PERIYAR UNIVERSITY

Salem-636011

(NAAC 'A++' Grade - State University - NIRF Rank 63)

DEPARTMENT OF MICROBIOLOGY

M.Sc., DEGREE

[Choice Based Credit System (CBCS)]

OBE Based Curriculum

(Effective from the academic year 2022-2023 and thereafter)

M.Sc., Microbiology

OBE BASED SYLLABUS

(With effect from the academic year 2022-2023 onwards)

Preamble

Post graduate Microbiology is a course focus on microbiology and its complete diversity exploring their relationship with various environments. Curriculum includes General Microbiology, Immunology & Vaccinology, Pharmaceutical Chemistry, 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 & Vaccinology, Pharmaceutical Chemistry, 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 - The graduates develop knowledge and skills in solving the challenges in the field of Microbiology.

PE02 - The graduates recognize, design and develop sustainable technologies to address the needs of community and expand the career opportunities in academic institutes, hospitals / clinical laboratories, food industry, effluent treatment plants, research laboratories and pharmaceutical industry through innovative techniques.

PEO3 - The Graduates 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 working in hospitals/ clinical laboratories, food industry, environment, research laboratories, pharmaceutical industry will be able to understand industrial processes, cleanrooms, and how to effectively evaluate microbial risks on products 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	78	100	5
Elective courses	3	60	100	4
Supportive courses	1	45	100	3
Project	1	24	100	14
Online courses	1	-	-	2
Total	23			

6. Curriculum structure

	Paper Code	Title of the Paper	Hrs/ Week	Credits	Marks		
					CIA	EA	Total
I	22UPMBC1C01	Core I - General Microbiology	5	4	25	75	100
	22UPMBC1C02	Core II - Immunology & Vaccinology	5	4	25	75	100
	22UPMBC1C03	Core III - Pharmaceutical Chemistry	5	4	25	75	100
	22UPMBC1E**	Elective -1	5	4	25	75	100
	22UPMBC1P01	Core Practical I – Basic Techniques in Microbiology	5	3	40	60	100
	22UPMBC1P02	Core Practical Il - Immunology & Pharmaceutical chemistry	5	3	40	60	100
II	22UPMBC1C04	Core IV - Medical Bacteriology and Parasitology	4	4	25	75	100
	22UPMBC1C05	Core V - Medical Mycology and Virology	4	4	25	75	100
	22UPMBC1C06	Core VI – Industrial Microbiology	4	4	25	75	100
	22UPMBC1E**	Elective - 2	4	4	25	75	100
	22UPMBC1S**	Supportive – 1	3	3	25	75	100
	22UPMBC1P03	Core Practical III – Diagnostic Microbiology	5	3	40	60	100
	22UPMBC1P04	Core Practical IV - Industrial Microbiology	5	3	40	60	100
		Value Education	2	2	25	75	100
		Swayam / Mooc Course		2	-	-	-
III	22UPMBC1C07	Core VII - Molecular Biology and Applied Biotechnology	5	4	25	75	100
	22UPMBC1C08	Core VIII – Bio Nano-technology and Omics	5	4	25	75	100
	22UPMBC1C09	Core IX – Food, Soil and Environmental Microbiology	5	4	25	75	100
	22UPMBC1E**	Elective – 3	5	4	25	75	100
	22UPMBC1P05	Core Practical V: Molecular Biology and Biotechnology	5	3	40	60	100
	22UPMBC1P06	Core Practical VI: Applied Microbiology	5	3	40	60	100
	22UPMBC1I01	Internship	2 wks	2	40	60	100
IV	22UPMBC1C10	Core X- Research Methodology and Computational biology	5	4	25	75	100
	22UPMBC1CS01	Credit Seminar	1	1	40	60	100
	22UPMBC1PR01	Project	24	14	40	60	100
		Total		94	735	1665	2400

Elective courses

1. Biofertilizers and Biocontrol Agents (22UPMBC1E01)
2. Entrepreneurship in Microbiology (22UPMBC1E02)
3. Algal Biotechnology (22UPMBC1E03)
4. Quality Control in Industries (22UPMBC1E04)
5. IPR, Biosafety and Bioethics (22UPMBC1E05)
6. Mushroom and Single Cell Protein Technology (22UPMBC1E06)
7. Ocular Microbiology (22UPMBC1E07)
8. Introduction to Microbial Endophytes (22UPMBC1E08)
9. Basics of Food Processing, Analysis & Safety (22UPMBC1E09)
10. Molecular Immunology and Immunotechnology (22UPMBC1E10)
11. Essentials of Bioinformatics for Biologist (22UPMBC1E11)
12. Microbes and the Life Science (22UPMBC1E12)

Supportive courses for other departments

1. Medical Laboratory Technology (22UPMBC1S01)
2. Microbiology (22UPMBC1S02)
3. Quality Control in Industries (22UPMBC1S03)
4. Health Science Management (22UPMBC1S04)

7. Credit Calculation

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

8. 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.

9. 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)	20 x 1=20 (Multiple choice questions)		
B	100 to 200 words (Answer any three out of five questions)	3 x 5=15 (Analytical type questions)		
C	500 to 1000 words (Either or type one pair from each unit)	5 x 8=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

10. Grading System

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

Range of Marks	Grade Points	Letter Grade	Description
90 - 100	9.0 – 10.0	O	Outstanding
80 - 89	8.0 – 8.9	D+	Excellent
75 - 79	7.5 – 7.9	D	Distinction
70 - 74	7.0 – 7.4	A+	Very Good
60 - 69	6.0 – 6.9	A	Good
50 - 59	5.0 – 5.9	B	Average
00 - 49	0.0	U	Re-Appear
ABSENT	0.0	AAA	Absent

11. Classification of Final Result

CGPA	Grade	Classification of Final Result
9.5 – 10.0	O+	First Class with Exemplary*
9.0 and above but below 9.5	O	
8.5 and above but below 9.0	D++	First Class with Distinction*
8.0 and above but below 8.5	D+	
7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A++	First Class
6.5 and above but below 7.0	A+	
6.0 and above but below 6.5	A	
5.5 and above but below 6.0	B+	Second Class
5.0 and above but below 5.5	B	
0.0 and above but below 5.0	U	Re-Appear

* The candidates who have passed in the first appearance and within the prescribed semesterof the PG Program are eligible.

SEMESTER - I

PROGRAMME OUTCOME vs COURSE OUTCOME													
SUBJECT	**COURSE OUTCOME**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO1 1**	**PO 12**
Core Paper 1: General Microbiology	Know about the basic aspects of microbiology, different methods of isolation of microorganism, preservation and controlling of microorganism.	✔	✔	✔									
	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 micro-organisms	✔	✔	✔	✔								
	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.	✔	✔	✔	✔								
Core Paper 2: Immunology & Vaccinology	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				✔	✔	✔		✔			✔	

Core Paper 3: Pharmaceutical Chemistry	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.	✔	✔	✔	✔	✔		✔					
Core Practical 1: Techniques in 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 2: 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	✔					✔	✔		✔	✔		✔

CORE I: GENERAL MICROBIOLOGY

Course Code: 22UPMBC1C01 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

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

1. Know about the basic aspects of microbiology, different methods of isolation of microorganism, preservation and controlling of microorganism.
2. Learn the basic morphology of different class of microorganism, its cellular components and the classification of different types of microorganism.
3. Know about the basic aspects of microbial taxonomy, classification systems and the life cycle of important class of microorganisms.
4. Know the basis of microbial physiology with its biochemical pathway and the ecology of the microbes with reference to Extreme Ecosystems.
5. 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 – Contribution of Leuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Joseph Lister, and John Tyndall. Preservation methods of microbes- Routine methods, liquid nitrogen preservation, freeze-drying (lyophilization).	Isolation of different types of bacteria – fungi – actinobacteria – cyanobacteria.	15

II	Microbial taxonomy	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), and oomycetes (Saproleina)	15
III	Morphological types	Sterilization and disinfection – physical and chemical methods for controlling microorganisms. Morphological types - Gram negative and Gram positive, Cyanobacteria, Archeabacteria.	Principle and application of bright field, dark field, fluorescence, electron microscope- TEM and SEM. Algae: Structure of algal cells, classification, reproduction and characteristics of Chlorophyta (green algae), Chrysophyta (golden-brown and yellow), Green algae, Diatoms, Euglenophyta (Euglenoids) & Cyanophyta.	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, Insect 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:

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 VACCINOLOGY

Course Code: 22UPMBC1C02 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

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, Haemato-poeisis. Ontogeny, origin, 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.		15
II	Organs of the Immune system and Immune response	Lymphoid tissues and organs - Primary lymphoid organs - Thymus, Bone marrow: Secondary	Generation of antibody diversity. Organisation and expression of	15

		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.	immunoglobulin genes.	
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, immunofluorescence , haem agglutination, RIA, ELISA. Factors governing antigen-antibody interactions: Affinity, avidity, valency, cross reactivity. The complement systems,	15
IV	Complement system, Transplantation and Tumour Immunology	Transplantation immunity - Organ transplantation and HLA tissue typing. Tumour Immunology-Genetics of neoplastic cell antigens expression of tumor antigens	Introduction to Vaccines - Types of vaccines – Recombinant vector vaccines, DNA vaccines, Vaccines against AIDS and Tropical Infectious Diseases Immuno therapy for cancer.	15
V	Hypersensitivity and Vaccinology	Hypersensitivity reactions - types and mechanisms, Hybridoma and monoclonals	The vaccine industry, Vaccine manufacturing, Vaccine additives and manufacturing	15

			residuals, World Health Organization (WHO) guidelines, Regulation and testing of vaccines, Vaccine safety, Limitations of vaccines.	

Text Books:

1. Rao, C.V. (2012) *An Introduction to Immunology*. 2nd Edition, Narosa Publishing House.
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.
2. William E. Paul (2018) *Fundamental Immunology*, 8th Edition, Willams and Wilkins Publishing.
3. Cruse, J., Lewis, R. and Wang, H. (2004) *Immunology Guidebook*, Academic Press.
4. Abbas, A.K., Litchman, A.H., Pober. J.S. (2017) *Cellular and Molecular Immunology*, 9th Edition, W.B.Saunders, USA.
5. Golds, R.A., Kindt T.J., Osborne B.A. (2005) *Immunology*, 5th Edition, Freeman and Company, New York.
6. Ivan M. Roitt and Peter J. Delves (2016) *Essential Immunology*, 13th Edition, Blackwell Science Ltd. Oxford.
7. 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.
8. Peter Wood (2006) *Understanding Immunology University of Manchester*, 2nd Edition, Pearson Education Lts, Essex.
9. Stefan H.E. Kaufmann, Sher, A., Ahmed, R. (2002) *Immunology of Infectious diseases*, ASM Press, USA.
10. Benjamini E, Coico R and Sunskise G,;Immunology – A short course, Wiley – Liss Publication, NY. Ed.4; 2000.

