaryotes and presents the operon concept.
CO4	Provide the molecular features of Genetic recombination.
CO5	Learn the types of mutation and DNA repair mechanisms

Unit I **(15 hours)**

Nucleic acids: Structure of DNA (Watson and Crick's model of DNA) – Different forms of DNA – B DNA, A DNA and Z DNA - Nucleic acids as hereditary material: DNA as genetic material (Griffith and Hershey – Chase experiment). Types of RNA – rRNA, mRNA and tRNA (Clover leaf model). Central Dogma – DNA Replication – Semi conservative Replication of DNA & Rolling circle, Enzymes involved in DNA Replication.

Unit II **(15 hours)**

Transcription: organization of transcriptional units, mechanism of transcription in prokaryotes, Post transcriptional modification of mRNA: capping, polyadenylation and splicing. Translation – Genetic code, Wobble hypothesis and the mechanism of translation. Transposable elements

Unit III **(15 hours)**

Mutation - Spontaneous mutation, Point mutation, Transition and Transversion. Induced mutation: Chemical mutagens and Physical mutagens. DNA Repair Mechanisms – Photoreactivation, Excision Repair, Recombination Repair. Regulation in Prokaryotes – *lac* operon, *ara* operon, *trp* operon.

Unit IV **(15 hours)**

Introduction to rDNA technology – Mode of action and application of Enzymes: Restriction endonucleases (Types I, II and III), DNA polymerase, DNA ligase, Alkaline phosphatase, Methyl transferases, Topoisomerase. Uses of Linkers and adapters. Structural properties and applications of Vectors (Plasmid vectors):- Artificial Vectors: pBR322 and pUC19 – Phage

Based vectors: lambda Vector – Cosmids – Phagemids – Bacterial Artificial Chromosome (BAC) and Yeast Artificial Chromosome (YAC).

Unit V **(15 hours)**

Construction of Genomic library and cDNA library – Principle and applications in analysis of recombinants: Selection and screening of recombinants (Colony hybridization, Insertional inactivation and Blue and white colony selection). Applications of r-DNA technology: Gene therapy;- *Ex vivo*: Serve Combined Immuno Deficiency (SCID) and *In vivo*: Cystic Fibrosis Transmembrane Regulator (CFTR) – Transgenic animals (sheep and mice) – Transgenic plants – Bt cotton and Golden rice.

Text Books:

1. David Freifelder, "Molecular Biology", Jones and Bartlett Publisher, 2/2004.

Reference Books:

1. Verma, P.S., Agarwal, V. K., "Genetics", S Chand and Company limited, 9/2019
2. Maloy, S.R., Freifelder, D. and Cronan, J.E., "Microbial Genetics", Jones and Barlett Publishers, US, 2001.
3. Darnell, J., Lodish, H., and Baltimore, D., "Molecular Cell Biology", Scientific American Books, New York, 1990.
4. Freifelder, D. and Malacinski, G.M. "Essentials of Molecular Biology", John and Bartlett Publishers, London, 1987.
5. Desmound S.T. Nicholl, "An introduction to Genetic Engineering (Second Edition) by (Studies in Biology Series)", Cambridge University Press, Cambridge, 2002.
6. Brown, T.A., "Gene Cloning", Bios Scientific publishers, Oxford University Press, United Kingdom. 1999.

e- Resources:

1. https://www.biochemistry.org/wp-content/uploads/2019/04/BASC02_full.pdf
2. https://www.vanderbilt.edu/AnS/Chemistry/Rizzo/Chem220b/Ch28.pdf
3. http://gdcganderbal.edu.in/Files/a8029a93-30ad-4933-a19a-59136f648471/Link/Transcription_Prokaryotes_2012-c_c610b1f3-17b2-48e8-b488-30de80f05ee7.pdf
4. http://www.bx.psu.edu/~ross/workmg/Struc_Nucleic_Acids_Chpt2.pdf
5. https://chem.ucr.edu/sites/g/files/rcwecm2681/files/2019-10/Chapter23.pdf
6. https://sites.engineering.ucsb.edu/~shell/che170/DNA-notes.pdf
7. https://www.pearson.com/content/dam/one-dot-com/one-dot-com/us/en/higher-ed/en/products-services/sanders-2e-info/pdf/ch8.pdf
8. https://www.cs.cmu.edu/~wcohen/GuideToBiology-pictures-color-release1.5.pdf
9. https://facultystaff.richmond.edu/~lrunyenj/bio554/lectnotes/chapter13.pdf
10. https://docs.ufpr.br/~microgeral/arquivos/pdf/pdf/Transposons.pdf

