PERIYAR UNIVERSITY

Salem-636011

(NAAC A Grade - State University - NIRF Rank 68)

DEPARTMENT OF MICROBIOLOGY

M.Sc., DEGREE

[Choice Based Credit System (CBCS)]

OBE REGULATIONS AND SYLLABUS

(Effective from the academic year 2018-2019 and thereafter)

M.Sc., Microbiology

OBE REGULATIONS AND SYLLABUS

(With effect from the academic year 2018-2019 onwards)

Preamble

Post graduate Microbiology is a course focus on microbiology and its complete diversity exploring their relationship with various environments. Curriculum includes Basics of Microbiology, Immunology & Immunotechnology, Pharmaceutical Biochemistry, Medical Bacteriology and Parasitology, Medical Mycology and Virology, Bioresource Technology, Molecular Biology and Applied Biotechnology, Bio Nano-technology and Infectomics, and Research Methodology and Computational Biology. M.Sc., Microbiology program designed by integrating the knowledge of cutting edge technologies like omics technologies and recombinant technologies for the heterologous expression allowing the generation of new and improved products and services in microbiology. It is envisaged to produce competitive graduates with a great spectrum of proficiency, interdisciplinary focus at par with international qualification. The detailed syllabus for each paper is constructed to inculcate the graduate with outcome based education pattern which provide space for Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation (K1 –K6).

1. General Graduate Attributes:

- **Communication skills:**

  The students gain the ability to accurately and effectively communicate information on microbiology using written, visual and oral reporting formats.

- **Research related skills:**

  The students thinking ability increases with the ability to apply the principles of scientific experimental design and methods to investigate microbiologically relevant problems. They may gain the ability to analyse critique scientific papers in microbiologically relevant research areas.

- **Team work:**

  The postgraduates acquires the ability to work effectively as a member and leader within a team. They are capable to employ the scientific method effectively as part of a collaborative team. And understands the role of network building in career development and has the ability to interact effectively with people from a wide range of backgrounds.

- **Knowledge:**

  The students will gains integrated knowledge on various scientific disciplines such as, microbiology, Immunology & Immunotechnology, Pharmaceutical Biochemistry, Medical Bacteriology and Parasitology, Medical Mycology and Virology, Molecular Biology and Applied Biotechnology, Bio Nano-technology and Infectomics, Food, Soil and Environmental Microbiology Research Methodology and Computational biology.

- **Global Perspective:**

  The graduates may acquire the current and emerging worldwide microbiological technologies, issues, and perspectives during their course period.

- **Critical thinking:**

  The graduates sustains the skill to apply the scientific process, including ability to acquire, assimilate, synthesize, analyze and critique microbiological information.

- **Problem solving:**

  The postgraduate students will have the attitude to evaluate and solve the problems with scientific evidences.

- **Analytical reasoning:**

  The students were enhanced in logical reasoning, critical data evaluation and formation of evidence-based opinions.

- **Scientific reasoning:**

  The students gain demonstrative understanding and evaluation of knowledge as the key to knowledge creation. An intellectual integrity, rigour, reasoning, analysis and interpretation of scientific and technical data.

- **Reflective thinking:**

  The student potential in self-discipline, planning, organizational and time management skills and the ability to work independently will be enhanced.

- **Digital literacy:**

  The data analysis ability to apply specific skills in acquiring, organizing, analyzing, evaluating and presenting microbiological information, in particular incorporating the increasing importance of digital-based activity.

- **Multicultural competence:**

  The students acquire an awareness of and appreciation for, the social and cultural context of the implications of microbiology and microbiological knowledge and investigation.

2. Programme Specific Qualification Attributes

Programme specific qualification attributes achieved through courses in the programme in terms of

- **Knowledge and understanding level (K1 and K2)**
- **Application level (K3)**
- **Analytical level (K4)**
- **Evaluation capability level (K5)**
- **Scientific or synthesis level (K6)**

1. Vision

Aspires to be a reference center for microbiology, committed to an academic excellence and to attain the national and international recognition for the quality of its education, research, and service activities in agriculture, medical and public health

2. Programme objectives and outcomes

PROGRAM EDUCATIONAL OBJECTIVES (PEOS):

PEO1 – To enable the post graduates to develop knowledge and skills in solving challenges in the field of Microbiology.

PE02 – To ensure that graduates will recognize, design and develop sustainable technologies to address the needs of community and expand the career opportunities in academic institute's hospitals / clinical laboratories, food industry, effluent treatment plants, research laboratories and pharmaceutical industry through innovative techniques.

PEO3 – To empower the graduates to develop leadership skills, decision making and serve with societal and ethical responsibilities.

PROGRAMME OUTCOME (POs)

PO1: Gains integrated knowledge on microbiology, Immunology & Immunotechnology, Pharmaceutical Biochemistry, Medical Bacteriology and Parasitology, Medical Mycology and Virology, Molecular Biology and Applied Biotechnology, Bio Nano-technology and Infectomics, Food, Soil and Environmental Microbiology Research Methodology and Computational biology.

PO2: Gains awareness of current and emerging worldwide microbiological technologies, issues, and perspectives.

PO3: Gains the ability to accurately and effectively communicate information on microbiology using written, visual and oral reporting formats.

PO4: Gains the ability to apply the scientific process, including ability to acquire, assimilate, synthesize, analyze and critique microbiological information.

PO5: Gains the ability to evaluate and solve the problems with scientific evidences.

PO6: Develops logical reasoning, critical data evaluation and formation of evidence-based opinions.

PO7: Gain an understanding of and the ability to apply the principles of scientific experimental design and methods to investigate microbiologically relevant problems. An ability to critique scientific papers in microbiologically relevant research areas.

PO8: Gain an ability to work effectively as a member and leader within a team. To be able to employ the scientific method effectively as part of a collaborative team. To understands the role of network building in career development and has the ability to interact effectively with people from a wide range of backgrounds.

PO9: Apply the gained knowledge as the key to knowledge creation. An intellectual integrity, rigour , reasoning, analysis and interpretation of scientific and technical data.

PO10: Recognize the need for planning, organizational and time management skills and the ability to work independently.

PO11: Demonstrate specific skills in analyzing, evaluating and presenting microbiological information, in particular incorporating the increasing importance of digital-based activity.

PO12: Gains an awareness of and appreciation for, the social and cultural context of the implications of microbiology and microbiological knowledge and investigation.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO1: The Graduates will able to work independently on lab protocols involving immunotechniques, identification of unknown pathogens, molecular techniques and biotechnological techniques.

PSO2: Design experiments to prove scientific process and to synthesize product / services for the benefit of community.

PSO3: Microbiologist usually works in hospitals/ clinical laboratories, food industry, environment, research laboratories, pharmaceutical industry and will able to understand industrial processes, cleanrooms, and how to effectively evaluate microbial risks to products from people and processes.

3. Candidate's 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/ Biochemistry/ Bioinformatics/ Biology/Chemistry with Botany/ Zoology as Allied Subjects] of this university or an examination of any other university accepted by the syndicate as equivalent thereto shall be eligible for admission to M.Sc. Degree Course in Microbiology.

4. Duration of the programme

The duration of the course is for two academic years consisting of four semesters.

5. CBCS- Structure of the programme

The programme structure comprises of two parts.

Course Component	**No. of courses**	**Hours of Learning**	**Marks**	**Credits**
Part A (Credit Courses)				
Core courses	16	75	100	5
Elective courses	2	60	100	4
Supportive courses	2	45	100	4
Research	-	-	-	-
Online courses	2			4
Total				
Part B (Self-Learning Credit Courses)				
Elective Foundation courses	2			2
Total	24	180	300	19

6. Curriculum structure for each semester as per your courses alignment

Semester	Paper code	Course	Hrs/ week	Credits	Marks		
					CIA	EA	Total
Sem - I	18MBC01	Core I - Basics of Microbiology	5	5	25	75	100
	18MBC02	Core II - Immunology & Immunotechnology	5	5	25	75	100
	18MBC03	Core III - Pharmaceutical Biochemistry	5	5	25	75	100
	18MBCE01	Elective -1	5	4	25	75	100
	18MBCP01	Core Practical I - General Microbiology	5	4	40	60	100
	18MBCP02	Core Practical Il - Immunology & Pharmaceutical chemistry	5	4	40	60	100
Sem - II	18MBC04	Core IV - Medical Bacteriology and Parasitology	4	5	25	75	100
	18MBC05	Core V - Medical Mycology and Virology	4	5	25	75	100
	18MBC06	Core VI - Bioresource Technology	5	5	25	75	100
	18MBCE02	Elective - 2	4	4	25	75	100
	18MBCS01	Supportive – 1	3	3	40	60	100
	18MBCP03	Core Practical III - Medical Microbiology	5	4	40	60	100
	18MBCP04	Core Practical IV - Industrial Microbiology	5	4	40	60	100
	18MBCI01	Internship	2 wks	-	40	60	100
		Value Education	2	-	40	60	100
Sem - III	18MBC07	Core VII - Molecular Biology and Applied Biotechnology	4	5	25	75	100
	18MBC08	Core VIII – Bio Nano-technology and Infectomics	4	5	25	75	100
	18MBC09	Core IX – Food, Soil and Environmental Microbiology	5	5	25	75	100
	18MBCS02	Supportive - 2	3	3	25	75	100
	18MBCP05	Core Practical V: Molecular Biology and Biotechnology	6	4	40	60	100
	18MBCP06	Core Practical VI: Applied Microbiology	6	4	40	60	100
		Swayam / Mooc Course		2	-	-	-
Sem - IV	18MBC10	Core XI- Research Methodology and Computational biology	6	5	25	75	100
	18MBCPR01	Project	24	4	40	60	100
		Total		94	725	1575	2300

7. Credit Calculation

Method of teaching	Hours	Credits
Lecture	1	1
Tutorial/Demonstration	1	1
Practical/Internship/Self-Learning	2	1

8. CBCS- Scheme of Examinations semester wise structure

9. Examinations

There shall be four semester examinations: first semester examinations at the middle of the first academic year and the second semester examination at the end of the first academic year. Similarly, the third and fourth semester examinations shall be held at the middle and end of the second academic year, respectively.

10. Scheme for Evaluation and Attainment Rubrics

Evaluation will be done on a continuous basis and will be evaluated four times during the course work. The first evaluation will be in the 7^{th} week, the second in the 11^{th} week, third in the 16^{th} week and the end- semester examination in the 19^{th} week. Evaluation may be by objective type questions, short answers, essays or a combination of these, but the end semester examination is a University theory examination with prescribed question paper pattern.

Attainment Rubrics for Theory Courses

External : 75 Marks
Internal : 25 Marks
Total : 100 Marks
Time : 3 hours

The following procedure will be followed for Internal Marks:

Theory Papers Internal

Best two tests out of 3 : 10 marks
Attendance : 5 marks
Seminar : 5 marks
Assignment : 5 marks

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25 marks

Question Paper Pattern (Theory)

Section	Approaches	Mark Pattern	K Level	CO coverage
A	One word (Answer all questions)	20X1=20 (Multiple choice questions)		
B	100 to 200 words (Answer any three out of five questions)	3X5=15 (Analytical type questions)		
C	500 to 1000 words	5X8=40 (Essay type questions)		

Attainment Rubrics for Lab courses

Practical : 40 Internal Marks
Attendance : 5 marks
Practical Test : 30 marks
(Best 2 out of 3)
Record : 5 marks

Attainment Rubrics for Research

Project
Internal Mark : 20 marks
Viva - voce : 20 marks
Project Report : 60 marks

11. Grading System

Evaluation of performance of students is based on ten-point scale grading system as given below.