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 CHEMISTRY

Course Code: 22UPMBC1C03 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

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	Properties of Elements in Periodic table - Atomic structure: Atom - Atomic orbital - Molecular orbital - Chemical element - Valence - Electron pair - Unpaired electron. Chemical formula - Structural formula. Chemical composition of cells.	Atomic nucleus - Isotope. Bonding: Chemical bond - Ionic bond - Covalent bond - Metallic bond - Hydrogen bond - Intermolecular force – Dipole Dipole bond - Mole Concept - Stoichiometry – balancing equation.	15

II	Macromolecular components of cell	Macromolecular components of the cell - Structural conformation- Carbohydrates - Monomers, oligomers, polymers, isomers. Lipids - simple lipids, compound lipids and derived lipids. Proteins - Primary, secondary, tertiary and quaternary structures.	Carbohydrate Metabolism. Lipid beta oxidation. Biological functions of macromolecules - Carbohydrates, Lipids, Proteins. Enzyme types, Enzyme kinetics, Enzyme Inhibition kinetics & Competitive Inhibition and mechanisms of action. Classification and uses of vitamins.	15
III	Pharmacokinetics and pharmacodynamics	Pharmacokinetics and pharmacodynamics - Routes of drug administration- Drug physical and chemical Properties of drugs. Pharmacophores. Beneficial and Adverse drug reactions. Principles of toxicity	Volume of distribution - biotransformation - Phase I and Phase II reactions - Bioavailability - excretion of drugs and their metabolites as defined by Henderson Hassle Batch equation. Determination of LD50, ED50 and therapeutic Index.	15
IV	GLPs and SOPs	Current good manufacturing practices, Good laboratory practices, Good documentation practices, Standard operating procedures, FSSAI, HACCP, ISO Standards, Laboratory information management system (LIMS). Pharmacopaea– Pharmacopaea updates, US, Europea, British and Indian Standard	Instrumentation operating procedures, Calibration of equipment's, Microbial spoilage of drugs, Infection risk and contamination control. Chemical disinfectants, antiseptics, antibiotics, anti-infectives. Production of endocrine and human growth	15

		Organization, Audit related to pharma. United States Federal Drug Administration Audits.	hormone. Preservative types and their uses.	
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, Trend analysis, Results and Discussions reporting (OOS & OOT), Out of specifications and Out of trend.	Bacterial endotoxin test (BET), Bio-burden analysis, Water analysis in pharmaceutics, Quality determination of raw material samplings and sterility checking for finished pharmaceutical products. Hospital waste disposal. Functions of Hospital Infection control and related ethical committee.	15

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9 Robert T. Morrison, Robert N. Boyd (2016). Organic Chemistry. Sixth edition Publisher: Pearson India, 1364 pages
10 RS Satoskar Nirmala Rege SD Bhandarkar (2015). Pharmacology and Pharmacotherapeutics24th Edition. 1170 Pages
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PRACTICAL – I

PRACTICAL EXAM: 7 HRS / DAY; 2 CONSECUTIVE DAYS

CORE PRACTICAL I: BASIC TECHNIQUES IN MICROBIOLOGY

Course Code: 22UPMBC1P01 **Hours: L + T + P = C**

Marks: 100 **0 0 6 3**

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:

1. Perform the various staining techniques of bacteria and study the growth rate of bacteria.
2. Competently cultivate algae in different types of media.
3. Demonstrate knowledge and understanding of immunology and the means of applying in the diagnostic and therapeutic techniques and research.
4. Understand the safe working practice in an immunology laboratory.
5. Develop skills to design diagnostic kits.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4, K5)	
I	Isolation of Microorganism	Isolation and Enumeration of Bacteria & Fungi from Soil Sample. Isolation of Arbuscular mycorrhizae (AM)		15
II	Bacterial Staining Methods Direct Microscopic observation of fungi Identification of Non sporulating fungi Determination of Bacterial Motility-		Simple, Grams, Capsule, & Spore Staining. Lactophenol Cotton Blue Staining (LPCB) Fungal Slide Culture Hanging Drop Method.	15

III	Biochemical Test Polymer Degradation Test-		IMVIC tests Catalase Test Oxidase Test Urease Test Nitrate Test Triple Sugar Ion Agar Test Carbohydrate fermentation Gelatin Casein &Starch Hydrolysis Test Cellulose hydrolysis Test	15
IV	Growth of microorganisms	Determination of microbial size by Micrometry 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. Antimicrobial activity.		15

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CORE PRACTICAL II - IMMUNOLOGY & PHARMACEUTICAL CHEMISTRY

Course Code: 22UPMBC1P02 **Hours: L + T + P = C**

Marks: 100 **0 0 6 3**

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 Identification of various immune cells by morphology – Leishman staining, Giemsa staining	15
II	Separation of Immune cells		Isolation of Buffy coat Antibody titration of human blood group antigen Purification of immunoglobulin – Ammonium Sulphate Precipitation	15
III	Precipitation Reactions		Precipitation reactions in gels – SRID, ODD, CIE, Immunoelectrophoresis and staining of precipitation lines	15
IV	Agglutination Reactions		Agglutination Reactions- Latex Agglutination reactions- RA, ASO, CRP, WIDAL	15
V	Pharmaceutical Microbiology		Test of Sterility for tablets, parenteral, Phenol co-efficient Test & Calculation of IC50 value	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
3. Celis, J.E. (1998) *Cell Biology: A Laboratory Handbook*, 2nd Edition, Immunocytochemistry, San Diego: Academic Press, pp 457-494
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SEMESTER – II

SUBJECT NAME	COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Core paper 4: 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.	✔		✓	✓	✓	✓						✓
Core Paper 5: 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 treatment.	✔	✓	✓	✓					✔			
	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.	✔	✓	✓	✓								
Core Paper 6: 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		✓		✓		✓						✓
Core Practical 3: Diagnostic Microbiology	Process the 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 sterilized 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 technique.	✓		✓			✓	✓	✓	✓	✓		
Core Practical 4: 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				✓	✓	✓	✓		✓	✓		

Core IV – MEDICAL BACTERIOLOGY AND PARASITOLOGY

Course Code: 22UPMBC1C04 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

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	Cultivation of aerobic and anaerobic microbes. Types of media and their purpose. Synthetic, Non – synthetic media. Applications of basal, Differential, Enriched and Selective media in bacterial growth. Types of inoculations.	Biochemical characteristics of bacteria. Indigenous normal microbial flora of human system and their importance. Virulence factors of pathogenic bacteria – Adherence, Colonization, Invasion, Toxins, Enzymes	15

II	Medical terminologies associated with bacterial infections. Collection and transport of clinical specimens. Hospital waste management and ethical committee. Gram positive pathogens	Medical Terminologies associated with Bacterial infections. Infectious dose, Epidemic, Pandemic, Sporadic, Endemic. Collection and transport of clinical specimens – Urine, Sputum, CSF, Blood Pus and Stool.	Nosocomial infections – Bacterial diseases affecting people based on age. Bacterial diseases affecting diabetic patients. Bacterial diseases affecting immunocompromised persons. Zoonotic infections	15
III	Epidemiology, Pathogenesis, Diagnosis and treatment of serious and common infections caused by Gram negative and Gram positive pathogens	The epidemiology, pathogenesis, symptoms, diagnosis and treatment most common bacterial diseases – Cholera, Diphtheria, Meningitis, Lyme disease, Gonorrhea, Syphilis, Cellulitis and Urinary tract infections.	The epidemiology, pathogenesis, symptoms, diagnosis and treatment of serious bacterial diseases – Bacterial Pneumonia, Tuberculosis, Bacterial Exotoxin and endotoxin related diseases, Infections by Multiple drug resistant strains	15
IV	Parasitology: Amoeba and Flagellates	Parasitology- introduction and classification. Sarco Mastigophora – Sarcodina - Intestinal amoeba – *Entamaeba histolytica*. Free living amoebae – *Naegleria fowleri*, *Acanthamoeba* spp. Mastigophora – Intestinal and genital flagellates – Giardia, Trichomonas.	Blood and tissue flagellates – *Leishmania donovani*, *Trypanosoma cruzi* and *T. brucei* complex. Apicomplexa – Haemosporina – Malarial Plasmodium, Ciliates – *Balantidium coli*	15

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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Core V - MEDICAL MYCOLOGY AND VIROLOGY

Course Code: 22UPMBC1C05 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

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:

1. 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.
2. Know about the different classes of antifungals, their mode of action, methods followed in diagnosis of fungal infections and its treatment.
3. Know about the different types of fungal infections, properties of the fungi causing these infections, the diagnostics methods and the treatment of these infections.
4. To know the basic concepts of viruses with its taxonomy, multiplication and the different types of animal viruses and its classification.
5. To understand the disease-causing nature of different class of animal viruses, new emerging viral diseases, its pathogenesis and treatment methods.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4, K5)	
I	Medical Mycology	Medical Mycology-Introduction-Historical Perspectives and Miles stones in Mycology, Fungal Taxonomy-Binomial nomenclature, Fungi: Cell wall - chemical composition and functions, membranes and their functions. Fungal repository and databases, Classification of medically important fungi.	Safety in Medical Mycology Laboratory-Biosafety Levels and its importance. Collection and Transport of fungal specimens- Methods of collection, processing and interpretation of result.	15

II	Antifungal therapy	Historical Perspectives and Current scenario, Classification of Antifungals-Polyene, Synthetic and Miscellaneous antifungals,	Antifungal Susceptibility testing- CLSI guidelines, Different methods of antifungal testing- E test, Agar dilution & Broth dilution. Diagnosis of Fungal infections Conventional and non-conventional methods, Current techniques in fungal diagnosis- amplification & sequencing methods, MALDI-TOF Mass spectrometry.	15
III	Mycosis	Superficial mycosis - Tinea, Cutaneous mycosis - Dermatophytosis. Subcutaneous mycosis - Mycetoma, Systemic mycosis- Blastomycosis and Histoplasmosis. Opportunistic mycosis - Candidiasis, Aspergillosis and Mucoromycosis, Oculomycosis-Fungal Keratitis and Endophthalmitis, Fungal Rhinosinusitis.		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 - Rabies, Yellow fever, Newly emerging viral diseases in Asia - SARS, Swine Flu, Hepatitis-C, Dengue fever, Chickenkunya, Zika virus, Nipah virus.	Cultivation of viruses. Impact of Corona virus.	15

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CORE VI – INDUSTRIAL MICROBIOLOGY

Course Code: 22UPMBC1C06 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

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	Biomass & Bioproduct	Introduction - Biomass, Biological wastes from domestic, agriculture and industries.	Different kinds of wastes – Solid and Liquid wastes. Biological waste treatment, Production of Bioenergy from wastes - Biofuels, Acetone, butanol. Biotransformations and bioresource systems analysis. Bioproducts: Biocatalysis and fermentations.	15
II	Fermentation Process	The range of fermentation process - Chronological development -	Industrially important microorganisms - Isolation, preservation and improvement of strains. Media for industrial	15

		Component parts of a fermentation process - Fermentation economics.	fermentation -Formulation and sterilization. Development of inoculum for various upstream process - Shake flask, Pre-Seed fermentation and seed fermentation.Raceway pond system	
III	Fermentor	Types and design - Parts of a fermentor, body construction, Temperature control, gas liquid exchange, mass transfer - heat transfer, oxygen transfer, aeration and agitation.	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	Intracellular and extra cellular products - Methods of recovery - Biomass separation by centrifugation, 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. Fermentation waste water and its characteristics.	15
V	Microbial Products	Different kinds of Microbial Products	Organic acids - Amino acids, Antibiotics - Penicillin, Enzymes, Vitamins, Alcoholic beverages - wine and beer, Fermented foods - bread, cheese and soy sauce. Recombinant Products - insulin, interferon and	15

			growth hormone, Fermentation products from natural wastes - molasses, starch wastes and cellulosic wastes. Microbial transformations - steroids, sterols and non-steroid compounds - Antibiotics.	