11. https://www.shcollege.ac.in/wp-content/uploads/NAAC_Documents_IV_Cycle/Criterion-II/2.3.2/ppt/Dr_Gibykuriakose_Transposibleelements.pdf
12. http://www.mantorlab.unimi.it/mantorlab/sito/Teaching_files/Lezione%2012%20-The%20Operon%20model.pdf

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Course Title : LAB: Immunology & Medical Microbiology	**Total Hours : 90**
Course Code : P24MBCP21	**Total Credits : 4**

Course Outcomes:

Cos	CO Statement
CO1	To understand and perform the agglutination reactions.
CO2	To understand the salient features of antigen antibody reaction & its uses in diagnostics and various other studies.
CO3	The students must Master hygiene procedures In connection with lab work withbiological material master techniques for Isolation and identification of pathogens from clinical specimens
CO4	Knowledge of Isolation and identification of mycosis infection and the biochemical tests for identification of medically important organisms
CO5	The students must be able to convey about the appearance of bacteria, ability to cause disease and detection methods of parasites

1. ABO blood grouping and Rh typing.
2. Widal slide test
3. Rapid plasma Reagin (RPR) test and Rheumatoid Arthritis (RA) test.
4. Oucheterlony double diffusion test (ODD).
5. Rocket immunoelectrophoresis.
6. Pregnancy tests.
7. Examination of Bleeding time and clotting time.
8. Blood cell count: RBC count WBC count and DC count.
9. Collection, isolation and identification of (any one) Microorganism from clinical specimens – Urine, Pus sample and throat swab
10. Antibiotic sensitivity test.
11. KOH preparation of hair for fungal observation.
12. Examination of parasites in clinical specimens - Ova/cysts in faeces.
13. Industrial visit and Report - Pharmaceutical, Multispecialty Hospitals and R&D Research Laboratories.

Text Books:

1. Cullimore D. R. (2010). Practical Atlas for Bacterial Identification, 2nd Edition. Publisher-Taylor and Francis.
2. Abbott A.C. (2010). The Principles of Bacteriology. Nabu Press.
3. Parija S. C. (2012). Textbook of Practical Microbiology. Ahuja Publishing House.

4. Cappuccimo, J. and Sherman, N. (2002) Microbiology: A Laboratory Manual, (6th Edition). Pearson Education, Publication, New Delhi.
5. Morag C. and Timbury M.C. (1994). Medical Virology. 4th edn. Blackwell Scientific Publishers.

Reference Books:

1. Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14th Edition). Elsevier, New Delhi.
2. Chart H. (2018). Practical Laboratory Bacteriology. CRC Press.
3. Moore V. A. (2017). Laboratory Directions for Beginners in Bacteriology. Triste Publishing Ltd.
4. Cheesbrough M. (2006). District Laboratory Practice in Tropical countries.- Part 22nd Edition.Cambridge University Press.
5. Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology. Pfaller. 7th Edition. Elsevier, Mosby Saunders.