Ten Point Scale			
Grade of Marks	**Grade points**	**Letter Grade**	**Description**
75 - 100	5.50 - 6.00	O	Outstanding
65 - 74	4.50 - 5.49	A	Very Good
55 - 64	3.50 - 4.49	B	Good
50 - 54	3.00 - 3.49	C	Average
35 - 49	1.50 - 2.99	D	Below Average
25 - 34	0.50 - 1.49	E	Poor
0 - 24	0.00 - 0.49	F	Fail
ABSENT	0.0	AAA	ABSENT

SUBJECT NAME	COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
I SEMESTER													
Basics of Microbiology	Know about the basic aspects of microbiology, different methods of isolation of microorganism, preservation and controlling ofmicroorganism.	✓	✓	✓									
	Learn the basic morphology of different class of microorganism, its cellular components and the classification of different types of microorganism	✓	✓	✓									
	Know about the basic aspects of microbial taxonomy, classification systems and the life cycle of important class of microorganisms	✓	✓	✓									
	Know the basis of microbial physiology with its biochemical	✓	✓	✓									

	pathway and the ecology of the microbes with reference to Extreme Ecosystems.												
	Know the distribution of microorganism, its diversity and the various microbial interactions present in the ecosystem.	✓	✓	✓									
Immunology & Immunotechnology	Describe the basic mechanism of innate and acquired immunity humoral and cell mediate immunity	√	√	√									
	Describe the cellular and molecular mechanism of lymphocyte production and activation		√	√				√	√				
	Understand the cellular process involved in inflammation and immunity, hypersensitivity reactions							√	√				
	Understand the mechanism of clonal selection, antibody diversity and various serological diagnostic techniques based on				√	√	√		√			√	

	antigen – antibody interaction												
Pharmaceutical Biochemistry	Able to draw the atomic, molecular structures and sketch out the orbitals and electronic configurations.	✓		✓		✓							
	Able to work out molar and millimolar conversions to prepare reagents or buffers of required strength for biological experiments and can balance Stoichiometric equations.	✓		✓									
	Able to explain the role of macromolecules in the living systems and can reason out diseases due to vitamin deficiency.	✓		✓		✓							
	Able to explain drug biotransformation reactions and drug interactions in living systems.	✓	✓	✓									
	Able to list the GLPs and standard guidelines to be followed for better instrument maintenance, environment control, preservation of	✓	✓	✓									

	test records and to keep up quality of finished sterile pharmaceutical products.												
	Gain well-rounded knowledge and are fully prepared for employment within the pharmaceutical and biomedical sciences industries.	✓	✓	✓									
Elective -1 Biocontrol and Entomology	The students will be able to know about the importance and applications of the biofertilizers for the sustainable agriculture	✓	✓		✓					✓			
	It provides in-depth knowledge in order to foster biofertilizers to overcome the applications of chemical fertilizers in the modern farming's	✓	✓		✓	✓		✓		✓			
	Provide opportunities for the students to develop bio-entrepreneur for the production of bioferilizers	✓			✓				✓				✓

	In-depth information about exploitation of natural wastes by producing bioorganic fertilizers	✓			✓	✓		✓		✓			
	The students will gain meticulous ideas on production of biopesticides as biocontrol agents					✓		✓		✓			✓
Core Practical I - General Microbiology	Perform the various staining techniques of bacteria and study the growth rate of bacteria.	✓	✓	✓									
	Competently cultivate algae in different types of media.		✓	✓				✓					
	Demonstrate knowledge and understanding of immunology and the means of applying in the diagnostic and therapeutic techniques and research.		✓	✓				✓	✓				

	Understand the safe working practice in an immunology laboratory.		✓	✓				✓	✓				
	Develop skills to design diagnostic kits.		✓	✓				✓					
Core Practical Il - Immunology & Pharmaceutical chemistry	Demonstrate knowledge and understanding of immunology and the means of applying in the diagnostic and therapeutic techniques and research	√					√	√		√	√		√
	Understand the safe working practice in an immunology laboratory	√				√		√		√	√		
	Develop skills to design diagnostic kits	√					√	√		√	√		√

BASICS OF MICROBIOLOGY

Course Code: 18MBC01 **Hours: L + T + P = C**

Marks: 100 **4 1 0 5**

Course Objectives

The course contents are designed to gain knowledge about the different forms of bacteria, fungi, algae, protozoan's along with the basic principles of microbial taxonomy. The learner will understand about the microbial metabolism and microbes thriving in extreme environments.

Course Outcome

At the end of the course, the learner will be able to

CO1. Know about the basic aspects of microbiology, different methods of isolation of

microorganism, preservation and controlling of microorganism.

CO2. Learn the basic morphology of different class of microorganism, its cellular

components and the classification of different types of microorganism.

CO3. Know about the basic aspects of microbial taxonomy, classification systems

and the life cycle of important class of microorganisms.

CO4. Know the basis of microbial physiology with its biochemical pathway and the

ecology of the microbes with reference to Extreme Ecosystems.

CO5.Know the distribution of microorganism, its diversity and the various microbial

interactions present in the ecosystem.

Syllabus

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4, K5)	
I	Introduction to Microbiology	Development of microbiology and the early discoveries Preservation methods of microbes for storage and microscopy studies Culture collections.	Isolation of different types of bacteria – fungi – actinobacteria – cyanobacteria. Sterilization and disinfection – physical and chemical methods for controlling microorganisms	15
II	Morphological types	Gram negative and Gram positive, Cyanobacteria, Archeabacteria and Eubacteria. Ultrastructure of prokaryotic and eukaryotic cells. Fungi: Cell wall - chemical composition and functions, membranes and their functions.	Algae: Structure of algal cells, classification, reproduction, characteristics of Chlorophyta (green algae), Chrysophyta (golden-brown and yellow), Green algae, Diatoms, Euglenophyta (Euglenoids), Rhodophyta (Red algae), Cyanophyta, Xanthophyta, Phaeophyta (Brown algae)	15

III	Microbial taxonomy	Definition, systematics, Nomenclature rules and identification Hierarchical organization and the position of microbes in the living world. Classification systems – Haeckel's three kingdom concept Whittaker's five kingdom concept three domain concept of Carl Woese.	Characterization of microorganisms Morphological, physiological and metabolisms. Modern classification of fungi - Ascomycetes(*Aspergillus*), Deuteromycetes (Candida), Zygomycetes(Mucor), Basidiomycetes(Agaricus), Acrasiomycetes(Dictyostelium), oomycetes (Saproleina) and Myxomycetes (Ceratiomyxa).	15
IV	Microbial respiration and fermentative pathway	Respiratory metabolism - Embden Mayer Hoff pathway - ED pathway Glyoxalate pathway – Kreb's cycle ETC - oxidative and substrate level phosphorylation -TCA cycle gluconeogenesis	Fermentation of carbohydrates - homo and hetero lactic fermentation. Bioenergetics, Cell division - endospore - structure and properties.	15

V	Microbial Ecosystems	Principles of microbial ecology Metabolic diversity - phototrophy, auxotrophy and lithotrophs. Microbial Habitat Nutrient cycles - Nitrogen, Sulphur Phosphorus and Iron, Animal - Microbial symbiosis, Plant - Microbial symbiosis	Microbial ecosystems - Fresh water, soil, plant, hydrothermal vents, hot springs, volcano, Marine (Open oceans and Deep sea organisms), barophiles and space. Microbial communications - Quorum sensing, Cell signaling, Biofilm.	15

References:

Text Books

1. Tortora, G.J., Funke, B.R. and Case, C.L. (2016) *Microbiology: An Introduction*, 11th Edition, Pearson Education, India
2. Madigan, T.M., Martinko, M.J., Bender, S.K., Buckley, H.D., Stahl, A.D. and Brock, T. (2017) *Brock Biology of Microorganisms*. 14th Edition, Licensing agency, UK.
3. Baveja, C.P. and Baveja, V. (2017) *APC Text Book of Microbiology*.4thEdition, Arya Publications, New Delhi.
4. Johanne, M.W., Linda, M.S. and Christopher, J.W. (2017) Willey Prescott's Microbiology 10E.10th Edition. McGraw Hill Education, India.
5. Dubey, R.C. and Maheshwari, D.K. (2013)*A Textbook of Microbiology*. Revised Edition, Chand and company, NewDelhi.
6. MeenaKumari, S. (2011) *Microbial Physiology*. 5th Edition, MJP publishers, Chennai.
7. Wheelis, M. (2008) *Principles of Modern Microbiology*. 4th Edition, Bartlett Publishers, UK.
8. Elizabeth, M.L. (1996). *Fundamentals of the Fungi*. 4th Edition, Prentice Hall International Inc, London.
9. Alexopoulus, C.J. and Mims, C.W. (1996) *Introductory Mycology*. 4TH Edition, Wiley Eastern Ltd. New Delhi.
10. **Lincoln, T. and Eduardo, Z. (2010) *Plant Physiology*, International Edition, 5th Edition,**Sinauer Associates, USA.

Web References

1. www.life.umd.edu/classroom/bsci424/BSCI223WebSiteFiles/LectureList.htm
2. www.microbiologyonline.org.uk
3. www.cambridge.org › Home › Academic › Life science › Microbiology and immunology
4. https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404
5. https://www.boundless.com/microbiology
6. www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635
7. www.grsmu.by/files/file/university/cafedry/.../files/essential_microbiology.pdf
8. https://microbiologyinfo.com/top-and-best-microbiology-books/

CORE - II: IMMUNOLOGY AND IMMUNOTECHNOLOGY

Course Code: 18MBC02 **Hours: L + T + P = C**

Marks: 100 **4 1 0 5**

Course Objectives

The course contents are designed to provide students with knowledge on how the immune system works and to state the role of immune system, be able to compare and contrast humoral and cell mediated immune responses, to distinguish and characterize various immune cells, to understand the mechanism of antibody diversity, to understand the role of cytokines in immunity, to understand the significance of the major histocompatibility and to provide an overview of the interaction between the immune system and pathogens.

Course Outcome

At the end of the course, the learner will be able to

1. Describe the basic mechanism of innate and acquired immunity; humoral and cell mediated immunity.
2. Describe the cellular and molecular mechanism of lymphocyte production and activation.
3. Understand the cellular process involved in inflammation and immunity, hypersensitivity reactions.
4. Understand the mechanism of clonal selection, antibody diversity and various serological diagnostic techniques based on antigen – antibody interaction.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Immunity & Cells of Immune system	History and scope of immunology; Types of immunity - Innate and acquired, active and passive, Cell mediated immunity and Humoral immunity, Haematopoeisis. Ontogeny, origin,		15

		development and differentiation of immune cells. Toll – like receptors Antigen presenting cells. T-helper and T-cytotoxic cells, Natural killer cells, Dendritic cells, Langerhan cells, Macrophages, Microphages.		
II	Organs of the Immune system and Immune response	Lymphoid tissues and organs - Primary lymphoid organs - Thymus, Bone marrow: Secondary lymphoid organ - Lymph node, spleen, MALT and GALT. Phagocytosis process. Clonal selection theory. B-lymphocytes and their activation, mechanism of T-cell activation. Thymus derived lymphocytes, Major histocompatibility complex. Structure and functions of Class I and II molecules.	Generation of antibody diversity. Organisation and expression of immunoglobulin genes.	15
III	Antigens and Ag – Ab reaction	Antigenicity: factors governing antigenicity. Antigen types, haptens, epitopes, adjuvants, carriers, bacterial, viral and tumour antigens, autoantigens, blood group antigens, T dependent, T independent antigens. Kinetics of antibody production - primary and secondary antibody response.	Antigen antibody reactions- precipitation, agglutination, immunoflouroscence, haem agglutination, RIA, ELISA. Factors governing antigen-antibody interactions: Affinity, avidity, valency,	15

			cross reactivity.	
IV	Complement system, Transplantation and Tumour Immunology	The complement systems: Mode of activation, classical, alternate and lectin pathway; Immuno haematology Introduction to autoimmune disorders and immunology of infectious diseases.	Transplantation immunity - Organ transplantation and HLA tissue typing. Tumour Immunology- Immuno diagnosis and Immunotherapy of Cancer	15
V	Hypersensitivity and Immunotechniques	Hypersensitivity reactions. Immunological tolerance. Immunosuppression	Immunotherapy. Hybridoma and monoclonals. Recombinant antibodies. DNA vaccines and edible vaccines. Immunotechniques - ELISA, Immuno electrophoresis,Flow cytometry- Fluorescent activated cell sorter- Applications in immunology	15

Text Books:

1. Rao, C.V. (2012) *An Introduction to Immunology*. 2nd Edition, Narosa Publishing House, India.

2. Richard M. Hyde (1995) Immunology, 3rd Edition, Willams and Wilkins Publishing
3. Joshi, K.R., Osama, N.O. (2012) *Immunology*, 5th Edition, Agrobios Ltd, India.

Reference Books:

1. Coico, R. and Sunshine, G. (2015) *Immunology: A Short Course*, 7th Edition,

John Wiley & Sons, 432 pages.