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CORE PRACTICAL - III

PRACTICAL EXAM: 7 HRS / DAY; 2 CONSECUTIVE DAYS

CORE PRACTICAL - III: MEDICAL MICROBIOLOGY LAB

Course Code: 22UPMBC1P03 **Hours: L + T + P = C**

Marks: 100 **0 0 6 3**

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 specimens and understand 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

Unit	Intended Learning Chapters		Hours of Instruction
	(K1, K2)	(K3, K4 & K5)	
I	Collection and transport of clinical specimens for microbiological examinations. Cultivation of Microbes- Basal, Differential and Selective media.	Antimicrobial sensitivity testing by disc-diffusion technique and determination of MIC.	15
II	Isolation and identification of bacterial pathogens from clinical specimens viz. Throat swab, pus, urine, sputum and stool.	Examination of parasites in clinical specimens- Floatation and sedimentation techniques of stool examination.	15
III	Blood smear examination for malarial parasites. Animal tissue culture – Egg inoculation methods of virus. Spotters of viral inclusions.	Cultivation and Identification of fungi by Lactophenol cotton blue (LPCB) mount of *Mucor, Rhizopus, Aspergillus, Penicillium, Fusarium, Curvularia, Bipolaris* & *Trichophyton*).	15

IV		Identification of Non sporulating fungi- Slide culture method, Cornmeal/Tap water agar. Identification of *Candida* species- Germ tube method, Sugar assimilation/ fermentation test, species differentiation on Hichrome agar.	15
V		Isolation and characterization of bacteriophage from natural sources. Techniques to diagnosis of Viruses-RT PCR	15

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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

CORE PRACTICAL - IV

PRACTICAL EXAM: 7 HRS / DAY: 2 CONSECUTIVE DAYS

CORE PRACTICAL - IV: INDUSTRIAL MICROBIOLOGY

Course Code: 21MBCP04 **Hours: L + T + P = C**

Marks: 100 **0 0 6 3**

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 microbes	Screening of antibiotic & pigment producing microorganisms from soil.		15
II	Enzyme and its production	Screening of enzyme producing organisms (e.g. Amylase and Cellulase). Production of industrially important enzymes by Submerged fermentation (e.g. Amylase). Production of industrially important	Purification of enzymes by filtration method/chemical method by ammonium sulphate.	15

		enzymes by solid state fermentation (e.g. Amylase). 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.		
III	Alcoholic fermentation	Production of wine by submerged fermentation. Production of alcohol from sugarcane molasses. Production of alcohol from beetroot wastes.	Characterization of alcohol: Nutritive value, Colour, Haze, Viscosity, foam Characteristics, gurting flavor	15
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. Hemen Sarma (Ed) and Majeti Narasimha Vara Prasad (Ed) (2021) Biosurfactants for a Sustainable Future: Production and Applications in the Environment and Biomedicine, Wiley Press, ISBN: 978-1119671008.

2. Basanta Kumar Rai and Dil Kumar Subba (2016) *Basic Practical Manual on Industrial Microbiology*, Dharan Multiple Campus, Nepal.
3. Kulandaivel and Janarthanan, S. (2012) *Practical Manual on Fermentation Technology*, ISBN: 9789381141809.
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SEMESTER – III

CORE - VII: MOLECULAR BIOLOGY AND APPLIED BIOTECHNOLOGY

Course Code: 22UPMBC1C07 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

Course Objectives

1. To impart the knowledge on structure of gene, genome organization and functions of genetic materials.
2. To focus on, transcription, translation, mutation and DNA repair in microbial system.
3. To teach protein synthesis and translation modification process
4. To give a better understanding of the cloning and expression of foreign genes in the bacterial system.
5. To produce genetically modified organisms for various applications

Outcome of the course

1. End of the course, learners will understand structure of gene, genome organization and functions of genetic materials.
2. Students will have deeper understanding on the transcription, translation, mutation and DNA repair
3. Learners will have better understanding on protein synthesis and translation modification process
4. Students will have thorough knowledge on cloning and expression of foreign genes
5. Students will be able to produce genetically modified organisms.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	**(K3, K4 & K5)**	
I	DNA, RNA & PNA	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.	DNA damage and repair mechanisms. Inhibitors of replication. Mutagens: Types, Physical and chemical mutagens. Gene transfer in bacteria - transformation - conjugation - transduction.	15
II	Transcription:	Types and functions of RNA polymerases, Various factors involved in transcription process	Transcription Initiation, elongation and termination. Regulatory elements of transcription. Inhibitors of Transcription. Operon models - *lac*, *trp*, *ara* operons.	15

III	Translation	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	Recombination 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 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

Book References

1.WatsonJD,BakerTA,BellSP,GannA,LevineMandLosickR.(2014)MolecularBiologyofthe Gene,6thedition,ColdSpringHarbourLab.Press,PearsonPublication.

2.Alberts B and Jhonson AD.(2014)Molecular BiologyoftheCell,6thedition, Garland Science.

3.KrebsJ,GoldsteinE,KilpatrickS.(2013)Lewin'sEssentialGenes,3rdEd.,JonesandBartlettLear ning

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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 OMICS

Course Code: 22UPMBC1C08 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

Course Objective

The objective of this course is to provide an insight into the fundamentals of Nano science 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 Science of Nano - definition and principles. History of nanotechnology.- Nano biotechnology - Opportunities, challenges. Introduction to Nanostructures: Carbon Nanotubes (CNT), Graphenes, Fullerenes, Nano Peapods, Quantum Dots and Semiconductor Nanoparticles Metal-based Nanostructures (Iron Oxide Nanoparticles) Nanowires Polymer-based Nanostructures including dendrimers. Introduction to metal based nanostructures, Protein-based Nanostructures: Nano motors: Bacterial (E.		12

		coli) and Mammalian (Myosin family) Nano biosensors: Types of nano-biomaterials. Generation of biomaterials. Top down and bottom up approaches - Physical, Chemical and Microbial synthesis of nanomaterial's - Silver, Gold, Titania, Carbon nanotubes, polymer Nano compositesetc.		
II	Characterization Techniques for Nanoparticles	Introduction to spectroscopy: Basic principles and applications of UV-Vis-, Fourier transformer infrared spectroscopy (FTIR) Field Emission Scanning Electron Microscopy (FESEM)- High Resolution Transmission Electron Microscope (HRTEM). Particle size analyser - X-ray diffraction (XRD) - Electron Spectroscopy: X-Ray Photoelectron Spectroscopy (XPS) and Auger Electron Spectroscopy (AES). Surface enhanced Raman spectroscopy (SERS). Toxicological aspects of nanoparticles: *In vitro* and *In vivo* methods Nano toxicology - Risks and Ethics.	Particle size analyser - X-ray diffraction (XRD) - Fourier transformer infrared spectroscopy (FTIR), Field Emission Scanning Electron Microscopy (FESEM)- High Resolution Transmission Electron Microscope (HRTEM) - Atomic force Microscopy (AFM)- Surface enhanced Raman spectroscopy (SERS) - X - ray Photoelectron Spectroscopy (XPS) - Auger electron spectroscopy (AES).	12

III	Nano science in biomedical application	Biomedical nanoparticles – Liposome's – Dentrimers Biodegradable polymers – Introduction and Rationale for Nanotechnology in Cancer Therapy - Passive Targeting of Solid Tumors: - Active Targeting Strategies in Cancer. Gold Nano cages for Cancer Imaging and Therapy- Nano biotechnology in Drug Delivery –Nano scale Delivery of Therapeutics – Nano suspension Formulations Viruses as Nano materials for Drug Delivery. Development of nanomedicines – Nanoshells – Nanopores – Nanotechnology in diagnostic application. Nanotechnology in Food industry - Nano science in agriculture: fertilizers and pesticides. Nanoscience for water treatment and fermentation process. Nanotechnology in textiles and Cosmetics - Nanotechnology in energy conversion - Nanocatalysts - Future of nanobiotechnology		12

IV	Genomics & Proteomics	Introduction and concepts of microbial genomics – types, Genome analysis, Genome mapping, Linkage analysis, genesequencing. SNPs, RAPD, RFLP. DNA microarray. Genomic databases, Future of genomics. Proteomics: Introduction and basic principles of proteomics. Types of proteomics - Expression proteomics, structural proteomics and functional proteomics, Tools and techniques in proteomics, Relation between geneand protein. Approaches for study of proteomics.	Protein sequences databases - SWISS-PROT, PDB, etc. Human Genome Project	12
V	Infectomics	Introduction and definitions of Infectomics. Infectomes. Genomics andproteomics of microbial infections - Structural and functional strategies. Types of infectomics - ecological, immuno and chemical infectomics	Infectomics – virulence of pathogens – pathogenic islands, host defense – Pharmacomes - infectomic approaches to the discovery of anti microbial agents cloning, PCR, gene knockout and knockin, antisense strategies.	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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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.
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9. www.nanotechnologyfordummies.com
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: 22UPMBC1C09 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