Course Title : **LAB: MOLECULAR BIOLOGY & RECOMBINANT DNA TECHNOLOGY**	Total Hours : 90
Course Code : **P24MBCP22**	Total Credits : 4

Course Outcomes:

Cos	CO Statement
CO1	Applying the skills gained through the molecular and microbial genetics through various techniques.
CO2	To understand about the method of gene transfer in bacteria through Transformation technique.
CO3	To gain the technical skills involved in extraction, manipulation of biomolecules and identification of gene and its expressions.
CO4	To conduct the antibiotic resistant by replica & gradient plate methods.
CO5	To understand the isolation of genomic & plasmid DNA from bacteria

Experiments

1. Replica plating technique
2. Isolation of antibiotic resistant *E. coli* by gradient plate method
3. Bacterial survival against UV irradiation
4. Transformation in bacterial cell.
5. Isolation of genomic DNA from bacteria.
6. Isolation of Plasmid DNA from bacteria.
7. RNA isolation from yeast
8. Restriction Digestion of Plasmid DNA – Single and Double digestion
9. DNA Ligation
10. PCR demonstration

11. Industrial visit and Submission of Report - International Vaccination Centre, The King Institute of Preventive Medicine and Research, Guindy, Chennai or any others.

Text Books:

1. Dubey R.C. and Maheshwari D. K. (2010). Practical Microbiology. S. Chand.
2. Cappuccimo, J. and Sherman, N. (2002). Microbiology: A Laboratory Manual, (6th Edition). Pearson Education, Publication, New Delhi.
3. Brown T.A. (2016). Gene Cloning and DNA Analysis. (7th Edition). John Wiley and Jones, Ltd.

Reference Books:

1. Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3rd Edition). John Wileys and Sons Ltd. 2012.
2. Maloy S. R., Cronan J.E. Jr. and Freifelder D. (2011). Microbial Genetics. (2nd Edition). Narosa Publishing Home Pvt Ltd.
3. Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5th Edition). ASM Press.

Course Title : NME - PERSONAL HEALTH & HYGIENE	**Total Hours : 60**
Course Code : P24MBN21	**Total Credits : 4**

Course Outcomes:

Cos	CO Statement
CO1	To understand the causes of diseases.
CO2	To have an idea about the types of infection and diseases.
CO3	Investigate the outbreaks of communicable diseases.
CO4	Give awareness about Prevention of disease and promoting health among populations.
CO5	To study about the working of immune system and the effect of chemotherapy.

Unit I **(12 Hours)**

Microbes in the environment and human health. Host microbe relationships – Symbiosis – Infection and disease – Pathogens, pathogenicity and virulence – Normal (indigenous) microflora- Nosocomial infections.

Unit II **(12 Hours)**

Kinds of diseases – Infectious and non-infectious diseases – Methods to prevent airborne and waterborne diseases.

Unit III **(12 Hours)**

Epidemiology – Introduction – Reservoirs of infection – Portals of entry – Portals of exit – Modes of disease transmission – Public health organizations.

Unit IV **(12 Hours)**

Immunity – Introduction – Types of immunity – Adaptive immunity: Active and Passive immunity – Physical barriers – Chemical barriers – Cellular defenses – Vaccine – Vaccination Schedule.

Unit V **(12 Hours)**

Antimicrobial chemotherapy – General properties of antimicrobial agents – Selective toxicity – Spectrum of activity – Mode of action – Side effects.

Text Books

1. Jacquelyn G. Black. 2001. Microbiology: Principles and Explorations(8th Edition),Willy Publications, UK.
2. Eugene Nester, Denise Anderson , Jr., Evans Roberts, C. and Martha Nester. 2007. Microbiology: A Human Perspective(8th Edition). McGraw-Hill Inc.,US.
3. Ananthanarayanan, R. and Jayaram Panicker, C.K. 2005. Text book of Microbiology, orient Long man, London.
4. Jawetz, E., Melnic, J.L. and Adelberg, E.A. 2004. Medical Microbiology(22nd Edition). McGraw Hill companies, New Delhi.
5. Prescott, Harley and Klein. 2006. Microbiology (6th Edition). The McGraw-Hill Publishing Co., Ltd., New Delhi.
6. Mims, C., Playfair, J., Roitt, Walkelin, D. and Williams, R. 2004. Medical Microbiology(3rd Edition). Mosby publications, US.
7. Ananthanarayanan, R. and Jayaram Panicker, C.K. 2005. Text book of Microbiology, orient Long man, London.
8. Greenwood, D. Richard C.B. Salk, John, F. and Peutherer. 2003. Medical Microbiology (5^{th} Edition). Churchill Livingstone, USA.