11. William E. Paul (2018) *Fundamental Immunology*, 8th Edition, Willams and Wilkins Publishing.
12. Cruse, J., Lewis, R. and Wang, H. (2004) *Immunology Guidebook,* Academic Press.
13. Abbas, A.K., Litchman, A.H., Pober. J.S. (2017) *Cellular and Molecular Immunology*, 9th Edition, W.B.Saunders, USA.
14. Golds, R.A., Kindt T.J., Osborne B.A. (2005) *Immunology,* 5th Edition, Freeman and Company, New York.
15. Ivan M. Roitt and Peter J. Delves (2016) *Essential Immunology*, 13th Edition, Blackwell Science Ltd. Oxford.
16. Janeway, C.A., Travers, P., Walport, M. and Shlomchik, M.J. (2001) *Immunobiology: The Immune System in Health and Disease*, 5th Edition, Garland Publishing, USA.
17. Peter Wood (2006) *Understanding Immunology University of Manchester*, 2nd Edition, Pearson Education Lts, Essex.
18. Stefan H.E. Kaufmann, Sher, A., Ahmed, R. (2002) *Immunology of Infectious diseases*, ASM Press, USA.

Web References

1. http://www.hhmi.org/biointeractive/immunology/lectures.html/
2. http://bitesized.immunology.org/what-is-immunology/
3. http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1365-2567
4. http://www.helmberg.at/immunology.pdf
5. http://www.mednotes.net/notes/immunology/

CORE - III: PHARMACEUTICAL BIOCHEMISTRY

Course Code: 18MBC03 **Hours: L + T + P = C**

Marks: 100 **4 1 0 5**

Course objectives

The course contents are designed to gain basic science knowledge in Chemistry, Microbiology and Pharmaceutical science as prerequisites, needed to understand cell biological functions. The learners will understand the atomic chemistry to explain the role of macromolecules involved in cell activities and also can prepare reagents and buffers of required strength by applying calculations. Learners acquire knowledge about the pharmocokinetic and pharmacological properties of drugs. Gain knowledge to apply Good Laboratory Practices and follow standard guidelines for better maintenance of instruments and keep up quality of finished pharmaceutical products and the experimenting area. Learners fully become prepared for employment within the pharmaceutical and biomedical sciences industries

Course outcome

At the end of the course, learners will be able to

1. Able to draw the atomic/molecular structures and sketch out the orbitals and electronic configurations.
2. Able to work out molar and millimolar conversions to prepare reagents or buffers of required strength for biological experiments and can balance Stoichiometric equations.
3. Able to explain the role of macromolecules in the living systems and can reason out diseases due to vitamin deficiency.
4. Able to explain drug biotransformation reactions and drug interactions in living systems.
5. Able to list the GLPs and standard guidelines to be followed for better instrument maintenance, environment control, preservation of test records and to keep up quality of finished sterile pharmaceutical products.
6. Gain well-rounded knowledge and are fully prepared for employment within the pharmaceutical and biomedical sciences industries.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Basic concepts in chemistry	Standard periodic table of the chemical elements - Atomic structure: Atom - Atomic orbital - Molecular orbital -	Atomic nucleus - Isotope. Bonding: Chemical bond - Ionic bond - Covalent bond - Metallic bond - Hydrogen bond -	15

		Chemical element - Valence - Electron pair - Unpaired electron. Chemical formula - Structural formula. Chemical composition of cells.	Intermolecular force - Dipole - - Mole - Stoichiometry -	
II	Macromolecular components of cell	Macromolecular components of the cell - Structural conformation and biological functions of macromolecules. Enzyme - Classification, nomenclature, properties and mechanisms of enzyme action. Carbohydrates, Lipids, Proteins.	Carbohydrates - Monomers, oligomers, polymers, isomers. Lipids - simple lipids, compound lipids and derived lipids. Lipid beta oxidation. Proteins - Primary, secondary, tertiary and quaternary structures. Classification and uses of vitamins.	15
III	Pharmacokinetics and pharmacodynamics	Pharmacokinetics and pharmacodynamics - Routes of drug administration- Drug physical and chemical actions - drug interactions - therapeutic applications of beneficial interactions. Adverse drug reactions. Principles of toxicity, evaluation	Volume of distribution - biotransformation - Phase I and Phase II reactions - Bioavailability - excretion of drugs and their metabolites as defined by Hendersson Hassle Batch equation. Determination of	15

			LD50, ED50 and therapeutic Index.	
IV	GLPs and SOPs	Current good manufacturing practices, Good laboratory practices, Good documentation practices, Standard operating procedures, HACCP, ISO Standards,Laboratory information management system (LIMS). Pharmacopaea– Pharmacopaea updates, US, Europea, British and Indian Standard Organization, Audit related to pharma. United States Federal Drug Administration Audits.	Instrumentation operating procedures, Calibration of equipment's, Microbial spoilage, Infection risk and contamination control. Chemical disinfectants, antiseptics, antibiotics, anti-infectives, endocrine and human growth hormone and preservatives.	15
V	Quality controls	Growth promotion test(GPT), Disinfectant efficacy study for different types of Disinfectants, Container Closure Integrity test(CCIT),Preservative efficacy study (PET), Qualitative and quantitative methods of environmental monitoring samples, Gowning qualifications, Isolation and identification of isolates - VITEK - Biochemical method,	Bacterial endotoxin test (BET), Bio-burden analysis, Water analysis in pharmaceutics, Biological indicators, Raw material samplings and sterility checking for finished products. Cosmetic microbiology-testing methods and preservation	15

		Trend analysis, Results and Discussions reporting (OOS & OOT), Out of specifications and Out of trend.		

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5 John E. McMurry (2015). The Organic Chemistry of Biological Pathways (2nd Edition). Publisher: WH Freeman and Company. 576 Pages
6 John L. Tymoczko, Jeremy M. Berg, LubertStryer. (2015). Biochemistry: A Short Course. Third Edition**.** Publisher. WH Freeman. 896 Pages
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8 Robert T. Morrison, Robert N. Boyd (2016). Organic Chemistry. Sixth edition Publisher: Pearson India, 1364 pages
9 RS Satoskar NirmalaRege SD Bhandarkar (2015). Pharmacology and Pharmacotherapeutics24th Edition. 1170 Pages
10 Sara E. Rosenbaum (Editor) 2016. Basic Pharmacokinetics and Pharmacodynamics: An Integrated Textbook and Computer Simulations, 2nd Edition.576 pages
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4. http://fda.gov/downloads/ScienceResearch/FieldScience/UCM397228.pdf

PRACTICAL - I

PRACTICAL EXAM: 7 HRS / DAY: 2 CONSECUTIVE DAYS

PRACTICAL I: GENERAL MICROBIOLOGY

Course Code: 18MBCP01 **Hours: L + T + P = C**

Marks: 100 **0 0 5 4**

Course Objectives

The learners will be able to gain adequate knowledge and acquire adequate skill to perform different staining techniques, growth rate of bacteria and biochemical test. To impart thorough knowledge and understanding of practical skills in immunology and means of applying these principles in diagnostic and therapeutic techniques and research.

Course Outcome

At the end of the course, learners will be able to:

CO1. Perform the various staining techniques of bacteria and study the growth rate of bacteria.

CO2. Competently cultivate algae in different types of media.

CO3. Demonstrate knowledge and understanding of immunology and the means of applying in the diagnostic and therapeutic techniques and research.

CO4. Understand the safe working practice in an immunology laboratory.

CO5. Develop skills to design diagnostic kits.

Syllabus

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4, K5)	
I	Microscopy	Phase contrast, Dark Field, Fluorescent Microscopy- Principle and Functions. Micrometry		15

II	Staining Techniques		Gram Staining Metachromatic granular Staining Spore Staining Capsule Staining Flagella staining Lactophenol Cotton Blue Staining Motility Test Fungal Slide Culture	15
III	Biochemical Test		IMVIC tests Carbohydrate fermentation Starch hydrolysis Test Cellulose hydrolysis Test Gelatin Hydrolysis Test Casein Hydrolysis Test Catalase Test Oxidase Test Urease Test Nitrate Test Triple Sugar Ion Agar Test	15
IV	Growth of microorganims	Isolation and cultivation of Algae Growth Curve-Growth rate and Generation Time		15
V	Bacterial metabolism	Effect of pH, temperature and osmotic pressure on growth of bacteria. Isolation of Arbuscular mycorrizae (AM) Preparation of Millique water Fumigation technique.		15

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2. Harley, J.P. 2013. *Laboratory Exercises in Microbiology*.9thEdition, McGraw Hill Education; New York.
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CORE PRACTICAL II - IMMUNOLOGY & PHARMACEUTICAL CHEMISTRY, (18MBCP02)

Course Code: 18MBCP02 **Hours: L + T + P = C**

Marks: 100 **0 0 5 4**

Course Objectives

The students will be able to gain adequate knowledge and understanding of practical skills in immunology and means of applying these principles in diagnostic and therapeutic techniques and research.

Course Outcome

At the end of the course, learners will be able to:

1. Demonstrate knowledge and understanding of immunology and the means of applying in the diagnostic and therapeutic techniques and research.
2. Understand the safe working practice in an immunology laboratory.
3. Develop skills to design diagnostic kits.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Haematology		Collection of human peripheral blood Separation of serum and plasma from human blood Blood grouping	15
II	Seperation of Immune cells		Isolation of Buffy coat Antibody titration of human blood group antigen Dead/fresh cell counting using Tryphan blue dye	15
III	Precipitation Reactions		Ouchterlony's Double Immuno-diffusion test Counter Immuno electrophoresis Quantification of Ig - Radial immunodiffusion - Rocket immune electrophoresis	15
IV	Agglutination Reactions		Antistreptolycin-O C-Reactive protein Rheumatoid Factor Beta-HCG	15

			TPHA Bacterial agglutination – WIDAL ELISA	
V	Pharmaceutical Microbiology		Sterility Testing (Tablet, Needle and Syringes, Parentral's) Phenol co-efficient Testing	15

Text Books

1. Talwar, G.P. (1983) *A Hand Book of Practical Immunology*, Vikas Publishing House, India
2. **Arthi, N. and Archana, A. (2008)** Lab Manual in Biochemistry, Immunology and Biotechnology, McGraw-Hill Education

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1. Celis, J.E. (1998) *Cell Biology: A Laboratory Handbook*, 2nd Edition, Immunocytochemistry, San Diego: Academic Press, pp 457-494

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3. http:/www.pleasanton.k12.ca.us/avhsweb/thiel/apbio/labs/Lab_Topic_19.pdf

SUBJECT NAME	COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
II SEMESTER													
Medical Bacteriology and Parasitology	Able to explain the procedures involved in the collection, transport and processing of	✓		✓	✓	✓	✓						✓

	clinical specimens.												
	Can make flow charts and explain about different media preparation, sterilization, inoculation and cultivation.	✓		✓	✓	✓	✓						✓
	Can interpret the results of morphological, biochemical, cultural characteristics of medically important bacteria and protozoans from the given samples to	✓		✓	✓	✓	✓						✓

	help in their identification.												
	Can provide required information on pathogenesis and symptoms of bacterial and protozoan diseases	✓		✓	✓	✓	✓						✓
	Comprehend the diagnosis of bacteria and protozoan infections and suggest prevention methods.	✓		✓	✓	✓	✓						✓
	Can brief about nosocomial infections and ethical committee.	✓		✓	✓	✓	✓						✓

Medical Mycology and Virology	To understand the basic aspects of fungi with its taxonomy, various fungal databases, know about fungal immunity and the methods used in the specimen collections.	✓		✓	✓								
	Know about the different classes of antifungals, their mode of action, methods followed in diagnosis of fungal infections and its treatme	✓		✓	✓								

	nt.												
	Know about the different types of fungal infections, properties of the fungi causing these infections, the diagnostics methods and the treatment of these infections.	✓		✓	✓	✓		✓					
	To know the basic concepts of viruses with its taxonomy, multiplication and the different types of animal viruses and its	✓		✓	✓								

	classification.												
	To understand the disease causing nature of different class of animal viruses, new emerging viral diseases, its pathogenesis and treatment methods.	✓		✓	✓								
Bioresource Technology	The students will be able to know about the nature and current status of the bio-resources	✓	✓		✓	✓		✓					
	Students will clearly get in-depth information	✓					✓			✓	✓		

	about utilization of natural resources on the production of microbial products like enzymes, organic acids, antibiotic, vitamins, alcoholic beverages, steroid and non-steroid components												
	The course will provide in-depth theoretical knowledge on exploitation of natural resources	✓						✓	✓	✓			✓