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	Introduction to Food microbiology: Morphology and Structure of Microorganisms in Foods (Yeasts and Moulds, Bacterial Cells Viruses). Important genera of Mould, yeast, bacteria, bacterial groups (lactic acid, acetic acid, butyric acid etc), Sources of microorganisms in food chain (raw	Intestinal beneficial bacteria, Probiotics, Prebiotics – Definition, functional foods, types, importance and economic values, Recombinant foods, Biosensors in food industry. Food Laws and Standards of India-FSSAI, AGMARK, BIS. Food Products with mandatory BIS Certification as per Food Safety and Standards. FSSAI Licensing and registration- Central license, State license, Registration, Responsibilities of the FBO, Role of Designated officer,	15

		materials, water, air, equipment etc) and microbiological quality of foods. Factors influencing microbial growth in foods. Food borne diseases. Spoilage of fruits, vegetables, meat, poultry, fish and seafoods. Methods of food preservation:	Food Safety Officer and Food Analyst. Food Safety and Standards Act of India, 2006: Provision, definitions and different sections of the Act and implementation.	
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, Milk quality testing.	Preservation of milk and milk products. Sanitation of dairy processing plant, food control agencies and their regulations.	15
III	Soil microbiology	Distribution of microorganisms in soil, Factors influencing the soil microflora	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	Composition of air, Number and types	Extremophiles –	15

	air and water	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 fauna of lake, ponds, river, estuary, mangrove and sea.	Thermophiles, mesophiles, psychrophiles, Deep Sea, Desert, Acidophilic, Alkalophilic and Halophilic microorganisms. Impact of environmental factors on the aquatic biota.	
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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2. Larry L. Barton, Robert J. C. McLean (2019). Environmental Microbiology and Microbial Ecology, 1st edition, Publisher: Wiley-Blackwell, ISBN-13: 978-1118966266.
3. Vijaya Ramesh, K. (2014) *Food Microbiology*, Neha Publishers & Distributors. ISBN10: 8180940194.
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PRACTICAL – V

PRACTICAL EXAM: 7 HRS / DAY: 2 CONSECUTIVE DAYS
CORE PRACTICAL IV: MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Course code: 22UPMBC1P05 **Hours: L+ T+ P=C**
0 0 6 3

Course Objectives

The content of the course is focused on the imparting technical skill on isolating DNA, plasmid DNA, cloning and screening for recombinants. The learners also will have fundamental understand tools and means of using bioinformatics related to genomics and metabolomics learning methods.

Course Outcome

The learner will be able to gain knowledge on

1. Isolation chromosal DNA from bacteria and demonstrate on agarose gel electrophoresis.
2. To be able to perform cloning of desired gene with specific plasmid vector
3. Able to preparation of competent cells.
4. To be able to screen for recombinants (Blue White screening).
5. To be able to perform sequence analysis BLASTN.

Intended Learning Chapters		**Hours of Instruction**
K1, K2	K3, K4, K5, K6	
Preparation of reagents for molecular biology experiments. Isolation of auxotrophic mutants. Calculation of transformation efficiency. Primer designing.Sequence analysis BLASTN.	UV mutagenesis and screening for auxotrophic mutants. Gradient Plate technique. Isolation of DNA from bacteria and molecular weight determination. Restriction digestion of plasmid DNA. Ligation of digested DNA. Preparation of competent cells. PCR amplification of desired gene. Confirmation of the insert by Colony PCR. Molecular Cloning. Screening for recombinants (Blue White screening). SDS PAGE for protein separation. PCR amplification of 16s rRNA gene. ARDRA (Amplified Ribosomal DNA Restriction Analysis).	15 15 15 15

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PRACTICAL - VI: APPLIED MICROBIOLOGY

Course Code: 22UPMBC1P06 **Hours: L + T + P = C**

0 0 6 3

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.

Cnnourse Outcome

1. 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.

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

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

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

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1, K2	K3, K4, K5, K6	
I	Test methods used in food laboratories as per BIS standards.	Isolation of yeast and molds from spoiled nuts, fruits and vegetables.	IS 5401-1 (2012): Microbiology of Food and Animal Feeding Stuffs - Horizontal Method for the Detection and Enumeration of Coliforms: Colony Count Technique at 30° C IS 5403 (1999): Method for Yeast and Mould Count of Foodstuffs and animal feeds IS 5887-1 (1976): Methods for Detection of Bacteria Responsible for Food Poisoning, Part I: Isolation, Identification and Enumeration of *Escherichia coli, Staphylococcus aureus Salmonella &Shigella*	15

II	Dairy Microbiology		Determination of quality of milk sample by methylene blue reductase test and resazurin method. Detection of number of bacteria in milk by standard plate count.	15
II	Soil Microbiology	Isolation of phosphate solubilizers from fertile soil. Isolation of nitrogen fixers (a) *Rhizobium* from root nodule and (b) *Azotobacter* from rhizosphere. Evaluation of root nodule by cross section of legume roots.	Isolation and enumeration of soil microorganisms (bacteria, fungi and actinomycetes). Screening of antagonistic bacteria in soil by agar block overlay method.	15
IV	Water Microbiology		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

V	Environmental Microbiology	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.		15

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SEMESTER - IV

RESEARCH METHODOLOGY AND COMPUTATIONAL BIOLOGY

Course Code: 22UPMBC1C10 **Hours: L + T + P = C**

Marks: 100 **4 1 0 4**

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

1. Know the basic aspects of research to frame a research problem, analyze the various methods used in research and to write a research report.
2. Know the various measurements used in calculations of buffers and understand the basic instruments used in laboratory.
3. Learn the principles, working and uses of sophisticated instruments and their usage in research.
4. Know the various biostatical formula used in the interpretation of experimental data to analyze the results statistically.
5. Learn and apply the various bioinformatics tools to perform sequence-based searches, and analyze the results using bioinformatics software's.

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- Format of Scientific reports, Scientific writing skills, components of research paper, publishing scientific papers-review process and Ethical issues- Copyrights & Plagarism.	ISSN, ISBN, impact factor, citation index, h-index, I- index, Google scholar, Scopus, Thomson& Reuters, Web of Science. software, Use of search engines for Scientific data mining, use of reference management tools and RSM	15

II	Biophysical Techniques	Principle and applications of centrifugation methods: Ultra, differential, Isopycnic & rate zonal centrifugation, Concept of digital microscopy& image analysis, spectroscopic methods-Principle & applications of UV-Visible, NMR, Infrared & X-ray diffraction and structural determination, Fluorescence and Confocal Microscopy, Fluorescence spectroscopy, FTIR, MALDI-TOF.	Standard solutions - 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, Advanced Instrumentation technique-Next generation DNA sequencing (NGS)		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. Data mining tools and applications SPSS software- Genomics and Proteomics-identification softwares.	15

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ELECTIVE PAPERS

SUBJECT NAME	COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5	PO 6	P O7	PO8	PO 9	PO 10	PO 11	PO 12
Elective -1 Biofertilizers and Biocontrol Agents	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					✓		✓		✓			✓
Elective Paper – 3: Entrepreneurship In Microbiology	By the end of the course, the students will be able to know about the significance of the bioentrepreneurship	✓	✓		✓					✓			
	The students will clearly get in-depth information about grants and scholarships for entrepreneurship	✓	✓		✓	✓		✓		✓			
	This course provides in depth knowledge on skill development, production biofertilizers, biopesticides and composting	✓			✓				✓				✓

	The course will also provide meticulous thoughts on the task of microbes in bioentrepreneur development	✓			✓	✓		✓		✓			
Elective Paper – 3: Algal Biotechnology	The students will be able gain knowledge in the structure, classification and characteristics of algae	√	√										
	The students will gain knowledge on various cultivation methods adopted for algae		√		√								
	The course will also give insights on optimization of culture methods for effective production of algal products				√	√							
	The course will train the students for developing new commercial products from algae							√	√	√			
Elective Paper - 4: Quality Control In Industries	To acquire the knowledge quality control in pharmaceutical industry	✓	✓		✓					✓			
	To learn the quality control audits in industries	✓	✓		✓	✓		✓		✓			
	To understand the basics of food safety and food quality.	✓			✓				✓				✓
	To realize the microbial quality control in hospitals	✓			✓	✓		✓		✓			
	To acquire knowledge on environment monitoring and regulations					✓		✓		✓			✓
Elective Paper – 5: Intellectual Property Rights (Ipr), Bio-Safety and Bioethics	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	√										√	√
Elective Paper – 6: Mushroom And Single Cell Protein Technology	Draw out the importance of Mushrooms and their applications in health and neutraceuticals.	√	√										
	Work out the production process for optimum mushroom yield.		√		√								
	Explain their beneficial and erratic role during human consumption.				√	√							
	List out the microbes employed in Single cell production and sketch out the methods for strain improvement.							√	√	√			
	Gain well-rounded knowledge and get fully prepared for employment, marketing and entrepreneur activities related to mushroom and SCP production industries							√	√	√			

ELECTIVE PAPER - 1: BIOFERTILIZERS AND BIOCONTROL AGENTS

Course Code: 22UPMBC1E01 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

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 fertilizers and their application to crop plants. Macro and micro nutrients - Nutritional deficiency in plants. Biological fixation of nitrogen.	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. Ancient farming - Crop rotation, Intercropping. Isolation, screening and mass production of bacterial biofertilizers.	15

II	Fungal and actinobacterial Biofertilizers	-	Fungal biofertilizers: Mycorrhizal fungi as natural biofertilizers. Types - Ecto, endo and ect-endomycorrhiza, Ectomycorrhizal association with higher plants, Arbuscularmycorrizal association (AM) *Glomus* spp., 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. Isolation and culture methods of *Frankia* spp.	15
III	Biomanure Technology	A general account of manures. Major classes of organic manures - Animal manure, Composts, Farm yard manure, Plant manure, Moulds. Methods of its preparation. 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 consortium as an inoculums.	Application of biofertilizers and manures - A combination of biofertilizer and manure applications with reference to soil, seed and leaf sprays.	15

IV	Introduction to biocontrol	Introduction to parasitoids, predators and pathogens. 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	Entomopathogenic bacteria, fungi, viruses, nematodes and protozoa in sustainable agriculture. Symptoms and their mode of action. Physical and biological pest control. Role of insects in biological pest control.	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 - Examples of biopesticides, *Bacillus thuringiensis* and its importance. Significance of biopesticides over chemical pesticides, Mass production of quality biocontrol agents - techniques, formulations, economics, field application and evaluation.	15

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ELECTIVE PAPER II: ENTREPRENEURSHIP IN MICROBIOLOGY

Course Code: 22UPMBC1E02 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

Course Objectives

This course aims to communicate the students with basic principles of bioentrepreneurship and developments. It covers skills, Entrepreneurship in India, National and International grants for entrepreneurship developments.

