SRI SANKARA ARTS AND SCIENCE COLLEGE

(AUTONOMOUS)

ENATHUR, KANCHIPURAM

[A Unit of Sri Kanchi Kamakoti Peetam Charitable Trust & Affiliated to University of Madras, Accredited with 'A' Grade by NAAC and ISO 9001-2015 Certified Institution]

Postgraduate Programme in Applied Microbiology

Regulations and Syllabus for

M.Sc., Applied Microbiology

(With effect from the Academic Year 2020-21)

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PREAMBLE

Microbiology is the branch of science that deals with microorganisms. Microbiology is a broad term which includes bacteriology, virology, mycology, parasitology and other branches. The program M.Sc., Microbiology is a promising branch in the field of life science. It is all about the microorganisms and their behavior in different environments such as aquatic, terrestrial, atmosphere and their associations with other living organisms. This program includes clinical, food & diary microbiology, recombinant DNA technology, environmental microbiolgy, microbial biotechnology, agriculture microbiology, microbial physiology and fermentation technology. There is a continuous demand for microbiologists as work force in education, industry and research. Hence, Microbiological tools and techniques are used in almost all fields which are indispensable for people working in fields like Agriculture, Food Industry, Medical Sciences, Environmental Science and Pharmaceutical Science etc…The syllabi for the two-year M.Sc. degree course in Microbiology are framed in such a way that the students at the end of the course, can be adept at Microbiological techniques for pursuing higher studies and can also apply Microbiological methods judiciously to a variety of industrial needs.

PROGRAMME LEARNING OUTCOME

NATURE AND EXTANT OF THE PROGRAMME

The postgraduate programme in Microbiology course focus on advanced studies in microbiology, molecular biology, microbial technology, food, etc. this course also include variety of research fields. It is beneficial for the aspiring researchers in various fields of life sciences including biotechnology and pharmaceutical industries. After obtaining this degree, a microbiologist may enter

into the job market or opt for undertaking further higher studies in the subject and the students may join industry, academia, or public health departments and play their role as microbiologists in a useful manner contributing their knowledge to the welfare of the society. Thus the postgraduate level degree in microbiology must prepare the students for all these objectives. The LOCF curriculum has been developed encompassing all the diversified aspects of Microbiology with reasonable depth of knowledge and skills so to as to specialize them in the various aspects of the subject. It also equips them with the expected professional expertise.

AIM OF THE PROGRAMME

The aim of the postgraduate degree in Microbiology is to make students knowledgeable about the various advanced concepts in a wide ranging context which involve the use of knowledge and skills of Microbiology. Their understanding, knowledge and skills in Microbiology needs to be developed through a thorough teaching learning process in the class, practical skills and research work through the hands-on, their presentation and articulation skills, exposure to industry and interaction with industry experts.

GRADUATE ATTRIBUTES

The students graduating in this degree must have an intricate knowledge of the advanced level of Microbiology as applicable to wide ranging contexts. They should have the appropriate skills of Microbiology so as to perform their duties as microbiologists. They must be able to analyze the problems related to microbiology and come up with most suitable solutions. As microbiology is an interdisciplinary subject the students might have to take inputs from other areas of expertise. So the students must develop the spirit of team work. Microbiology is a very dynamic subject and practitioners might have to face several newer problems. To this end, the microbiologists must be trained to be innovative to solve such newer problems. Several newer developments are taking place in microbiology. The students are trained to pick up leads and see the possibility of converting these into products through entrepreneurship. Furthermore, the students are made to interact with industry experts so that they may able to see the possibility of their transition into

entrepreneurs. They are also made aware of the requirements of developing a Microbiology enterprise by having knowledge of patents, copyrights and various regulatory processes to make their efforts a success.