	The course will also provide meticulous ideas on different types of fermentors and their functions	✓			✓	✓	✓	✓		✓			
	The course contents will give several opportunities for the students to develop bio-entrepreneur for the production of microbial products by utilizing natural wastes		✓		✓		✓						✓
IPR, Biosafety & Bioethics	Students can know rules on how to	√	√	√									

	protect patents , copyrig hts, tradem arks, and other forms of IPRs have become a standar d compon ent of interna tional trade agreem ents												
	Studen ts may become patent attorne y, who has the speciali zed qualific ations necessa ry for represe nting clients in obtaini ng patents and acting in all matters	√			√	√			√				√
	Gain knowle	√			√	√		√	√				

	dge in procedures relating to patent law and practice, such as filing an opposition												
	To understand the importance of biosafety and to expose them to various biosafety committees and its importance	√						√					√
	To inculcate the ethical implications in hospitals, clinical laboratories and research	√										√	√
Core Practical III -	Process the	✓		✓			✓	✓	✓		✓	✓	✓

Medical Microbiology	clinical samples and examine them microscopically and macroscopically.												
	Isolate bacteria and parasites from clinical specimens.	✓		✓			✓	✓	✓		✓		
	Perform various staining and biochemical tests to analyze the samples for the presence of possible pathogens.	✓		✓			✓	✓	✓		✓		
	Prepare sterilize	✓		✓			✓	✓	✓		✓		

	d culture media required for pathogen isolation, pure culturing and preservation process.												
	Subject the pathogenic isolates for confirmatory tests and sensitivity assays to suggest most optimal treatment candidates.	✓		✓		✓	✓	✓	✓		✓		✓
	Cultivate viruses using	✓		✓			✓	✓	✓		✓		

	embryonic egg inoculation techniqu e.												
Core Practical IV - Industrial Microbiology	The students will able to know about the techniques to isolate and screen the significant microorganisms capable to produce products	✓	✓		✓	✓		✓					
	Provide meticulous ideas for the production of ethanol from natural and industrial wastes	✓	✓		✓	✓	✓	✓		✓	✓		
	Provide in-depth		✓		✓	✓	✓	✓		✓	✓		✓

	knowledge and ideas for the production of biosurfactant and its characterization												
	The students will get an idea to isolate and characterize the microbial products for further applications	✓	✓		✓	✓	✓	✓		✓	✓		
	The course contents will give several opportunities for the students to develop bio-entrepreneur for the production of microbial				✓	✓	✓	✓		✓	✓		

	products by utilizing natural wastes												
Food, Soil and Environmental Microbiology	The students will be able to know about the significance of the microbes in soil, food, dairy and environment	✓	✓			✓	✓	✓					
	Provide in-depth information about the harmful effects and beneficial role of microbes in each sector	✓	✓			✓	✓	✓		✓			
	Provides in depth knowledge on water and waste		✓							✓	✓		✓

	water treatment to tackle the current environmental problems												
	Provide meticulous thoughts on the task of microbes in waste water treatment and solid waste management		✓		✓	✓		✓					
	Give several opportunities for the students to develop as a researcher in food, dairy, agriculture and conservation sectors	✓	✓			✓		✓		✓	✓		

SEMESTER - II

Core IV – MEDICAL BACTERIOLOGY AND PARASITOLOGY

Course Code: 18MBC04 **Hours: L + T + P = C**

Marks: 100 **4 1 0 5**

Course Objectives

The students will gain knowledge about the different types of bacteria and protozoan. Collection and processing of specimens for microbiological analysis. Virulence factors of bacterial and protozoan pathogens. The mechanism of pathogenesis, laboratory diagnosis and treatment of bacterial and protozoan infections.

Course Outcome

At the end of the course, learners will be able to:

1. Able to explain the procedures involved in the collection, transport and processing of clinical specimens
2. Can make flow charts and explain about different media preparation, sterilization, inoculation and cultivation.
3. Can interpret the results of morphological, biochemical, cultural characteristics of medically important bacteria and protozoans from the given samples to help in their identification.
4. Can provide required information on pathogenesis and symptoms of bacterial and protozoan diseases.
5. Comprehend the diagnosis of bacteria and protozoan infections and suggest prevention methods.
6. Can brief about nosocomial infections and ethical committee.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Culturing and Preservation techniques, Normal flora cum Virulence	Microscopic appearance and Colony characteristics of different bacteria. Various Synthetic and Non – synthetic media for bacterial cultivation. Applications of basal, Differential, Enriched and Selective media in bacterial growth.	Maintenance and preservation techniques – Refrigeration, Freeze drying, Oil overlaying, Periodic transfers. Indigenous normal microbial flora of human	15

			system and their importance. Virulence factors of pathogenic bacteria. .	
II	Processing of clinical specimens, Hospital waste management and ethical committee. Gram positive pathogens	Collection and lab processing of clinical specimens – Urine, Sputum, CSF, Blood Pus and Stool. Gram positive bacteria – The epidemiology, pathogenesis, diagnosis and treatment of infections caused by pathogenic species of bacteria. *Staphylococci*, *Streptococci*, *Enterococci*, *Corynebacterium*,*Treponemapallidum*,*Mycobacterium*, and *Clostridium*.	Hospital waste disposal – Nosocomial infections – Functions of Hospital Infection control and related ethical committee.	15
III	Gram negative pathogens	Pathogens belonging to the genus – *Escherichia, Klebsiella, Proteus*, *Salmonella, Shigella, Vibrio, Pseudomonas*, *Neisseria* and Zoonotic infections.	Gram Negative bacteria - The epidemiology, pathogenesis, symptoms, diagnosis and treatment of infections caused by medically important pathogenic species of bacteria	15
IV	Parasitology: Amoeba and Flagellates	Parasitology- introduction and classification. Sarco Mastigophora –	Blood and tissue flagellates – *Leishmania*	15

		Sarcodina - Intestinal amoeba – *Entamaeba histolytica*. Free living amoebae – *Naegleria fowleri*, *Acanthamoeba* spp. Mastigophora – Intestinal and genital flagellates – Giardia, Trichomonas.	*donovani, Trypanosoma cruzi* and *T. brucei* complex. Apicomplexa – Haemosporina – Malarial Plasmodium, Ciliates – *Balantidium coli*. .	
V	Helminthology	Helminthology – Cestodes – *Taenia solium, Taenia saginata.* Trematodes – *Schistosoma haematobium, Faciola hepatica, Faciola buski*. Nematodes – *Trichuris trichura*, Intestinal nematode-*Enterobius vermicularis, Ascaris lumbricoides*.	Filarial nematode - *Wucheriria bancrofti*. Extra intestinal nematodes – *Trichinella spiralis*.	15

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MEDICAL MYCOLOGY AND VIROLOGY

Course Code: 18MBCP05 **Hours: L + T + P = C**

Marks: 100 **4 1 0 5**

Course Objectives

The course contents are designed to understand the basic information about the fungi, viruses and their associated diseases based on the signs and symptoms.

Course Outcome

At the end of the course, learners will be able to:

CO1. To understand the basic aspects of fungi with its taxonomy, various fungal databases, know about fungal immunity and the methods used in the specimen collections.

CO2. Know about the different classes of antifungals, their mode of action, methods followed in diagnosis of fungal infections and its treatment.

CO3. Know about the different types of fungal infections, properties of the fungi causing these infections, the diagnostics methods and the treatment of these infections.

CO4. To know the basic concepts of viruses with its taxonomy, multiplication and the different types of animal viruses and its classification.

CO5. To understand the disease causing nature of different class of animal viruses, new emerging viral diseases, its pathogenesis and treatment methods.

Syllabus

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4, K5)	
I	Medical Mycology	Introduction-Historical Perspectives and Miles stones in Mycology, Fungal Taxonomy- Binomial nomenclature, fungal repository and databases, Classification of medically important fungi, Immunity to fungal diseases- cellular and humoral Immunity. Collection and Transport of fungal specimens.		15

II	Antifungal therapy	Historical Perspectives and Current scenario, Classification of Antifungals- Polyene, Synthetic and Miscellaneous antifungals,	Antifungal Susceptibility testing-CLSI guidelines, Diagnosis of Fungal infections- Conventional and non-conventional methods, Current techniques in fungal diagnosis.	15
III	Mycosis	Superficial mycosis - Tinea, Piedra, Cutaneous mycosis - Dermatophytosis. Subcutaneous mycosis - Sporotrichosis, Mycetoma, Systemic mycosis- Blastomycosis and Histoplasmosis. Opportunistic mycosis - Candidiasis, Aspergillosis and Mucoromycosis,Miscelleneous mycosis- oculomycosis, Emerging fungal diaseases.		15
IV	Virology	Discovery, nomenclature and classification of virus. Life cycle of Bacteriophage - Lytic and Lysogenic cycles. Definitions - Lysogen, Prophage, Temperate phage, Viroids, Virusoids, Satellite RNAs, Prions. Morphology and distinctive properties of phages - T4, Lambda, M13 and PI. Animal viruses. Grouping of animal viruses based on Baltimore system of classification	Bacteriophage typing and its applications. Comparison of multiplication of bacteriophages	15

V	Clinical virology	Epidemiology, life cycle, pathogenicity, diagnosis, prevention and treatment of human viral infections caused by animal viruses - Pox virus, Parvo virus, Reo virus, Retro virus, Hepadna virus. Zoonotic viral infections - Rabbies, Yellow fever, Pappataci fever. Newly emerging viral diseases in Asia - SARS, Swine Flu, Hepatitis-C, Dengue fever, Chicken kunya, Zika virus, Nipah virus.	Cultivation of viruses.	15

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1. Errol Reiss, Jean Shadomy, H. and Marshall Lyon, G. (2011) *Fundamental Medical Mycology.* 1stEdition, Wiley Blackwell.
2. Mehrotra, R.S. and Aneja, K.R. (2015) *An introduction to Mycology.* 2ndEdition, New Age International (P) Ltd, New Delhi.
3. JegadishChander (2018)*A Text Book of Medical Mycology.* 4th Edition, Jaypee Brothers Medical Publishers,Interprint, New Delhi.
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5. Flint, S.J., Enquist L.W., Racaniello, V.R. and Skalka, A.M. (2009) *Principles ofVirology-1-Molecular Biology,* 3rd Edition. ASM Press, Washington.
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CORE VI - BIORESOURCE TECHNOLOGY

Course Code: 18MBC06 **Hours: L + T + P = C**

Marks: 100 **4 1 0 5**

Course Objectives

The aim of Bioresource Technology course is to know current bio-resources and their exploitations on the production of microbial products. The content of the precise course include nature of the bio-resources, industrially important microorganisms, up and down stream process, functions of the fermentors, primary and secondary metabolites and production of recombinant products. It also covers production of steroids, sterols and non-steroid compounds through microbial transformations.

Course Outcome

1. By the end of the course, the students will be able to know about the nature and current status of the bio-resources.
2. The students will clearly get in-depth information about utilization of natural resources on the production of microbial products like enzymes, organic acids, antibiotic, vitamins, alcoholic beverages, steroid and non-steroid components.
3. The course will provide in-depth theoretical knowledge on exploitation of natural resources.
4. The course will also provide meticulous ideas on different types of fermentors and their functions.
5. After the study, the course contents will give several opportunities for the students to develop bio-entrepreneur for the production of microbial products by utilizing natural wastes.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Introduction to Bioresource	Introduction - Biomass, Biological wastes from domestic, agriculture and industries.	Biological waste treatment, Bioenergy – Biofuels-Production of Biofuels, Acetone-butanol production, Biotransformations and bioresource systems analysis. Bioproducts: Biocatalysis and fermentations.	15
II	Bioprocess technology	Fermentation process - The range of fermentation	Development of inoculum for various upstream process.	15

		process - Chronological development – Component parts of a fermentation process - Fermentation economics. Industrially important microorganisms - Isolation, preservation and improvement of strains - Handling, media for industrial fermentation - Formulation and sterilization,		
III	Fermentor types and design	Parts of a fermentor, body construction, heat production - gas liquid exchange - mass transfer - heat transfer - oxygen transfer - stirring and mixing. Scale up and scale down fermentation process. Control of temperature, pH, form pressure	Sterilization of bioreactors and nutrients. Computer application in fermentation technology. Fermentation types – Submerged, solid state, batch and continuous fermentation.	15
IV	Downstream processing	Recovery of intracellular and extra cellular products - Biomass separation by centrifugation,		15

		filtration, chemical and Electro flocculation. Cell disintegration - physical, chemical and enzymatic methods. Extraction - solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods, Concentration by precipitation, ultrafiltration, reverse osmosis. Drying and crystallization.		
V	Microbial Products		Organic acids - Amino acids, Antibiotics, Enzymes, Vitamins, Alcoholic beverages - wine and beer, Fermented foods - bread, cheese and soy sauce. Recombinant Products - insulin, interferon and growth hormone, Fermentation products from natural wastes - molasses, starch wastes and cellulosic wastes. Microbial transformations - steroids and sterols. Non-steroid compounds –Antibiotics.	15

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PRACTICAL - III

PRACTICAL EXAM: 7 HRS / DAY: 2 CONSECUTIVE DAYS

CORE PRACTICAL - III: MEDICAL MICROBIOLOGY (18MBCP03)

Course Objectives

The course contents are designed to gain adequate hand on knowledge and acquire adequate skill to identifybacteria, fungi and parasites from clinical samples,cultivate viruses in embryonated eggs and identify the various pathogenic bacteria, fungi and parasites based on morphology, cultural and biochemical characteristics.