Course Outcome

6. By the end of the course, the students will be able to know about the significance of the bioentrepreneurship.
7. The students will clearly get in-depth information about grants and scholarships for entrepreneurship.
8. This course provides in depth knowledge on skill development, production biofertilizers, biopesticides and composting.
9. The course will also provide meticulous thoughts on the task of microbes in bioentrepreneur development.
10. After the study, the course contents will give several opportunities for the students to develop as a researcher in varying sectors.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Evolution of the concept of entrepreneur	Entrepreneurship: Definitions – concept of Entrepreneurship. Methods of food preservation: Traditional, physical and chemical methods.	Global bio business. Entrepreneurship in India. Development – need – role of resource, talent and spirit – process of Entrepreneurship to socio – economic gains.	15
II	Grants and scholarships for entrepreneurship	Institutions and schemes of government of India – Schemes and programmes, Department of science and technology schemes, Nationalized banks – other financial		15

		institutions etc – SIDBI – NSIC – NABARD – IDBI – IFCI – ICICI etc.		
III	Skills for entrepreneurs	Communication skills, problem solving skills; Business plan development; Market need – market research, SWOT analysis, identify your competition.	Financial plan – obtain financing for your business, insure your business, Marketing – mix – product, distribution, price, promotion, and set marketing goals.	15
IV	Composting	domestic waste, agricultural and industrial waste, Types of composting. vermicomposting.	SCP production, mushroom cultivation.	15
V	Biofertilizers and Biopesticides.	Production of teaching kits (plasmid DNA isolation, serum electrophoresis) and diagnostic kits (WIDAL test kits, ABO blood grouping kits).	Mass production of Biofertilizers and Biopesticides	15

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ELECTIVE PAPER - 3: ALGAL BIOTECHNOLOGY

Course Code: 22UPMBC1E03 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

Course Objectives

Algal Biotechnology course is to make the student understand the potential of algae and its applications in various fields. The course intends a thorough understanding of the classification and cultivation of algae. The students will also be able to understand the biotechnological potentials of algae at the end of the course.

Course Outcome

1. The students will be able gain knowledge in the structure, classification and characteristics of algae
2. The students will gain knowledge on various cultivation methods adopted for algae
3. The course will also give insights on optimization of culture methods for effective production of algal products
4. The course will train the students for developing new commercial products from algae

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Introduction to algal biotechnology	Classification, structure, reproduction and other characteristics of algal divisions, Distribution of algae, Characteristics of- blue green algae, dinoflagellates, Microalgae, thallus organization. Introduction to algal biotechnology: Resource potential of algae; commercial utility of algae. Algae as a source of food and feed; Algae as a source of pigments, fine chemicals, fuel and bio-fertilizers. Distribution of economically important algae in India.		12

II	Cultivation of algae	Algal production systems; Measurement of algal growth. Large-scale cultivation of algae. Evaporation and uniform dispersal of nutrients; Harvesting algae. Drying. Algal production systems: Isolation, Screening, Strain selection, Plating, Strain selection, Algal growth curve, Culture media, Measurement of algal growth. indoor cultivation methods and scaling up. Large-scale cultivation of algae. Evaporation and uniform dispersal of nutrients; Harvesting algae. Drying.		12
III	Estimation studies	Lipid, protein, amino acids, waxes, glycerol, vitamins, pigments, chlorophyll, carotenoids and phycobiliproteins, biomass, medium selection, optimization of medium, pH, temperature, light sources, CO_2 supplements.		12
IV	Commercial utility of algae	Types of bioreactors. Algae as a source of food and pigments	Extraction methods - lipid, pigments, Carbohydrate.	12

			Algal immobilization and its applications; Blue-green algal bio-fertilizer: Method of preparation, application and its advantages over inorganic fertilizers.	
V	Biotechnological approaches		Biotechnological approaches for production of important algae, biofuel, hydrogen production, important bioactive molecule. Aqua, cattle feed and bio-fertilizer conversion methods. Algal control: Methods of control of algae; Algicides-preparation and Application; Algal culture collection centers in India and abroad and their importance	12

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ELECTIVE PAPER - 4: QUALITY CONTROL IN INDUSTRIES

Course Code: 22UPMBC1E04 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

Course Objective

The objective of this course is to enhance knowledge on quality control management in the various industries.

Course Outcome

1. To acquire the knowledge quality control in pharmaceutical industry
2. To learn the quality control audits in industries.
3. To understand the basics of food safety and food quality.
4. To realize the microbial quality control in hospitals
5. To acquire knowledge on environment monitoring and regulations

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4, K5)	
I	Quality Control in pharmaceutical industry	Concept, evolution and scopes of quality control and quality assurance, Analysis of raw materials, finished products, packaging materials, in process quality control.	Quality control in pharma industry according to Indian and US Pharmacoepia: Tablets, capsules, ointments, creams, ophthalmic and surgical products.	12
II	Industrial quality control and quality audits:	Process quality control- sterile and non-sterile preparations, Industrial responsibilities– social and environmental safety.	Quality control – raw materials, purity check, quality check of finished products,	12
III	Food safety and Food Quality:	Introduction to Food Safety, Food Safety System, Definition of food safety and concept of safe food; characterization of food hazards.	Microbiological criteria of food, food products, beverages. Monitoring of factory hygiene and sanitation.	12

		Physical & Chemical hazards.		
IV	Microbial quality control in Hospitals	Control of Healthcare associated infections (HAI) - Culture Identification, Sensitivity pattern, report preparations. Quality in Healthcare Organisations-The Past, Present and Future of Healthcare Quality.	HAI surveillance. Monitoring water quality in hospital, Environmental monitoring and clean room commission.	12
V	Microbes and their applications:	Quality control in biodegradation and bioremediation.	Microbes used in the biofertilizers and bio-pesticides and bio-fuels.	12

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3. U.S. Environmental Protection Agency (EPA). Washington, DC (2014). 21-Food and drugs, chapter I--Food and Drug Administration.
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ELECTIVE PAPER – 5: INTELLECTUAL PROPERTY RIGHTS (IPR), BIO-SAFETY AND BIOETHICS

Course Code: 22UPMBC1E05 **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	Introduction to IPRs, Basic concepts and need for Intellectual Property – Patents, Copyrights, Trademarks, Traditional Knowledge, Plant varieties, Trade Secrets, Geographical Indications, IPR in India and Abroad. IPR– Genesis and Development – the way from WTO to WIPO – TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations IPs of relevance to Microbiology / Biotechnology and few Case Studies.		12

II	Agreements and Treaties	International Treaties and Conventions on IPRs History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Patent Act of India, Patent Amendment Act, Paris Convention. Design Act, Trademark Act, Geographical Indication Act		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: Practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad Searching International patent Databases; Country-wise patent searches (USPTO, esp@cenet (EPO), Patents scope (WIPO), IPO, EPO, etc.).National & Patent Cooperation treaty(PCT) filing procedure; Time frame and cost; Status of the patent applications filed;	12

			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 Basmati rice, Commercialization and Licensing.	
IV	Biosafety	Introduction to Biosafety – General GLP, Biological Safety Cabinets – Biosafety level of specific microbes – Risk assessment - Primary Containment for Biohazards; Biosafety guidelines and regulations – International & National	Biosafety in relation to transgenic research, GMOs & LMOs – Concerns and Challenges, Role of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs – Risk analysis & assessment	12
V	Bioethics	Bioethics – Hstory and development, Definition,	ELSI of gene therapy, germ line,	12

		Ethical implications of cloning - Reproductive cloning & therapeutic cloning	somatic, embryonic and adult stem cell research. Bioethics in animal research - Norms in India - Licensing of animal house - Bioethics – norms for conducting studies on human subjects. Human genome project and its ethical implications. Bioethics committees – IAEC, CPCSEA, OECD, etc.	

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.
3. Shaleesha A. Stanley, Bioethics, Wisdom educational service-2010

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5. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co.Pvt. Ltd., 2007.
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3. http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
4. www.patentoffice.nic.in
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6. http://www.cbd.int/biosafety/background.shtml
7. http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
8. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html

ELECTIVE PAPER – 6: MUSHROOM AND SINGLE CELL PROTEIN TECHNOLOGY

Course Code: 22UPMBC1E06 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

Course objectives

The course contents are designed to gain basic science knowledge Mushroom cultivation and production of Single cell proteins. The learners will understand the nutritional benefits of the microbes concerned and also related drawbacks. Learners acquire knowledge about the prevailing market demands and scope of these technologies. They learn to apply the gained knowledge for strain improvement to support their entrepreneurship talents.

Course outcome

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

1. Draw out the importance of Mushrooms and their applications in health and neutraceuticals.
2. Work out the production process for optimum mushroom yield.
3. Explain their beneficial and erratic role during human consumption.
4. List out the microbes employed in Single cell production and sketch out the methods for strain improvement.
5. Gain well-rounded knowledge and get fully prepared for employment, marketing and entrepreneur activities related to mushroom and SCP production industries.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Mushrooms and Applied Mushroom Biology	Definition of a Mushroom, Mushroom Hunting, Ecological Classification of Mushrooms, Magnitude of Mushroom Species	Mushroom Science---Food Supply through Mushroom Themselves, Mushroom Biotechnology. Mushroom spoilages and mushroom borne diseases.	15
II	Principle of Mushroom Cultivation and Production	Mushroom Cultivation: Major Phases of Mushroom Cultivation, Selection of An Acceptable Mushroom Species/Strains, Secreting a Good Quality of Fruiting Culture, Development of Robust Spawn, Preparation of	Management of Fruiting/Mushroom Development, Harvesting Mushrooms Carefully. Differences in Mushroom Production Patterns, World Mushroom Market.	15

		Selective Substrate/Compost, Care of Mycelial (Spawn) Running		
III	Benefits of Mushroom	Enhancement of Human Health through Mushroom Derivatives: Nutritional Value of Mushrooms, Medicinal Properties of Mushrooms, Mushroom Nutriceuticals.	Mushroom Bioremediation-- Benefit the Environment through Mushroom Mycelia.	15
IV	Single cell proteins	History, Sources - Alga, Yeast and Bacteria, Comparison of SCP microbes. Cultivation – Submerged fermentation and Semisolid fermentation.	Production of SCP – Raw materials, Factors affecting SCP production. SCP production in India.	15
V	Benefits and Drawbacks of SCP	Nutritional Benefits of Single Cell Protein Technology, Other advantages and applications of SCP.	Drawbacks of Single Cell Protein Technology. Strain improvement and Future of single cell proteins.	15

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ELECTIVE PAPER - 7: OCULAR MICROBIOLOGY

Course Code: 22UPMBC1E07 **Hours: L + T + P = C**

Marks: 100 **4 1 0 4**

Course Objectives

This part of the curriculum helps the students to have a basic knowledge related to the eye and its structure along with the basic techniques followed for its isolation and to know about the various diseases that affects the eye and caused by different groups of microorganisms.