Besides attaining the attributes related to the profession of Microbiology, the postgraduates in this discipline should also develop ethical awareness which is mandatory for practising a scientific discipline including ethics of working in a laboratory and ethics followed for scientific publishing of their research work in future. The students graduating in microbiology should also develop excellent communication skills both in the written as well as spoken language, managerial skills and computing skills which is indispensible for them to pursue higher studies from some of the best and internationally acclaimed universities and research institutions spread across the globe.

PROGRAMME EDUCATION OBJECTIVE (PEO)

The students of postgraduate degree will able to obtain:

- This course provides an introduction to the significance and effect of microorganisms in various fields of life sciences.
- This course explains the advanced sections of microbiology like Microbial taxonomy, Immunology, Microbial genetics, Food microbiology, Medical microbiology, Agricultural Microbiology, Environmental microbiology, Industrial microbiology and Bioinformatics.
- This course provides necessary theoretical and practical experience in all divisions of microbiology to become an effective professional.
- The course helps to work in research organizations, hospitals, biotechnological, agricultural, food and pharmaceutical industries.
- It is beneficial for further studies such as M.Phil and Ph.D. course provides student with an understanding of the role of microbes in human, animals, plants and various environments.

PROGRAM OUTCOMES (POs)

- To better understanding of the key principles of microbial functioning at an advanced level of Taxonomy, Molecular, Biochemical, Industrial, Medical and other basic and applied applications.
- To understand fundamental principles of biology include central dogma, diversity of life, inheritance and how these principles related to microorganisms.
- To familiarize with the role of microbes in human, animal and plant disease, also with the environments.
- To develop proficiency in the quantitative skills necessary to analyze biological problems with knowledge of specialized techniques used in the field of life sciences.
- To provide broad exposure to various communities, ecological and commercial issues in the field microbiology.
- To be able to collect, analyze and interpret scientific data, including developing a familiarity with microbiology laboratory techniques and safety procedures.
- To ability to design and carry out research experiments and to interpret data.
- To get awareness of ethical issues in Microbiology research and careers options.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: Gain an understanding and acquire knowledge in to the bacterial, fungal, algal and viral morphology, their diversity, taxonomy and physiology

PSO2: Understands the importance of immunity, pathogenesis, cultivation, identification, epidemiology and control of pathogens through therapeutics and prophylaxis.

PSO3: Evaluate the important role of microorganisms related to food, soil and agriculture for environmental conservation and food safety.

PSO4: Application of appropriate strategies in bio-processing and fermentation technology, with emphasis on industrial production of biomass and their products.

PSO5: Application of recombinant DNA technology the concepts of Genomics and Proteomics through analytical, molecular and *in silico* techniques for the betterment of society.

PSO6: Examine the significance of research using computational and statistical tools for better applicability.

PSO7: Ensure bio-safety and bioethics for social responsibility, environmental sensitization and obtain Intellectual Property Rights for various research findings.

REGULATIONS

1. DURATION OF THE PROGRAME

1.1 Two years (four semesters)

1.2 Each academic year shall be divided into two semesters. The odd semesters shall consist of the period from June to November of each year and the even semesters from December to May of each year.

1.3 There shall be not less than 90 working days for each semester.

2. ELIGIBILITY FOR ADMISSION

2.1 **Pass** in B.Sc. Degree program in any Branch of Science or Medicine or any other degree recognized as equivalent by the Syndicate.

3. CREDIT REQUIRMENTS AND ELIGIBILITY FOR AWARD OF DEGREE

3.1 A Candidate shall be eligible for the award of the Degree only if he/she has undergone the prescribed course of study in a College affiliated to the University for a period of not less than two academic years and passed the examinations of all the four Semesters prescribed earning a minimum of **91 credits as per the distribution given in Regulation** and also fulfilled such other conditions as have been prescribed thereof.