Course Outcome

At the end of the course, learners will be able to:

1. Gain knowledge on identification of bacteria and parasites from clinical specimens.
2. Analyze the clinical specimensandunderstand the different methods to cultivate fungi.
3. Understand the methods to collect and transport of clinical specimens.
4. Gain knowledge on examination of parasites from clinical specimens.
5. Understand the various methods to cultivate viruses

List of Experiments

1. Collection and transport of clinical specimens for microbiological examinations.
2. Cultivation of Microbes- Basal, Differential and Selective media.
3. Isolation and identification of bacterial pathogens from clinical specimens viz. Throat swab, pus, urine, sputum and stool.
4. Antimicrobial sensitivity testing by disc-diffusion technique and determination of MIC.
5. Examination of parasites in clinical specimens- Floatation and sedimentation techniques of stool examination.
6. Blood smear examination for malarial parasites.
7. Cultivation and Identification of fungi by Lactophenol cotton blue (LPCB) mount of *Mucor, Rhizopus, Aspergillus, Penicillium, Fusarium, Curvularia, Bipolaris*&*Trichophyton*).
8. Identification of Non sporulating fungi- Slide culture method, Cornmeal/Tapwater agar.
9. Identification of *Candida* species- Germ tube method,Sugar assimilation/ fermentation test, species differentiation on Hichrome agar.
10. Isolation and characterization of bacteriophage from natural sources.
11. Animal tissue culture – Egg inoculation methods of virus.
12. Spotters of viral inclusions.

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1. Patrick Murray, R. and Ellen Jo Baron (2007) Manual of Clinical Microbiology, 9th Edition,Vol 1. ASM Press, Washington.
2. James G. Cappuccino and Natalie Sherman (2014) Microbiology A laboratory Manual, 10th edition - Pearson Education.
3. Benson, J.H. (1996) *Microbiological Applications*: *A Laboratory Manual in General Microbiology 7th* edition, Wn. C. Brown Publication IOWK, USA.
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5. Patrick R. Murray, Ken S. Rosenthal, Micheal A. Pfaller (2005) *Medical Microbiology*, 5th Edition, Elsevier/Mosby, Philadelphia.
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3.http://www.dnatube.com/video/30156/Germ-Test-Tube--Identifying-Yeast
4.http://www.cdc.gov/dpdx/diagnosticprocedures/blood/specimenproc.html
5.http://www.microbelibrary.org/library/laboratory-test/3107-egg-inoculation-for virus-cultivation

PRACTICAL - IV

PRACTICAL EXAM: 7 HRS / DAY: 2 CONSECUTIVE DAYS

CORE PRACTICAL - III: INDUSTRIAL MICROBIOLOGY

Course Code: 18MBCP04 **Hours: L + T + P = C**

Marks: 100 **0 0 5 4**

Course Objectives

The aim of this course is to know various methods adopting to isolate, screen the industrially important microorganism and apply for the production of microbial products like enzyme, antibiotic, alcohol and biosurfactants. It also covers purification and characterization of the products by appropriate methods.

Course Outcome

1. By the end of the course, the students will able to know about the techniques to isolate and screen the significant microorganisms capable to produce products.
2. The course will provide meticulous ideas for the production of ethanol from natural and industrial wastes.
3. The course will also provide in-depth knowledge and ideas for the production of biosurfactant and its characterization.
4. From this course, the students will get an idea to isolate and characterize the microbial products for further applications.
5. After the study, the course contents will give several opportunities for the students to develop bio-entrepreneur for the production of microbial products by utilizing natural wastes.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Isolation and screening of antibiotic producing	• Screening of antibiotic producing microorganis	-	15

	microbes	ms from soil.		
II	Enzyme and its production	• Screening of enzyme producing organisms (e.g. Amylase and Cellulase). • Production of industrially important enzymes by Submerged fermentation (Any one enzyme). • Production of industrially important enzymes by solid state fermentation (Any one enzyme). • Assay of extracellular enzymes produced by bacteria: a) Amylase, b) Protease and c) Lipase.	• Purification of enzymes by filtration method/chemical method by ammonium sulphate.	15
III	Alcoholic fermentation	• Production of wine. • Production of alcohol from agricultural wastes (sugarcane molasses and beetroot). • Biofuel Production- Alcohol &	• Characterization of alcohol: Nutritive value, Colour, Haze, Viscosity, foam Characteristics, gurting flavor	15

		Hydrogen		
IV	Production of organic acid and metabolites	• Microbial production of citric acid by using *Aspergillus*. • Production of extracellular metabolites from actinomycetes	• Production and extraction of biosurfactant. • Quantification and characterization of biosurfactant. • Synthesis and separation of bioactive compounds - TLC or Column Chromatography. • Immobilization of cells and enzymes.	15
V	Antibiotic sensitivity test	a) Kirby Bauer's method and b) MIC determination by filter paper assay and broth dilution assay.	-	15

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1. Basanta Kumar Rai and Dil Kumar Subba (2016) *Basic Practical Manual on Industrial Microbiology*, Dharan Multiple Campus, Nepal.
2. Kulandaivel and Janarthanan, S. (2012) *Practical Manual on Fermentation Technology*, ISBN: 9789381141809.
3. Mathur, N. and Singh, A. (2007) *Industrial Microbiology: A Laboratory Manual*, Pointer publishers.
4. Arnold L. Demain, Julian E. Davies, Ronald M. Atlas, Gerald Cohen, Charles L. Hershberger, Wei-Shou Hu, David H. Sherman, Richard C. Willson and David Wu, J.H. (1999) *Manual of Industrial Microbiology and Biotechnology*, 2nd Edition.
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3. http://www.uvi.edu/files/documents/Research_and_Public_Service/WRRI/Introduction_to_Environmental_Microbiology.PDF
4. http://www.wdcm.org/workshop2014/student_three_one.pdf
5. https://www.bd.com/ds/technicalCenter/misc/difcobblmanual_2nded_lowres.pdf

SUBJECT NAME	COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
III SEMESTER													
Molecular Biology and Applied Biotechnology	Draw the structure of nucleic acid and explain genome organization in detail.	✓		✓	✓		✓						
	Can explain with illustrations the replication, transcription and translation processes.	✓		✓	✓		✓						
	Can list and explain the mechanisms of physical /chemical	✓		✓	✓		✓						

	mutagens upon genomes and the counter repair mechanism inherent in living cells to avoid mutations causing cancers and deleterious syndromes.												
	Students can write down the steps involved in cloning and expression of foreign genes with supportive figures.	✓		✓	✓								
	Students gain the knowledge and as well will be able to describe the creation of genetically	✓		✓	✓								

	modified organisms.												
Bio Nano-technology and Infectomics	To acquire the knowledge of basic science required to understand the fundamentals of nanoscience	√	√						√				
	To get familiarize with the basic concepts characterization of nanoparticles	√	√		√				√				
	To realize the biomedical applications of nanoscience		√		√		√			√			
	To obtain a sound understanding in genomics and proteomics	√	√		√		√						
	To understa	√	√			√		√					

	nd the high through put omic approac hes												
Food, Soil and Environme ntal Microbiolog y													
Core Practical V: Molecular Biology and Biotechnolo gy	Isolate plasmid, chromos omal DNA and RNA to quantify and characte rize them			✓			✓				✓	✓	
	Perform SDS and Gel electrop horesis			✓			✓		✓		✓	✓	
	Prepare competent cells and carry out transfor mation studies. Became skillful in inserting foreign DNA into various			✓			✓		✓		✓	✓	

	vectors												
	Express foreign DNA in *E. coli* and other system and evaluate the presence of recombinant DNA in cloned host			✓			✓				✓	✓	
	Perform TLC to analyse compound mixtures			✓			✓				✓		
	Do PCR technique to amplify nucleic acid sequences			✓			✓		✓		✓	✓	
	Isolate auxotrophic and antibiotic resistant mutants			✓			✓				✓		
Core Practical VI: Applied Microbiology	By the end of the course, the students will able	✓			✓								

	to know about the techniques to isolate and assess the harmful microorganisms in food, milk and milk products.												
	The course will also provide meticulous ideas for the enumeration of air and water borne microorganisms.	✓			✓								
	From this course, the students will get an idea to isolate and characterize the microbes in extreme environmental conditio	✓			✓		✓						

	ns.												
	After the study, the course contents will give several practical knowledge opportunities for the students.	✓		✓	✓		✓						

CORE - VII: MOLECULAR BIOLOGY AND APPLIED BIOTECHNOLOGY

Course Code: 18MBC07 **Hours: L + T + P = C**

Marks: 100 **4 1 0 5**

Course Objectives

Content of the curriculum is constructed to import the knowledge on structure of gene, genome organization and functions of genetic materials. Special focus on transcription, translation, mutation, DNA repair, protein synthesis and translation modification process in microbial system is given. Sufficient space is provided to understand various tools like cloning and expression of foreign genes in the bacterial system and apply them in various applications.

Outcome of the course

Learners are enabled to learn following at the end of the course:

1. Structure of gene, genome organization and functions of genetic materials.
2. Transcription, translation, mutation, DNA repair and protein synthesis and translation modification process
3. Cloning and expression of foreign genes
4. Students will be able to produce genetically modified organisms.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	

I	Basics of Molecular Biology	Structure, types and functions of DNA, RNA and peptide nucleic acid (PNA), Replication methods: Requirement for DNA replications and post replication event. Inhibition of DNA replication	Gene transfer in bacteria transformation conjugation transduction	15
II	Transcription	Types and functions of RNA polymerases, Various factors involved in transcription process - Initiation, elongation and termination	Regulatory elements of transcription. Inhibitors of Transcription. Operon models - lac, trp, ara operons	15
III	Protein synthesis	Steps in translation process - Details of initiation, elongation and termination. Post translation modifications	Inhibitors of Protein synthesis. Elucidation of genetic code - Wobble hypothesis.	15
IV	Principles of recombinant DNA technology	Principles of recombinant DNA technology. Gene cloning in bacteria, Construction of genomic and cDNA libraries, Transposons. Screening of recombinants - Phenotypic expression of characters	Hybridization techniques. DNA sequencing methods - strategies for genome sequencing.	15
V	Applications of recombinant DNA technology	Applications of recombinant DNA technology – enzymes, vectors, plasmids and cosmids, and Bacmids. Production of recombinant products like insulin, interferon, tissue plasminogen activator, subunit vaccines.	Genetically modified organisms (GMO's). Gene silencing - Gene knockouts and gene therapies, antisense technologies. Genetic engineering of plants for viruses, herbicide tolerance.	15

Text Books:

1. David Freifelder (2001). Microbial Genetics. Narosa Publishing House, New Delhi Larry Snyder and Wendy Champness (2002). Molecular Genetics of Bacteria. ASM press, USA.

2. Principles of gene manipulation – An introduction to genetic engineering. R.W. Old& S.B. Primrose
3. Alexander N. Glazer, Hiroshai and Nikaido, 2007. Microbial Biotechnology

Reference Books:

1. Thomas D. Borck (1990). The emergence of bacterial genetics. Cold Spring Harbor Laboratory, USA
2. Benjamin Lewin (2000). Genes VII. Oxford Univ. Press.
3. Genomics – Construction of BAC, YAC libraries – *E. coli* genome – MIcroarray – Preparation and Application - Analysis of transcripts – Gene expression; Agricultural, industrial and medical applications of cloning technology.
4. Winnaker, EL 1987. From Genes to Clones : Introduction to Gene Technology. VCH Publications, Federal Republic Germany.
5. El-Mans, E.M.T and Bryce C.F.A., 2006. Fermentation Microbiology and Biotechnology.