Course Outcome

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

1. To have a thorough understanding in to the structure of the eye and its associated parts, various diseases of the eye and the methods to control it.
2. Know about the laboratory methods of isolation of ocular microorganism associated with eye, the media used in its isolation and the methods followed in the diagnosis.
3. Know the bacterial flora of the eye and its role in disease process.
4. To know the basics concepts in fungal flora of the eye, the classification of fungal organism and the major fungi that causes diseases in humans.
5. To understand the diseases causing nature of the parasites, its pathogenesis and treatment methods for parasitic infections of the eye.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Introduction to Ocular Microbiology	Structure of the Eye and its functions, Normal ocular flora, Process of vision, common eye diseases & its prevention-trachoma, Glaucoma conjunctivitis, corneal ulcer.	Mechanical, Chemical & radiational injuries. Health education-National plan for control of Blindness-Functioning of Eye bank- Corneal transplant	12
II	Basic Laboratory techniques in Ocular microbiology	Fixing of slides-Microscopy-LPCB, KOH, Grams staining, Geimsa staining & Calcofluor staining. Diagnosis of fungal infections of the eye - culture and molecular methods.	Collection of ocular samples-conjunctival swab, corneal scraping, Aqueous fluid, vitreous fluid, Lacrimal Sac and Corneal button. Media used for culture of microorganism, Methods of	12

			Inoculation-C streak and interpretation of culture	
III	Ocular Bacteriology	Introduction- Bacteria of medical importance, Gram positive cocci-Staphylococci, Steptococci, Pneumococci; Gram negative cocci-Neisseria; Gram positive bacilli-Corynebacterium.	Gram negative bacilli Enterobacteriaceae, Mycobacteria, Actinomycetes-Nocarida	12
IV	Ocular Mycology	Introduction- Description of fungi, yeast, dimorphic fungi, Taxonomic classification of fungi, fungi causing ocular infection-Fusarium, Aspergillus, Mucor, Candida, Rhinosporidium and Dermatiaceous fungi.		12
V	Ocular Parasitology	Introduction-Importance of parasites in Eye infection, Classification of medically important parasites- Life cycle, Pathogenesis and diseases caused by *Acanthamoeba, Microsporidia, Toxoplasma and Onchocerca.*		12

Text Book:

1. Mukherjee PK & Bandyopadya Preeti Ocular Microbiology2010 Jayapee Publishers
2. Savitri Sharma Ocular Microbiology. 1988. Aravind Eye Hospital and Post Graduate Institute of Ophthalmology, 189 pages
3. Atlas of Diagnostic Ocular Microbiology. Wilhelmiuss. 1993. Mosby International Publishers.
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6. Practical Medical Microbiology and Cytology of Eye- Kathleen Byrle, Eileen Bund, Khalid Tabbara, Robert Hyndiuk, Butterworth Heinemann
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3. https://www.intechopen.com › chapters
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5. https://www.mdpi.com
6. https://entokey.com › ocular-microbiology

ELECTIVE PAPER - 8: INTRODCUTION TO MICROBIAL ENDOPHYTES

Course Code: 22UPMBC1E08 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

Course Objectives

The course contents are designed to understand the basic information related to the interaction among microorganisms which have evolved to be in symbiotic relationship with the higher plants producing novel metabolites for human usage.

Course Outcome

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

1. To understand the basic aspects of fungi with its interaction among plants, its types and the importance of this symbiotic relationship
2. To have a knowledge on the distribution of these endophytes among the various categories of the plant kingdom and the significance of its presence in the higher plants.
3. To know about the various bioactive compound produced by these endophytes, the methods used for isolation and characterization of the compounds from them.
4. To know about the various anticancer drugs produced by these endophytes and the Importance of these anticancer compounds in the treatment of this deadly disease.

Unit	**Unit Title**	**Intended Learning Chapters**		**Hours of Instruction**
		(K1, K2)	**(K3, K4 & K5)**	
I	Introduction to Endophytes	Definition, & Discovery of Endophytes, Evolution of Endophytes, Types of Endophytes- Bacterial & Fungal,	Host plant -Endophyte Interactions- Resistance to disease, Protection from Insect, Growth Promotion of host, Physiological and Ecological role of Endophytes.	12
II	Fungal Endophyte Diversity	Endophytes of Woody plants, Seaweeds and Medicinal plants,	Bioprospecting of endophytic fungi- Antimicrobial compounds, Anticancer, Antioxidant, Immunomodulatory and Immunosuppressive compounds from Endophytes- their importance and application.	12
III	Methodology of Endophyte isolation	Isolation and cultivation of endophytes from plants- criteria for selection of plant materials,	Isolation and Identification of Endophytic fungi Cultivation of Endophytes- Media	12

			composition & uses, Method of Screening of Endophytes- Primary and Secondary screening	
IV	Methods of Screening of Endophytes	Primary and Secondary screening. Optimization of media components for production of bioactive compounds- Carbon source, Nitrogen source, pH, temperature & period of Incubation.	Analysis of Bioactive compounds- Role of Instrumentation in analysis.	12
V	Anticancer compounds from Endophytes	Natural anticancer lead molecules and their production- Taxol, camphothecine, Vinca alkaloids, Podophyllotoxin- Biochemistry of the compound, Biosynthesis in plant & Biology of Synthesis in fungi, Mode of action, production cost of the compounds- Endophytic fungi as alternate source of production		12

Text Book:

1. Ajay Kumar, Radhakrishnan E.K. 2020. Microbial Endophytes Functional Biology and ApplicationsWoodhead Publishing.
2. Bhim Pratap Singh.2019. Advances in Endophytic Fungal Research- Present Status and Future ChallengesSpringer, Cham XIX, 360.
3. Dinesh K. Maheshwari.2017. Endophytes: Biology & BiotechnologySpringer International Publishing AG.
4. Ravindra H. Patil (Editor), Vijay L. Maheshwari 2021. Endophytes: Potential source of compounds of commercial and therapeutic applications Springer; 1st ed. 2021 edition.
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ELECTIVE PAPER - 9: BASICS OF FOOD PROCESSING, ANALYSIS & SAFETY

Course Code: 22UPMBC1E09 **Hours: L + T + P = C**

4 0 0 4

Course Objectives

The coarse contents are designed to help the students to have a basic knowledge related to the Food processing methods, the microbiological aspects of food analysis with greater importance to the food hygiene in a food industry. Apart from this the students will get an idea of the various food safety laws governing the food industry.

Course Outcome

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

1. To have a thorough understanding in to the principles of food processing and packaging and the various aspects of packaging including the safety of the packing materials.
2. Know about the various microorganism associated with the food and the various factors influencing microbial growth in foods.
3. Know the different methods to enumerate the microorganism in food materials.
4. To have an idea in to the classical methods of food analysis and the use of instrumental analysis in foods.
5. To understand the food laws governing the food companies the various acts, statues and food laws governing the imported foods.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Principles of Food Processing and Packaging.	Food Processing Operations: Manufacturing processes: batch, Semi-batch and continuous Cleaning of raw materials: equipment, modes of operation. Disintegration of materials: Filtration and membrane separation: principles, design features and general applications Sorting and grading of foods: weight, size, shape, buoyancy, photometry sorting.	Food Packaging: Effect of Environment on Food Stability: Light, Oxygen, Water, Temperature, Sensitivity to Mechanical Damage and attack by biological agents, Different packaging materials used for food packaging and their properties. Evaluation of quality and safety of packaging materials –testing procedures	12

II	Food Microbiology& Food Hygiene	Classification and nomenclature of microorganisms. Morphology and Structure of Microorganisms in Foods (Yeasts and Moulds, Bacterial Cells Viruses). Microbial growth in foods: Intrinsic (pH, Moisture Content, Oxidation–Reduction Potential, Nutrient Content, Antimicrobial Constituents) and Extrinsic Parameters (Temperature of Storage, Relative Humidity of Environment, Presence and Concentration of Gases in the Environment).	Food pathogens *Aeromonas hydrophila, Bacillus cereus and other Bacillus Species, Brucella, Campylobacter, Clostridium botulinum, Clostridium perfringens, Escherichia coli, Listeria monocytogenes, Salmonella, Shigella, Staphylococcus aureus, Vibrio, Yersinia Enterocolitica, Fungi, virus etc* Enumeration Methods- Plate Counts, Most Probable Number Counts.	12
III	Physical, Chemical and Instrumental analysis	Basic principles of Classical Methods of food analysis: Law of mass action, Le chateliers principle, stoichiometry, volumetric and gravimetric analysis. Preparation of standards, working standards and solutions of known concentration (percent, molar, normal, ppm and ppb)	Classical analytical techniques: Gravimetric, Titrimetric, Refractometry and Polarimetry: Principle, Instrumentation and applications of each technique in food analysis	12
IV	Food Laws and Food Standards of India.	Food Safety and Standards Act of India, 2006: Provision, definitions and different sections of the Act and implementation.	FSS Rules and Regulations (2011) - Licensing and registration: Central license, State license, Registration, Responsibilities of the FBO, Role of Designated officer, Food Safety Officer and Food Analyst.	12
V	Quality control of Imported Foods	Food import system, Food safety& Standards (import) regulations 2017,Process of obtaining food import licence,	Food import clearance system in India- steps involved in food import clearance & review process Flow of sampling & analysis,	12

			Disposal of rejected Food consignmnets & Food samples.	

Text Books:

1. Ahvenainen, R. (Ed.) 2003 Novel Food Packaging Techniques, CRC Press.
2. Cappuccino JG, Sharman N (2002). Lab Manual of Microbiology. Pearson Education Publishing
3. Coles, R., McDowell, D. and Kirwan, M.J. (Eds.) 2003 Food Packaging Technology, CRC Press
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8. Fuller, G.W. (1999) New Food Product Development. From concept to market place. CRC press, New York.
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3. https://www.eufic.org
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ELECTIVE PAPER - 10: Molecular Immunology and Immunotechnology

Course Code: 22UPMBC1E10 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

Course Objective

The students will gain knowledge about genes that control properties of immunoglobulin and isoantigens. This course also focuses on the use of antibodies in biotechnical applications with a special emphasis on technologies for isolation, purifying and production of antibodies

Course Outcome

1. Compare the generation of diversity in antibodies and T Cell Receptors.
2. Highlight the role of MHC genes and products. Discuss in-depth the genetics, clinical/ forensic significance of human blood groups and types.
3. Evaluate polyclonal, monoclonal and humanized antibodies and production of these
4. Analyze achieved results of immunological serum analyses by means of ELISA