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2. www.bestwebbuys.com/Microbiology-N_10038066-books.html
3. www.en.wikipedia.org/wiki/Molecular_biology
4. www.web-books.com/MoBio/

CORE - VIII: BIONANOTECHNOLOGY AND INFECTOMICS (18MBC08)

Course Code: 18MBC08 **Hours: L + T + P = C**

Marks: 100 **4 1 0 5**

Course Objective

The objective of this course is to provide an insight into the fundamentals of Nanoscience and Nanotechnology. Further this course also deals with the understanding between pathogens and their hosts.

Course Outcome

1. To acquire the knowledge of basic science required to understand the fundamentals of nanoscience
2. To get familiarize with the basic concepts characterization of nanoparticles.
3. To realize the biomedical applications of nanoscience
4. To obtain a sound understanding in genomics and proteomics
5. To understand the high throughput omic approaches

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Nanotechnology & its importance	The Journey and History of biotechnology to nanotechnology. Opportunities, challenges, definition and principles of nanoscience and nanotechnology. Types of nano-biomaterials. Generation of biomaterials. Top down and bottom up approaches - Physical, Chemical and Microbial synthesis of nanomaterials - Silver, Gold, Titania, Carbon nanotubes, polymer nanocomposites etc		12
II	Characterization Techniques for Nanoparticles		Particle size analyser - X-ray diffraction (XRD) - Fourier transformer infrared spectroscopy (FTIR), Field Emission Scanning Electron Microscopy (FESEM)-High Resolution Transmission Electron	12

			Microscope (HRTEM) - Atomic force Microsopy (AFM)- Surface enhanced Raman spectroscopy (SERS) - X - ray Photoelectron Spectroscopy (XPS) - Auger electron spectroscopy (AES). *In vitro* and *In vivo* analysis of nanoparticles	
III	Nanoscience in biomedical application		Nanosensors in diagnosis - Nanorobotics in surgery Nanotechnology in tissue regeneration - Nanotechnology durg targeted delivery. Nanotechnology in Food industry - Nanoscience in agriculture: fertilizers and pesticides. Nanoscience for water treatment and fermentation process. Nanotechnology in textiles and Cosmetics - Nanotechnology in energy conversion - Nanocatalysts - Nanotoxicology - Risks and Ethics. Future of	12

			nanobiotechnology	
IV	Genomics & Proteomics	Introduction and concepts of microbial genomics. Methods of gene sequencing. Genome prediction. Types of genomics - Structural, functional, comparative and environmental genomics. SNPs, RAPD, RFLP. DNA microarray - Types and applications. Genomic databases, Future of genomics. Proteomics: Introduction and basic principles of proteomics. Relation between gene and protein. Approaches for study of proteomics. Types of proteomics - Expression proteomics, structural proteomics and functional proteomics	Protein sequences databases - SWISS-PROT, PDB, etc. Human Genome Project	12
V	Infectomics	Introduction and definitions of Infectomics. Infectomes. Genomics and proteomics of microbial infections - Structural and functional strategies. Types of infectomics - ecological, immuno and chemical infectomics	DNA and protein microarrays, cloning, PCR, gene knockout and knockin, antisense strategies. Pharmacomes - definition and functions. Future of Infectomics	12

Text Books

1. Subbiah Balaji (2010) *Nanobiotechnology*, MJP Publishers.
2. Viswanathan, B. (2009) *Nanomaterials*, Narosa Publishing House.
3. Textbook of Nanoscience and Nanotechnology by T. Pradeep
4. David S. Goodsell (2004) *Bionanotechnology*, John Wiley & Sons.

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1. The Nanobiotechnology Handbook 21 Apr 2017 by Yubing Xie
2. Nanoscience and Nanotechnology: Fundamentals of Frontiers - 2013 by Shubra Singh M.S. Ramachandra Rao
3. Nanostructures and Nanomaterials: Synthesis, Properties and Applications (World Scientific Series in Nanoscience and Nanotechnology) Paperback – 4 Jan 2011- by Cao
4. Shah, M.A. and Tokeer Ahmad (2010) *Principles of Nanoscience and Nanotechnology*, Narosa Publishing House.
5. Niemeyer, C.M. and Mirkin, C.A. (2004) *Nanobiotechnology: Concepts, Applications and Perspectives*, Wiley - VCH.
6. Carl C. Koch (2002) *Nanostructured Materials: Processing, Properties and Potential Applications*, *N*oyes Publications, William Andrew Publishing Norwich, New York, U.S.A.
7. Dale, J.W. (1998) *Molecular Genetics of bacteria*, 3rd Edition, Wiley Publishers.
8. Singer, M. and Berg, P. (1991) *Genes and Genomes*, University Science Books.
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10. www.nanobotblogspot.com
11. www.microbiologyprocedure.com/genetics/microbial-genetics/microbial-genetics.htm
12. www.web-books.com/MoBio/
13. http://www.nature.com/nrmicro/focus/metagenomics/index.html

CORE - IX: FOOD, SOIL AND ENVIRONMENTAL MICROBIOLOGY

Course Code: 18MBC09 **Hours: L + T + P = C**

Marks: 100 **4 1 0 5**

Course Objectives

This course aims to communicate the students with basic principles of microbiology and their applications to soil, food, dairy and environment. It also prepares the student to address pressing environmental challenges by developing a fundamental understanding of the microbial communities and processes in natural and built environments. It lays and builds upon the foundation of basic microbiology, microbial energetics and diversity to applying the tools provided by microbiology ranging from traditional to state of art for addressing relevant environmental concerns. It provides an in depth exploration of the diverse role of microbes and microbial communities in each sector.

Course Outcome

1. By the end of the course, the students will be able to know about the significance of the microbes in soil, food, dairy and environment.
2. The students will clearly get in-depth information about the harmful effects and beneficial role of microbes in each sector.
3. This course provides in depth knowledge on water and waste water treatment to tackle the current environmental problems.
4. The course will also provide meticulous thoughts on the task of microbes in waste water treatment and solid waste management.
5. After the study, the course contents will give several opportunities for the students to develop as a researcher in food, dairy, agriculture and conservation sectors.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Food microbiology	Food as a substrate for microorganisms. Sources of contamination of microorganisms in foods, Factors influencing microbial growth in foods. Food borne diseases. Spoilage of fruits, vegetables, meat, poultry, fish and seafoods. Methods of food preservation: Traditional, physical and chemical methods.	Applications of food microbiology: Beneficial uses of microorganisms in food, Intestinal beneficial bacteria, Probiotics, Prebiotics – Definition, functional foods, types, importance and economic values, Recombinant foods, Biosensors in food industry.	15
II	Dairy microbiology	Microflora of milk and milk products, Fermented milk and milk products: Sauerkraut, Buttermilk, Cream, Yogurt, Cheese, Kafir and kumiss. Microbes involved in fermentation: Starter lactic acid cultures. Spoilage of milk and milk products, Milk borne diseases,	Preservation of milk and milk products. Sanitation of dairy processing plant, food control agencies and their regulations.	15

		Milk quality testing.		
III	Soil microbiology	Distribution of microorganisms in soil, Factors influencing the soil microflora	Biogeochemical cycles: Carbon, Nitrogen, Phosphorus and Sulfur, Interactions among microorganisms: Mutualism, commensalism, ammensalism, synergism, parasitism, predation and competition. Interaction of microbes with plants: Rhizosphere, phyllosphere, mycorrhizae. Nitrogen fixation: Symbiotic and asymbiotic. Soil reclamation.	15
IV	Microbiology of air and water	Composition of air, Number and types of microorganisms in air, Distribution and sources of air borne organisms, Aerosol, Airborne diseases, Assessment of air borne microbes, Air sanitation - Physical and chemical methods. Microbiology of water: Physico-chemical properties of water, Microbial assessment of water. Aquatic micro flora and	Extremophiles – Thermophiles, mesophiles, psychrophiles, Deep sea, Desert, Acidophilic, Alkalophilic and Halophilic microorganisms. Impact of environmental factors on the aquatic biota.	15

		fauna of lake, ponds, river, estuary, mangrove and sea.		
V	Environmental Microbiology	Microbes and environment, Classification of wastes. Waste treatment - Types and characterization of solid and liquid wastes. Treatment of solid wastes - composting, vermiform composting, silage, pyrolysis and saccharifications. Treatment of liquid wastes - Primary, secondary (anaerobic and aerobic) - trickling, activated sludge, oxidation pond and oxidation ditch-tertiary - disinfection.	Xenobiotic compounds and their degradation: Crude oil, hydrocarbon, pesticides and heavy metals. Bioaccumulation of heavy metals, Biofouling, Bioleaching and Bioremediation. Bioluminescence and microbes. Biodegradation of natural substances - Cellulose, xylan, hemicellulose, starch, fructose, mannan, pectin and lignin.	15

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8. Alexander, M. (1977)*Introduction to Soil Microbiology*. John Wiley and Sons NewYork.
9. Subba Rao, N.S. (1995) *Soil Microorganisms and plant growth*, Oxford and IBH, New York.
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7. http://site.iugaza.edu.ps/tbashiti/files/2010/02/Environmental_Microbiology.pdf
8. http://trishul.sci.gu.edu.au/courses/bbs3728/lecture1.pdf
9. https://www.kobo.com/us/en/ebook/microbial-ecology-2
10. https://www.pdfdrive.com/principles-and-applications-of-soil-microbiology-d8264286.html

PRACTICAL - V

PRACTICAL EXAM: 7 HRS / DAY: 2 CONSECUTIVE DAYS

CORE PRACTICAL - V: MOLECULAR BIOLOGY AND BIOTECHNOLOGY

(18MBCP06)

Course Objectives

The contents for above practicals are designed to impart hand on experimental knowledge on the various techniques in molecular biology and biotechnological experiments. This would enable them to design experiment for the production of recombinant products using above molecular techniques.

Coarse Outcome

At the end of the course, learners will be able to

1. Isolate plasmid, chromosomal DNA from the bacteria.
2. Became skillful in the inserting foreign DNA in to various vectors and transform.
3. Express foreign DNA in *E.coli* and other system.
4. Evaluate the presence of recombinant DNA in the different host used in the cloing
5. Isolate mutants from normal organisms.

List of Experiments

1. Isolation and quantification of DNA and RNA
2. Isolation of plasmid DNA from bacteria
3. Restriction digestion of plasmid
4. Determination of molecular weight of DNA
5. Cloning of fragment in plasmid
6. Preparation of competent *E.coli* cells
7. Transformation of plasmid DNA to the E.coli cells
8. Screening for transformants - Blue white selection
9. PCR amplification of DNA fragment
10. Screening for recombinant proteins by SDS - PAGE
11. Screening by TLC
12. Isolation of auxotrophic mutants
13. Isolation of antibiotic resistant bacteria.

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2. DNA Cloning – A practical approach (V.1-4) D.M. Glover and B.D. Hames, IRL Press, 1995
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4. Surzyeki S., 2000. Basic Techniques in Molecular biology, Springer
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3. http://www.gbiosciences.com/pdf/protocol/310plasmid_isolation_(alkaline_lysis)_teacher.pdf
4. https://www.dnalc.org/resources/animations/gelelectrophoresis.html

PRACTICAL - VI: APPLIED MICROBIOLOGY

Course Code: 18MBCP06 **Hours: L + T + P = C**

0 0 5 4

Marks: 100

Course Objectives

This course is designed to prepare the students for sensible knowledge in a wide range of profession. This paper provides the scientific discipline that deals with the application of microorganisms and the knowledge about them. Applications include microbial biotechnology, agriculture, food microbiology and bioremediation. It also covers significant experiments linked with soil, food, dairy and environment.

Course Outcome

CO1. By the end of the course, the students will able to know about the techniques to isolate and assess the harmful microorganisms in food, milk and milk products.

CO2. The course will also provide meticulous ideas for the enumeration of air and water borne microorganisms.

CO3. From this course, the students will get an idea to isolate and characterize the microbes in extreme environmental conditions.

CO4. After the study, the course contents will give several practical knowledge Opportunities for the students.

Syllabus

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1, K2	K3, K4, K5, K6	

I	Dairy Microbiology	Isolation of yeast and molds from spoiled nuts, fruits and vegetables.	Detection of number of bacteria in milk by breed count.	15
II	Soil Microbiology	Isolation of phosphate solubilizers from fertile soil.	Determination of quality of milk sample by methylene blue reductase test and resazurin method.	15
III	Plant Pathogens	Isolation of nitrogen fixers (a) *Rhizobium* from root nodule and (b) *Azotobacter* from rhizosphere.	Detection of number of bacteria in milk by standard plate count.	15
IV	Water Microbiology	Evaluation of root nodule by cross section of legume roots.	Bacteriological examination of specific food (a) Curd (b) Raw meat (c) Fish (d) Ice cream.	15
V	Environmental Microbiology	Isolation of plant pathogens - Study of the following diseases: Tobacco mosaic, Bacterial blight of paddy, Red root of sugarcane, Citrus cancer, Downy mildew of bajra, Powdery mildow of cucurbits, Head smut of	Isolation and enumeration of soil microorganisms (bacteria, fungi and actinomycetes). Screening of antagonistic bacteria in soil by agar block overlay method. Physical, chemical and microbial assessment of water and potability test for water. Colour, pH, alkalinity, acidity, COD, BOD, TS, TDS and TSS. Microbiological assessment - MPN index presumptive, confirmatory and completed tests. Quantification of microorganisms in air: Open plate, liquid impingement techniques and through air sampler.	15

		sorghum, Leaf rust of coffee, Leaf spot of mulberry, Root knot of mulberry. Isolation of dye degrading microbes from soil samples. Screening of nitrate reducers using aqueous potassium nitrate broth. Bacterial reduction of nitrate from ground waters. Bacterial reduction of hexavalent chromium in aqueous medium.		

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3. Garg, N., Garg, K.L. and Mukerji, K.G. (2010) *Laboratory Manual of Food Microbiology*, I.K. International Publishing House Private LTD.
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2. http://www.unido.org/fileadmin/media/documents/pdf/Agro/MacroLab.pdf
3. http://www.fao.org/docrep/014/T0610E/T0610E.pdf
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6. http://krishikosh.egranth.ac.in/bitstream/1/2047193/1/ANAND-22.pdf
7. https://jascoinc.com/wp-content/uploads/2017/09/APP-Note-UV0004-Chromium-Quantitative-Determination.pdf

SUBJECT NAME	COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
IV SEMESTER													
Research Methodology and Computational biology	Know the basic aspects of research to frame a research problem, analyse the various methods used in research and to write a research report.	✓		✓	✓	✓	✓	✓					
	Know the various measurements used in calculations of buffers and understand the basic instruments used in laboratory.	✓			✓	✓	✓	✓		✓			
	Learn the principles, working and uses of sophisticated instruments and their usage in	✓			✓	✓	✓	✓		✓			

	research.												
	Know the various biostatical formula used in the interpretation of experimental data to analyze the results statistically.	✓			✓	✓	✓	✓		✓			
	Learn and apply the various bioinformatics tools to perform sequence-based searches, and analyze the results using bioinformatics software's.	✓			✓	✓	✓	✓		✓		✓	

RESEARCH METHODOLOGY AND COMPUTATIONAL BIOLOGY

Course Code: 18MBC10 **Hours: L + T + P = C**

Marks: 100 **4 1 0 5**

Course Objectives

The coarse contents are designed to gain a general insight in to the research aspects of microbiology with a basic understanding in to the handling and working of instruments; use of biostatics tools in research and application of bioinformatics to problem solving in real research problems

Coarse Outcome

At the end of the course, learners will be able to

CO1. Know the basic aspects of research to frame a research problem, analyze the various methods used in research and to write a research report.

CO2. Know the various measurements used in calculations of buffers and understand the basic instruments used in laboratory.

CO3. Learn the principles, working and uses of sophisticated instruments and their usage in research.

CO4. Know the various biostatical formula used in the interpretation of experimental data to analyze the results statistically.

CO5. Learn and apply the various bioinformatics tools to perform sequence-based searches, and analyze the results using bioinformatics software's.

Syllabus

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4, K5)	
I	Research Methodology	Meaning and importance. Review of literature - Review and synopsis presentation. Types of Research and research tools, Research designs - Experimental and non-experimental. Preparation of research report. Guidelines for preparing an article	ISSN, ISBN, impact factor, citation index, h-index, I- index, Google scholar, Scopus, Thomson& Reuters, Web of Science. Plagarism and Antiplagarism software, Computational-RSM	15

II	Units of measurements	Laboratory Instruments - Balances - Centrifuges - Water Bath - Incubator - Colorimeter (Photometer). Bioinstrumentation - Principles and applications of pH meter, Centrifuge, UV-Vis spectrophotometer.	Mole, equivalents - Molarity- Molality and normality). Cleaning of laboratory glassware's.	15
III	Bioinstrumentation	Chromatographic Technique- Principles, types and applications of Chromatography - Thin layer chromatography(TLC), Gas Liquid Chromatography (GLC) ,High pressure liquid chromatography (HPLC),Fast performance liquid chromatography (FPLC), Gas chromatography - Mass spectrometry (GC-MS). Compound Microscope- Transmission Electron Microscope (TEM) and Scanning Electron microscope (SEM)- Principles, Procedure and Specimen preparation, Fluorescent Microscope.		15

IV	Biostatistics		Introduction- Basic concepts, Sampling and data collection, Data presentation, Descriptive Statistics - Measures of central tendency and Measures of dispersion, Population parameters, sample estimates and confidence intervals. Basic concepts of probability. Probability distributions, Z-scores, Student's t- test, Chi square test, Correlation, regression, ANOVA,	15
V	Biological databases	Database searching, Sequence analysis, Pair alignment, Visualizing protein structures, Predicting structure and function of protein using sequences,	Computer based drug designing. Submission of nucteotides in NCBI-FASTA, Construction of phylogenetic tree. SPSS software- Genomics and Proteomics- identification softwares.	15

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2. Ranjit Kumar .2014.Research Methodology 4th Ed. edition Sage Publishing;

3. Panneerselvam R .2013.Research Methodology. Second Edition PHI learning Private Limited, New Delhi
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3. https://www.pdfdrive.com/research-methodology-books.html
4 https://edisciplinas.usp.br/.../BLOCO%202_Research%20Methods%20The%20Basics.p...
5 https://www.ncbi.nlm.nih.gov/pubmed/24272431
6 https://www.slideshare.net/jippyjack5/application-of-biostatistics

ELECTIVE COURSES

ELECTIVE PAPER - 1: BIOCONTROL AND ENTOMOLOGY

Course Code: 18MBCE01 **Hours: L + T + P = C**

Marks: 100 **4 1 0 5**

Course Objectives

The aim of Biocontrol and Entomology course is to introduce necessary and application relevance of biofertilizers and biocontrol agents for the students who are in more attentiveness in the development of sustainable agriculture. The content of rigorous course includes significance of microbial lbiofertilizers namely, bacteria, fungi, cyanobacteria and actinorhiza. It also covers various methods applications of biocontrol agents and biomanures for the current agriculture.

Course Outcome

1. By the end of the course, the students will be able to know about the importance and applications of the biofertilizers for the sustainable agriculture.
2. The students will clearly learn in-depth knowledge in order to foster biofertilizers to overcome the applications of chemical fertilizers in the modern farming's.
3. The course will also provide opportunities for the students to develop bio-entrepreneur for the production of bioferilizers.
4. The students will clearly get in-depth information about exploitation of natural wastes by producing bioorganic fertilizers.
5. The students will gain meticulous ideas on production of biopesticides as biocontrol agents

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Current status of fertilizer and biofertilizers	History, importance and present status of different types of fertilizers and their application to crop plants. Importance of macro and micro nutrients - Nutritional deficiency in plants. Biological	Cyanobacterial Biofertilizers: *Nostoc*, *Anabaena*, *Gloeocapsa* and *Scytonema*. Symbiotic association with *Azolla*, Lichens, Bryophytes and Higher plants. Bacterial biofertilizers: Free living forms - *Azatobacter*, *Azospirillum*. Symbiotic forms: Rhizobium-Legume association. Isolation and screening	15

		fixation of nitrogen.	and mass production of bacterial biofertilizers.	
II	Fungal and actinobacterial Biofertilizers	-	Fungal biofertilizers: Types of fungal biofertilizers - Ecto, endo and ect-endomycorrhiza, Ectomycorrhizal association with pines, Arbuscularmycorrizal association (AM) *Glomusspp.*,Nutrient uptake and exchange.Isolation and field enrichment of mycorrhiza. Actinomycetes as biofertilizers: History and biology of actinorhiza, Actinorhizal associations in higher plants, *Frankia spp.*	15
III	Biomanure and its applications	Biomanures technology: A general account of manures - Moulds, Composts Farm yard manure, Oil seed cakes - Castor and neem, Green leaf manures - Gyricidia, Sesbania and Crotalaria, Agro-industrial wastes - Poultry manure and saw-dust, Vermi Compost, Microbial compost - pure culture and	Application of biofertilizers and manures - A combination of biofertilizer and manure applications with reference to soil, seed and leaf sprays.	15

		consortium as an inoculums.		
IV	Introduction to biocontrol	History, principles and scope of biological control. Important groups of parasitoids, predators and pathogens. Principles of classical biological control- importation, augmentation and conservation. Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects.	Role of insect Entomopathogenic nematodes, viruses, bacteria, fungi and protozoa in biocontrol and their mode of action.	15
V	Biocontrol agents	Definition and importance of biological pests and bio-pesticides in agriculture.	Brief conception of Integrated Pest Management (IPM), Integrated Pest and Disease Management (IDPM). Biopesticides - Advantages of bio-pesticides over chemical pesticides, Types of bio-pesticides, *Bacillus thuringiensis* and its importance. Mass production of quality biocontrol agents - techniques, formulations, economics, field release/application and evaluation.	15

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6. http://www.normevents.fr/frd-9/biofertilizer-frankia.pdf
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ELECTIVE PAPER – 2: INTELLECTUAL PROPERTY RIGHTS (IPR), BIO-SAFETY AND BIOETHICS (18MBCE02)

Course Code: 18MBCE02 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

Course Objectives

This part of the curriculum helps students to have an ability to understand and conduct research to meet desired needs within the legal, social, ethical, safety & sustainability aspects in biology and the biocontainment.

Course Outcome

- Students can know rules on how to protect patents, copyrights, trademarks, and other forms of IPRs have become a standard component of international trade agreements.
- Students may become patent attorney, who has the specialized qualifications necessary for representing clients in obtaining patents and acting in all matters
- Gain knowledge in procedures relating to patent law and practice, such as filing an opposition.
- To understand the importance of biosafety and to expose them to various biosafety committees and its importance
- To inculcate the ethical implications in hospitals, clinical laboratories and research.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Introduction to Intellectual Property	IPR - Definition - Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Plant varieties, Trade Secrets, Geographical Indications, IP as a factor in R&D; IPs of relevance to		12

		Microbiology / Biotechnology and few Case Studies.WTO - Definition - Functions - Forms of IPR Protection.		
II	Agreements and Treaties	History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments. Paris Convention.		12
III	Basics of Patents and Concept of Prior Art	Introduction to Patents; Concept related to patents novelty, non-obviousness, utility, anticipation, etc.	Types of patent applications: Ordinary, Patent Co-operation treaty (PCT), Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in context of "prior art"; Patent databases; Searching InternationalpatentDatabases; Country-wise patent searches (USPTO, esp@cenet (EPO), Patents scope (WIPO), IPO, EPO,	12

			etc.).National & Patent Cooperation treaty(PCT) filing procedure; Time frame and cost; Status of the patent applications filed; Revocation of patent, Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes Patent licensing and agreement Patent infringement-meaning, scope, litigation, case studies – Neem, Turmeric and Pasmati rice , Commercialization and Licensing.	
IV	Biosafety	Introduction: Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Biosafety guidelines and regulations (International); Biosafety	Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Biosafety in relation to transgenic research and	12

		guidelines – National ; Definition of GMOs & LMOs;	applications. Biopiracy	
V	Bioethics	Definition - Ethical implications of cloning: Reproductive cloning, therapeutic cloning	Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research. Animal ethics - Norms in India - Licensing of animal house - Ethical clearance norms for conducting studies on human subjects. Ethical implications of human genome project. Bioethics committees – IAEC, CPCSEA, OECD, etc.	12

Text Book:

1. Senthil Kumar Sadhasivam and Mohammed, Jaabir. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, India.
2. Singh K. Intellectual Property Rights on Biotechnology, BCIL, and Newdelhi-1993.
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Department of Microbiology
School of Biosciences
Periyar University
Salem - 636 011, Tamil Nadu

M.Phil. Microbiology
Syllabus

(For the students admitted from 2018 - 2019 onwards)

1. Eligibility

Candidates who have qualified for post graduate degree (any biological science) of this university or any other University recognized by the syndicate as equivalent there to shall be eligible to register for the Degree of Master of Philosophy (M. Phil) their respective subject and undergo the prescribed course of study in an approved institution or department of this University.