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Genetics of B-cell & T-cell production	Genetic basis of Immunoglobulin diversity – isotypes, class switching, generation of antibody diversity, allotypes, and idiotypes. Genetics of T – lymphocytes – Surface receptors, Antigens – Diversity of TCR, T cell surface alloantigens, other markers of Human T and B lymphocytes.		12
II	Genetic basis of isoantigens	Major Histocompatibility antigens – MHC genes and products, Structure of MHC molecules, Genetics of HLA Systems – Antigens and HLA typing. Genetics of complement components.	Genetics of Immunohematology – Genetic basis and significance of ABO and other minor blood groups in humans, Bombay blood groups, Secretors and Non-secretors, Rh System and genetic basis of D-antigens. Clinical and forensic relevance of ABO and minor blood	12

			groups.	
III	Antigens and immunoglobulin purification techniques	Preparation of antigens-bacterial, fungal, viral pathogens-different methods.	Standardization and quantification of antigens. Raising of polyclonal antibodies in animals-different routes of inoculation-immunization protocol. Purification and quantification of immunoglobulins.	12
IV	Molecular engineering	Molecular engineering methods to improve and modify immunological specificities and reactions.	Antigen engineering for better immunogenicity and use for vaccine development. Antibody engineering– Hybridoma Technology, recombinant DNA technology for antibody engineering humanized, chimeric antibodies its application	12
V	Immunotechniques		Separation of immune cells-T cells-B cells. Density gradient-lymphocyte stimulation test, ELISpot, Immuno histochemistry, Western blot, Flow cytometry-T cell subset analysis- B cell analysis. Immunolabelled Assay- Immuno-fluorescence assay, Radioimmuno Assay, ELISA	12

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1. Benacerraf B, Immunogenetics and Immunodeficiency; William Clowes and Sons ltd. London. 1975.
2. Zaleski MB, Dubiski S, Niles EG and Cunningham RK, Immunogenetics; Pitman, Toronto. 1983.
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4. Williamson AR and Turner MN, Essential Immunogenetics; Blackwell Scientific Pulications, London. 1987.
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8. Carl A. K. Borre bacck, Antibody Engineering, Oxford University Press. Ed.2; 1995.
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ELECTIVE PAPER - 11: ESSENTIALS OF BIOINFORMATICS FOR BIOLOGIST

Course Code: 22UPMBC1E11 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

Course Objective

Curriculum of the course is designed to educate the post graduate with various computational tools available for the biologist to validate and analysis the genomic, proteomics datas. Focuses on the use of different tools and programmes will help the biologist to display the results in a better way in a short span of time.

Course outcome

1. To learn about the basic computer programming and script languages.
2. To be able to understand various databases used for genomics and proteomics anlaysis
3. To analyze sequences and Multiple Sequence Alignment.
4. To learn about proteomics and genomics analysis for the given organisms

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	**(K3, K4 & K5)**	
I	Introduction to Bioinformatics	Introduction and scope of Bioinformatics, Basics of Computer and operating systems, Linux Operating system (vi editor, few basic commands like directory creation, deletion, permission setting etc.). Introduction to programming and scripting languages - basics of Python.		
II	Sequence Analysis	Sequence data in bioinformatics - protein and DNA sequences. Concepts of sequence identity, similarity, and homology. Definitions of homologues, orthologues, and paralogues.	Useful Bioinformatics databases - Pfam, Uniprot, KEGG, NCBI, PDB etc. Using BLAST and its various versions (BLASTp, BLASTn, BLASTx, tBLASTn, etc) for sequence search.	
III	Comparing two sequences	Pairwise alignment: Needleman-Wunsch global and Smith-Waterman local alignment methods using dynamic programming.	Scoring matrix - scoring matrices for nucleic acid and proteins sequences, PAM and BLOSUM series; Gap penalty methods - linear and affine.	

			Multiple sequence alignment (MSA) - Progressive alignment ClustalW, T-COFFEE method, HMM methods, and ClustalOmega. Motifs analysis using randomized methods. Phylogeny analysis.	
IV	Omics Analysis		Protein and DNA sequencing methods. Genome browsers. Differential gene expression analysis and biomarker identification using transcriptomics. Computational epigenomics: Concepts and algorithms to measure transcriptional regulation; methylation and alternative sp licing; CHiPseq, small RNA analysis, validation of wholegenome datasets. Comparative genomics studies and population genomics.	
V	Protein Structure and Function		The hierarchical structure of proteins - primary sequence, secondary and tertiary structures, structures. Characterizing a protein using sequence information - Expasy tools. Secondary structure prediction from protein sequence, active site prediction tools.	

References

1- Introduction to bioinformatics, 5th edition- Arthur M Lesk, Oxford university press.
2- Introduction to bioinformatics, Anna Tramontano, Chapman & Hall/ ckc.
3- https://linux.com
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ELECTIVE PAPER - 12– MICROBES AND THE LIFE SCIENCE

Course Code: 22UPMBC1E12 **Hours: L + T + P = C**

Marks: 100 **4 0 0 4**

Course Objectives

The course helps to uncover the life evolution mystery in a scientific way. It provides justification why anaerobiosis preceded aerobic respiration. The subject helps to appreciate the importance of microbes in all levels of environmental components and how they can be engaged in avoiding environmental pollution. Bioprospecting of microbes for the sustainability of environmental resources is also a part of this subject. The subject also deals with the microbial techniques that can be employed for the benefit of human health.

Course Outcome

Intended learning outcomes

Upon completion of this subject, students should be able to

1. Explain the most accepted theory for the origin of life and Draw out the time scale of life evolution into different forms.
2. Give flow chart about the energy levels and food chain.
3. Provide required information about the important role of microbes in all environmental components.
4. Elaborate on the microbial bioprospecting for the sustainability and maintenance of environmental resources
5. Explain human anatomy and gut microbiome.
6. Apply gained knowledge for controlling pollution and increase the productivity in non hazardous way using microbial techniques.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Evolution of microbes and Oxygenesis	Big Bang Theory, Evolution of life, Evolution of aerobic atmosphere, Prokaryotic and Eukaryotic cells, Evolution of Plant, Animal and Monera. Structural organization. Genomic organization,	Cell cycle, Mitosis – Prophase, metaphase, Anaphase, Telophase, Meiosis-I and Meiosis –II, Karyokinesis, Cytokinesis, Programmed cell death.	15
II	Natural Resources	Levels of organization in nature - Food chain and Trophic structure, Biogeochemical Cycles, Interdependence of man and environment. Consequences of Human	Definition and sources of pollution, Different types of pollution –Land, Air (Global warming, Green-house effect), Water, Radiation, E-wastes, Biomedical wastes.	15

		Impact on the Natural Environment,	.	
III	**Wastewater Technology**:	Wastewater treatment system (unit process): Physical screening, flow equalization, mixing, flocculation, flotation, granular medium filtration, adsorption, Chemical precipitation, Disinfection, Dechlorination, Biological: (aerobic and anaerobic, suspended and attached growth processes.) Effluent disposal, control and reuse..	Water pollution control, Regulation and limit for disposals in the lakes, rivers, oceans, and land. Direct and indirect reuse of treated effluents and solid wastes, Current industrial wastewater treatment and disposal processes (Textile, dairy, paper and pulp manufacturing industries)..	15
IV	Terrestrial and Agricultural Microbiology	Role of microbes in soil fertility, Useful and Harmful microbes to crop growth, Microbes for sustainable development – Microbial fuels, Carbon di oxide sequestration. Biopesticides – Biological contol agents- Bacillus thruringiensis, Trichoderma, Baculoviruses, Chitinase producing bacteria.	Biofertilizers, Plant growth promoting bacteria, Phytoremediation. Composting process. Transgenic plants - water stress and salinity resistant plants.	15
V	Microbes for human health	Human Anatomy, Microbes in commesalism, mutualism and parasitism. Gut microbiome, Microbes as Probiotics – Benefits of Fermented foods, Microbial colourants, Microbial preservatives Bacteriocins, Nicins.	Microbial metabolites as antimicrobial agents and drug leads, Therapeutic bacteriophages, Nano microbiology and targeted drug delivery.	15

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1. Hartl, D. L. (1988). *A primer of population genetics* (2nd edition). Sunderland, MA: Sinauer Associates.
2. Minkoff, E. C. (1983). *Evolutionary biology.* Reading, MA: Addison-Wesley Publishing Company.
3. Sober, E. (1994). *Conceptual issues in evolutionary biology.* Cambridge, MA: MIT Press.
4. Lodish et al.2004. Molecular Cell Biology " (Scientific American Book)
5. Alberts et al. .2002. The Biology of the Cell
6. Cooper & Hausman .2004. The Cell – A Molecular Approach
7. Tamarin, R., 1991, Principles of Genetics, 3rd edition.
8. De Robertis, E.D.P. and Robertis, E.M.F. 1991. Cell and molecular biology. Lea and Febiger
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10. Dubey RC and Maheswari DK (2005). A text book of Microbiology, Revised Multicolour edition, S.Chand Publishers, New Delhi.
11. Purohit SS (2005). Microbiology - Fundamentals and Applications. Student Edition Publishers, Jodhpur.
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SUPPORTIVE COURSES

PROGRAMME OUTCOME vs COURSE OUTCOME													
SUBJECT NAME	**COURSE OUTCOME**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Supportive Course 1: Medical Laboratory Technology	Learn the handling of instruments and various measurements used in the laboratory	✓	✓		✓								
	Learn about the basics of laboratory techniques its significance in diagnostic evaluation					✓	✓						
	Identify and differentiate the different types of bacteria and fungi in clinical samples						✓	✓	✓		✓		
	Learn the differential diagnosis by the help of different serological techniques	✓	✓						✓	✓	✓		
	Learn the various methods used in Sterilization	✓	✓	✓									
Supportive Course 2: Microbiology	Know about the basic aspects of microbiology, different methods of isolation of microorganism, preservation and controlling 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 commercial importance of microorganisms									✓		✓	✓
Supportive Course 3: Health Science Management	To acquire the knowledge health policy and policy making process	✓	✓	✓									
	To get familiarize with the health care system	✓	✓	✓						✓	✓		

	in India												
	To understand the health care delivery structure in central and state.	✓	✓	✓						✓	✓	✓	
	To realize the importance of health care reforms	✓	✓	✓									
	To obtain a sound understanding in maintenance of records	✓									✓	✓	✓
Supportive 4: Quality Control In Industries	To acquire the knowledge quality control in pharmaceutical industry	✓	✓		✓					✓			
	To learn the quality control audits in industries		✓			✓							
	To understand the basics of food safety and food quality								✓				✓
	To realize the microbial quality control in hospitals					✓							
	To acquire knowledge on environment monitoring and regulations					✓							✓

SUPPORTIVE-I: MEDICAL LABORATORY TECHNOLOGY

Course Code: 22UPMBC1S01 **Hours: L + T + P = C**

Marks: 100 **4 1 0 5**

Course Objectives

The course contents are designed to gain a general insight in to the basic aspects of medical laboratory, measurements, equipment's used, the various microbiological and biochemical procedures and the safety aspects in a Medical laboratory.