Candidates who have qualified their postgraduate degree on or after 1st January, 1991 shall be required to have obtained a minimum of 55% of marks in their respective postgraduate degrees to BECOME eligible to undergo the prescribed course of study in an approved Institution or department of this University.

In the case of teachers (or) others registering for part time registration, the minimum percentage of marks for registration is 50%.

For the candidates belonging to SC/ST community and those who have qualified for the Master's degree before 01.01.1991 the minimum eligibility marks shall be 50% in their Master's Degree.

2. Duration

The duration of the M. Phil course shall extend over a period of one year from the commencement of the course.

3. Course of study

Course of study for the degree shall consist of (a) Part-I comprising three written papers according to the Syllabus prescribed from time to time: and (b) Part-II Dissertation.

Part -I shall consist of Paper -I Research Methodology and Paper -II an advanced paper in the main subject. There shall be a third paper which shall be the background paper relating to the proposed Dissertation conducted internally by the College/Departments.

4. Scheme of Examinations

Part I: Written Examination (Paper I, II & III)

The examination of papers I, II and III shall be held at the end of the year. The duration for each paper shall be 3 hours carrying a maximum of 100 marks.

Paper -III examination will be conducted by the College/ Departments and the marks obtained b the candidate along with the question paper and valued answer scripts shall be sent to the University at least 15 days before the commencement of the examinations of paper I and II.

Part II: Dissertation

The exact title of the Dissertation shall be intimated with in one month after the completion of the written examination. Candidates shall submit the Dissertation to the University through the Supervisor and Head of the Department at the end of the year from the commencement of the course which shall be valued by internal examiner (supervisor) and one external examiner appointed by the University from a panel of four names sent by the Supervisor through the Head of the Department/Principal at the time of submitting the Dissertation.

The examiners who value the Dissertation shall report on the merit of candidates as "Highly Commended" (75% and above) or "Commended" (50% and above & below 75%) or "Not Commended" (Below 50%).

If one examiner commends the Dissertation and the other examiner, does not commend, the Dissertation will be referred to the third valuation shall be final. Submission or resubmission of the Dissertation will be allowed twice a year.

The allotment of marks for (i) Theory (ii) Dissertation and Viva Voce are as follows:

(i) Theory Papers

Internal : 25 Marks
External : 75 Marks
Total : 100 Marks

(ii) Project Dissertation

Dissertation : 100 Marks
Viva Voce : 50 Marks
Total : 200 Marks

(iii) Internal assessment for course I, II and III

Test : 10 Marks
Seminar : 10 Marks
Attendance : 05 Marks
Total : 25 Marks

S. No	Paper	Title of Paper	Exam Hrs	Max. Mark
1	Paper I	Research Methodology and its Applications	3	100
2	Paper I	Advances in Microbiology	3	100
3	Paper I	Guide Paper	3	100
4	Part II	Dissertation	-	200
Total				500

5. Passing Minimum

A candidate shall be declared to have passed Part-I of the examination if he/she secures not less than 50% of the marks in each paper including Paper-III for which examination is conducted internally.

A candidate shall be declared to have passed Part-II of the examination if his/her dissertation is at least commended. All other candidates shall be declared to have failed in the examination.

6. Restriction in number of chances

No candidate shall be permitted to reappear for the written examination in any paper on more than two occasions or to resubmit a Dissertation more than once. Candidates shall have to qualify for the degree passing all the written papers and dissertation within a period of three years from the date of commencement of the course.

7. Conferment of Degree

No candidate shall be eligible for conferment of the M. Phil degree unless he/she is declared to have passed both the parts of the examination as per the regulations.

8. Qualifications for persons conducting the M. Phil course

No teacher shall be recognised as a Supervisor unless he possesses a Ph. D degree or two years of PG teaching experience after qualifying for M. Phil or M.Litt. Degree.

Only the post graduate departments of affiliated colleges and departments of the University will be recognized for conducting the M. Phil course provided; however, the Syndicate shall have the power to decide any other institutions of higher learning/ research within the University area for conducting the M.Phil course on merits.

PART-TIME

9. Eligibility

(i) Teacher candidates working in the University Departments.

(ii) Teacher candidates working in the affiliated colleges and whose qualifications are approved by the University.

(iii) Teacher candidates working in Polytechnics approved by the Director of Technical Education or in Higher Secondary Schools and High Schools approved by State Board or Central Board of Secondary Education or Educational Institutions of IAF (within Periyar University area) who possess a Master's Degree. For the Master's Degree qualified prior to 01.01.1991, no minimum marks is prescribed; but on or after 01.01.1991, a minimum of 55% of the marks is prescribed, provided that for the candidates belonging to SC/ST community a concession of 5% of marks will be given in the minimum eligibility marks prescribed.

10. Duration

The course of study shall extend over a period of two years from the commencement of the course. The examinations for Part-I shall be taken at the end of the first year and Part-II Dissertation at the end of the second year.

11. Regulations

The Regulations governing the full-time M.Phil course with regard to the course of study, scheme of examinations passing minimum, etc and qualifications of guide conducting the M. Phil course shall apply to part-time candidates also.

12. Restriction in number of chances

No candidate shall be permitted to reappear for the written examination in any paper on more than two occasions or to resubmit a Dissertation more than once. Candidates shall have to qualify for the degree passing all the written papers and dissertation within a period of four years from the date of commencement of the course.

M.Phil. MICROBIOLOGY (Choice Based Credit System)

Course of Study

Part	Course	Course Code	Name of the course	Credits	Marks		
					IA	UE	Total
I	I	18DMPMB01	Research Methodology and its Applications	4	25	75	100
	II	18DMPMB02	Advances in Microbiology	4	25	75	100
	III	18DMPMB03	Research Background Paper	4	25	75	100
II	IV		Dissertation and Evaluation Viva-voce	8 + 4 (12)	50	100	150 50
			Total	24			500

PAPER – I: RESEARCH METHODOLOGY AND ITS APPLICATIONS (18DMPMB01)

Course Objectives

The course contents are designed to gain knowledge about the research ideas, various aspects relating to research such as preparation of research paper, various citation index, use of statistics, principle and application of various instruments, and role of bioinformatics in research. The learner will get an understanding about the research related skills.

Course Outcome

At the end of the course, the learner will be able to

1. Known the basics aspects of research process, Data presentation and Research report writing.
2. Learn the principles of statistics and its tools, the basics of the various advanced instruments for analysis in research.
3. To provide an exposure to the students on the basic skills for becoming a researcher in microbiology.

UNIT - I

Research Methodology - Meaning and importance. Review of literature - Review and synopsis presentation. Types of Research and research tools, Research designs - Experimental and non-experimental. Preparation of research report. Guidelines for preparing an article - ISSN, ISBN, impact factor, citation index, h-index, I- index, Google scholar, Scopus, Thomson& Reuters, Web of Science. Plagarism and Antiplagarism software, Computational- RSM.

UNIT - II

Biostatistics - Introduction - Basic concepts, Sampling and data collection, Data presentation, Descriptive Statistics - Measures of central tendency and Measures of dispersion, Population parameters, sample estimates and confidence intervals. Basic concepts of probability. Probability distributions, Z-scores, Student's t- test, Chi square test, Correlation, regression, ANOVA, SPSS, RSM.

UNIT - III

Units of measurements (Mole, equivalents - Molarity-Molality and normality), Cleaning of laboratory glassware's. Laboratory Instruments Principles and applications of pH meter, Centrifuge, UV-Vis spectrophotometer. Molecular techniques - Electrophoresis, PCR, RAPD, RFLP, field Gel Electrophoresis (PFGE), Two dimensional electrophoresis (IEF), DGCE, TGGE and TRFLP. STRR and LTRR analysis cDNA library - screening by oligonucleotide probe, nick translation, site directed mutagenesis.

UNIT - IV

Bioinstrumentation- Chromatographic Technique- Principles, types and applications of Chromatography -Thin layer chromatography(TLC), Gas Liquid Chromatography (GLC) ,High pressure liquid chromatography (HPLC),Fast performance liquid chromatography (FPLC), Gas chromatography - Mass spectrometry (GC-MS). Compound Microscope- Transmission Electron Microscope (TEM) and Scanning Electron microscope (SEM)- Principles, Procedure and Specimen preparation, Fluorescent Microscope.

UNIT - V

Bioinformatics and IPR - An overview of bioinformatics. Biological databases- Database

searching, Sequence analysis, Pair alignment, Visualizing protein structures, Predicting structure and function of protein using sequences, computer based drug designing. Submission of nucteotides in NCBI-FASTA, Construction of phylogenetic tree. Phylogenetic analysis Genomics, Proteomics. Drug design and commercial bioinformatics. Intellectual property rights, patents, trade secrets, copyrights and trade mark. Patenting transgenic organisms. Plant breeder's right. Ethics in animal biotechnology.

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PAPER – II: ADVANCES IN MICROBIOLOGY (18DMPMB02)

Course Objectives

The course contents are designed to gain knowledge about the various advances that have been made in the field of microbiology with regard to the instrumentation used in research and advanced science knowledge with regard to microbial technology, secondary metabolites, clinical microbiology and microbial pharmaceuticals.

Course Outcome

At the ends of the course, learners will be able to

1. Gain knowledge to the advanced microbial techniques and effectively learn the applications of the instruments.
2. Acquire knowledge of the various secondary metabolites production and their biological applications.
3. Understanding the importance of various emerging diseases and its diagnostic methods.
4. The students will be able to know about the advanced developments in Microbiology.

UNIT - I

Introduction – Development of microbiology and the early discoveries - Isolation of different types of bacteria – fungi – actinobacteria – cyanobacteria. Microbial taxonomy: Definition, systematics, Nomenclature rules and identification, Microbial respiration and fermentative pathway - respiratory metabolism, Fermentation of carbohydrates - homo and hetero lactic fermentation. Bioenergetics, Cell division - endospore - structure and properties.

UNIT - II

Current trends: Exploration of bioactive compounds from extremophiles. Bioremediation, Biosensors, Biofuel, Biofilms. Remote sensing microbiology, Microbial communication - Quorum Sensing. Barcoding of microbes - application in clinical and industrial fields, Microbial techniques: Confocal microscopy, DNA Microarray for comparative and Evolutionary genomics: Flow cytometry, Atomic flame photometry, Plasma emission spectroscopy, Infra-red spectrophotometry. Tandem mass spectroscopy, Electron Spin Resonance spectroscopy, MOLDI-TOF mass spectrometry.

UNIT - III

Microbes and Health: GLP, laboratory and hospital acquired infection. Emergence of MDR and XDR microbes. Harmful microbes and biological weapons. Automated diagnostic method. Recombinant vaccines. Environmental aspects of emerging diseases. Microbial pharmaceutics and biotechniques: Drug discovery and design, British and Indian Pharmacopacea, Marine microbial antibiotics, Microbial therapeutic enzymes, Microbial pigments, Single cell proteins. Microbial Products and their bioprocesses.

UNIT - IV

Pharmacokinetics and pharmacodynamics - Routes of drug administration- volume of distribution - biotransformation - Phase I and Phase II reactions - bioavailability - excretion of drugs and their metabolites as defined by Hendersson Hassle Batch equation. Adverse drug reactions. Principles of toxicity, evaluation and determination of LD50, ED50 and therapeutic Index.

UNIT - V

Microbial Technology: Microbes in nanotechnology, Nanoscience in biomedical application: Nanosensors in diagnosis - Nanorobotics in surgery Nanotechnology in tissue regeneration - Nanotechnology durg targeted delivery. Applications in tissue engineering and therapeutics. Biopolymers, Biosurfactants, Biofertilizers, Biopesticides, Bioluminescence, Genetically modified organisms. Gene silencing - Gene knockouts and gene therapies, antisense technologies. Gene therapy, Stem cell therapy. Carbon sequestration by microbes.

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