Course Outcome

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

1. Learn the handling of instruments and various measurements used in the laboratory.
2. Learn about the basics of laboratory techniques its significance in diagnostic evaluation.
3. Identify and differentiate the different types of bacteria and fungi in clinical samples.
4. Learn the differential diagnosis by the help of different serological techniques.
5. Learn the various methods used in Sterilization.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4, K5)	
I	Role of Medical Laboratory technologists	Ethics of laboratory practice. Ethical Principles and standards for a clinical laboratory professional, Good Laboratory Practice (GLP)- Introduction to Basics of GLP	Accreditation, Advantages of Accreditation. Safety measures in a Laboratory. Cleaning of glassware's General precautions for avoidance of laboratory accidents.	12
II	Instrumentation	Principle, working, care & maintenance and calibration of Weighing balance, Magnetic stirrer, Centrifuges, Incubator Principle, working, care & maintenance and calibration of Weighing balance, Magnetic stirrer, Centrifuges, Incubator, Hot air oven, Spectrophotometer	Safety measures in Microbiology Laboratory. Occurrence of lab infections, route of infections in laboratory & safety measures followed for use of pathogens in teaching & laboratory.	12

		& pH meter. Incubator, Hot air oven, Spectrophotometer & pH meter.		
III	Examination of clinical Specimens	Methods of Collection, transport and processing of clinical specimens - Blood, Urine, Sputum, Pus &Faeces for microbiological examination.	Types of media- Semi synthetic, Synthetic, Enriched, Selective and Differential media. Staining techniques- Simple and differential- Gram's, Capsule & Spore. Fungi- Lactophenol cotton blue (LPCB) & Potassium Hydroxide.	12
IV	Hematology	Introduction to hematology, collection of blood sample and anticoagulants, Specimen collection and processing in hematology, haemocytometer and procedure for RBC, WBC, ESR count.	Introduction to histopathology- laboratory organization, care & maintenance of equipment's used in histopathology laboratory. Basic concepts of fixation and various types of fixative used in histopathology, tissue processing and mounting- mounting media, advantages & disadvantages	12
V	Bio-medical waste	Concepts and Perceptions, Waste Generation, Segregation, Disposal, Record Keeping, Management of Bio-medical Waste	Hospital acquired infection, Specimen collection from patients, clinics and hospitals, Specimen collection for epidemiological investigations, role of microbiology laboratory in control of nosocomial infections.	12

References

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6. Dubey, R.C. and Maheshwari, D.K. (2013) *A Textbook of Microbiology*, Revised Edition, Chand and company, NewDelhi.
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8. Ramnick, Sood (2006). *Textbook of Medical Laboratory Technology*Jaypee Brothers Publishers.
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10. Mukherjee, K.L. (2010) *Medical Laboratory Technology*, Vol. I, II & III - Manual of Histopathological Techniques &their Diagnostic application, Churchill Levingston.

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2. http://www.cartercenter.org/health/ephti/learning_materials/lecture_notes/medical_lab_technology_students.html
3. http://apps.who.int/iris/bitstream/10665/37042/1/WHO_OFFSET_21.pdf
4. http://www.sciencedirect.com/science/book/97814831679.

SUPPORTIVE - II: MICROBIOLOGY

Course Code: 22UPMBC1S02 **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 that are of commercial importance.

Course Outcome

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

1. Know about the basic aspects of microbiology, different methods of isolation of microorganism, preservation and controlling of microorganism.
2. Know about the basic aspects of microbial taxonomy, classification systems and the life cycle of important class of microorganisms.
3. Know the basis of microbial physiology with its biochemical pathway and the ecology of the microbes with reference to Extreme Ecosystems.
4. Know the commercial importance of microorganisms.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	History and discovery of microorganisms	Biogenesis and abiogenesis,Contributions of Spallanzani, Pasteur, Tyndal, Joseph Lister, Koch [Germ Theory], Edward Jenner and Flemming [Penicillin].		9
II	Sterilization and culturing techniques	Sterilization technique – Definition, Physical methods – heat, radiation, ultrasonic action, filtration. Chemical methods- disinfection, sanitization, anti sepsissterilants and fumigation.Types of culture media and their preparation for bacterial cultivation. - Broth tubes, slants, stabs and plate media. Pure culture techniques.	Anaerobic culturing techniques. Maintenance and preservation techniques -	9

III	Microbial physiology	Microscopical appearance and Staining techniques -. Colony characteristics of different bacteria. Microbial cellular morphology: Cellular structures - Capsule, Cell, Periplasmic space, Spores, Flagella, Cilia, Pili and other cellular inclusions.	TSI and antibiogram	9
IV	Medical microbiology	Introduction to medical microbiology - Infectious Diseases process – Diagnosis – Process of sample collection, transport and examinations of the specimensEpidemiology, pathogenicity, diagnosis and treatments of bacterial diseases - diarrhea, typhoid, cholera, leptospirosis, tuberculosis, Fungal diseases - Athlete's foot, aspergillosis and dermatitis. Parasite diseases - amoebiasis, malaria and taeniasis		9
V	Microbial biotechnology	Microbial synthesis of commercial products: Protein pharmaceuticals: interferons and growth hormones – Antibiotics: novel antibiotics Microbial metabolites - Production and use of enzymes, organic solvents, single cell proteins, beverages (beer and wine), baker's yeast and milk products.	Production of microbes as biofertilizers and biopesticides. Production of genetically engineered microbial products.	9

References

1. Prescott, L.M., Harley, J.P. and Klein, D.A. (2003) *Microbiology*, 5th Edition, McGraw Hill, New York.

2. Madian, M.T., Martinko, J.M., Parker, J. and Brock, T.D. (1997) *Biology of Microorganisms, 8th edition*. Prentice Hall International Inc. London.
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Supportive – III: Health Science Management

Course Code: 22UPMBC1S03 **Hours: L + T + P = C**

Marks: 100 **4 1 0 5**

Course Objective

The objective of this course is to enhance and develop the knowledge on health care system and policies on health care management

Course Outcome

1. To acquire the knowledge health policy and policy making process
2. To get familiarize with the health care system in India.
3. To understand the health care delivery structure in central and state.
4. To realize the importance of health care reforms
5. To obtain a sound understanding in maintenance of records

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Introduction to health policy	Introduction to health policy - Public health law - Individual rights vs. public interest	Analyzing Policy Options for Health System Improvement, Health policymaking and the policy process – factors influencing the policy	9
II	Health care system	Role of primary health care to achieve health for all, indigenous systems – Ayureda, Homeopathy and unani	government health scheme, health insurance schemes, Problems in hospital administration case studies evaluation – solutions	9
III	Health care delivery structure	central level – union ministry of health and family welfare, state, district, village and block levels; State level – ministry of health, state health directorate, district health organisations, Health care system in developing and developed countries.		

IV	Health care reform	Introduction, Importance and scope of Health care reform, Health care workforce, Understanding the Major Elements of the Patient Protection and Affordable Care Act		9
V	Professionalism	Communication − Maintaining accurate records − Communicating with others. Professional Development Action Plans − Sharing	Self Evaluation and Peer Evaluation	9

Reference Books

1. Goel, S. L.. Hospital Administration and Management: Theory and Practice. India: Deep & Deep Publications, 2007.
2. Hospital & Health Services administration-Principles & practices, Tabish, OUP
3. Statistical Methods in the Biological & Health Science: J.Susan Milton (McGraw-Hill)
4. An Introduction to Biostatistics, a manual for students in health sciences: P.S.S. Sunder Rao: J. Richard
5. An Introduction to Health Planning for Developing Health Systems, Andrew Green, Third Edition, Oxford university press.
6. Pradeep Bhardwaj 2015 Latest in Healthcare Management, jaypee publishers , jaypee@jaypeebrothers.com

Web sites

1. http://www.oxfordjournals.org/our_journals/heapol/bookrev.html
2. http://onlinelibrary.wiley.com
3. http://www.bmj.com/content/
4. http://www.who.int/topics/health_policy/en/

Supportive – IV: Quality Control in Industries

Course Code: 22UPMBC1S04 **Hours: L + T + P = C**

Marks: 100 **4 1 0 5**

Course Objective

The objective of this course is to enhance knowledge on quality control management in the various industries.

Course Outcome

1. To acquire the knowledge of quality control in pharmaceutical industry
2. To learn the quality control audits in industries.
3. To understand the basics of food safety and food quality.
4. To realize the microbial quality control in hospitals
5. To acquire knowledge on environment monitoring and regulations

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	Quality Control in pharmaceutical industry:	Basic of pharmaceutical products and their quality control: Manufacture of Sterile and non sterile Medicinal Products.	Process of Sterilization, packaging, stability information for bulk drugs of different forms, vaccines – based on both chemical and microbiological parameters. raw materials-purity check, quality check of finished products in pharmaceutical industry.	15
II	Industrial quality control and quality audits:	Definition of Quality control and Quality audit – Difference between the terms. Process of quality control and tools used	Industrial responsibilities – social and environmental safety. British, European, USA-US and Indian pharmacopoeias. Safety of working labs and emergency response. Handling of hazardous materials	15

III	Food safety and Food Quality:	Microbiological criteria of food, food products, beverages. Monitoring of factory hygiene and sanitation, Food quality evaluation	Evaluation of nutritional, functional, microbial, shelf life and physicochemical analysis. Food Safety and Standards Authority of India (FSSAI). Food contaminants and diseases.	15
IV	Microbial quality control in Hospitals:	Control of Healthcare associated infections (HAI) - Report preparations for Culture Identification, Antibiogram, pathogen and endotoxin load, HAI surveillance, resistance surveillance	Corrective action system, Monitoring water quality in hospital, Suggestive healthcare infrastructures and clean room commission.	15
V	Microbes and their applications in environmental quality control:	Environmental Monitoring – Microbes as biological indicators of environmental pollution monitoring. Quality control in biodegradation and bioremediation.	Microbes used in the biofertilizers and bio-pesticides and bio-fuels.	15

References

1. Nally, J. D. (Ed.) (2007). Good Manufacturing Practices for Pharmaceuticals, Sixth Edition,Informa Healthcare USA, Inc., ISBN 10: 0-8593-3972-3 & ISBN 13: 978-0-8493-3972-1, New York.
2. The training manual for Food Safety Regulators. (2011) Food Safety regulations and food safety management. Food Safety and Standards Authority of India, New Delhi (*http://www.fssai.gov.in/ trainingmanual.aspx*)
3. Abdul Malik, Zerrin Erginkaya, Saghir Ahmad, Hüseyin Erten (2014) *Food Processing: Strategies for Quality Assessment*, Springer.
4. U.S. Environmental Protection Agency (EPA). Washington, DC (2014). 21-Food and drugs , chapter I--Food and Drug Administration.
5. WHOTRS823. (1992). WHO expert committee on specifications for pharmaceutical preparations: thirty-second report. WHO Technical Report Series: 823, ISBN 92 4140823 6, ISSN 0512-3054, Geneva