4. COURSE OF STUDY, CREDITS AND SCHEME OF EXAMINATION

4.1 The Course Components and Credit Distribution shall consist of the following:

(Minimum Number of Credits to be obtained)

COURSE COMPONENTS/ NAME OF THE COURSE	**NUMBER OF COURSES**	**CREDITS**	**CREDITS ALLOTTED**
Core subject including Project	**15 Courses**	**4**	**60**
Elective	**5 Courses**	**3**	**15**
Extra Disciplinary	**2 Courses**	**3**	**6**
Soft Skill	**4 Courses**	**2**	**8**
Internship	**1 Course**	**2**	**2**
Total Credits			**91**

4.2 Inclusion of the Massive Open Online Courses (MOOCs) available on SWAYAM and NPTEL

4.3.1 Students can choose the MOOC course available on SWAYAM and NPTEL under Core, Elective or Soft Skill category. He/she will be awarded degree only after producing valid certificate of the MOOC course for credit mobility.

5. REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTER

5.1 Eligibility: Students shall be eligible to go to subsequent semester only if

they earn sufficient attendance as prescribed there for by the Syndicate from time to time.

5.2 Attendance: All Students must earn 75% and above of attendance for appearing for the University Examination. (Theory/Practical)

5.3 Condonation of shortage of attendance: If a Student fails to earn the minimum attendance (Percentage stipulated), the Principals shall condone the shortage of attendance up to a maximum limit of 10% (i.e. between 65% and above and less than 75%) after collecting the prescribed fee of Rs.250/-each for Theory/Practical examination separately,(Theory Rs.250/- Per semester/Per Student: Practical Rs.250/- Per semester/Per Student) towards the Condonation of shortage of attendance. Such fees collected and should be remitted to the University.

5.4 Non-eligibility for Condonation of shortage of attendance: Students who have secured less than 65 % but more than 50 %of attendance are NOT ELIGIBLE for Condonation of shortage of attendance and such Students will not be permitted to appear for the regular examination, but will be allowed to proceed to the next year/next semester of the program and they may be permitted to take next University examination by paying the prescribed Condonation fee of Rs.250/- each for Theory/Practical separately. Such fees shall be remitted to the College. Name of such Students should be forwarded to the Principal along with their attendance details in the prescribed format mentioning the category (3 copies) Year wise/Branch wise/Semester wise together with the fees collected from them, so as to enable them to get permission from the College and to attend the Theory/Practical examination subsequently without any difficulty.

5.5 Detained students for want of attendance: Students who have earned less than 50% of attendance shall be permitted to proceed to the next semester and to complete the Program of study. Such Students shall have to repeat the semester, which they have missed by rejoining after completion of final semester of the course, by paying the fee for the break of study as prescribed by the College from time to time.

5.6 Condonation of shortage of attendance for married women students: In respect of married women students undergoing PG programs, the minimum attendance for Condonation (Theory/Practical) shall be relaxed and prescribed as 55% instead of 65% if they conceive during their academic career**.** Medical certificate from the Doctor (D.G.O) attached to the Government Hospital and the prescribed fee of Rs.250/-there fore together with the attendance details shall be forwarded to the College to consider the Condonation of attendance mentioning the category.

5.7 Zero Percent (0%) Attendance: The Students, who have earned 0% of attendance, have to repeat the program (by rejoining) without proceeding to succeeding semester and they have to obtain prior permission from the College immediately to rejoin the program.

5.8 Transfer of Students and Credits: The strength of the credits system is that it permits inter Institutional transfer of students. By providing mobility, it enables individual students to develop their capabilities fully by permitting them to move from one Institution to another in accordance with their aptitude and abilities.

5.8.1 Transfer of Students is permitted from one Institution to another Institution for the same program with same nomenclature.

Provided, there is a vacancy in the respective program of Study in the Institution where the transfer is requested.

Provided the Student should have passed all the courses in the Institution from where the transfer is requested.

5.8.2 The marks obtained in the courses will be converted and grades will be assigned as per the College norms.

5.8.3 The transfer students are eligible for classification.

5.8.4 The transfer students are not eligible for Ranking, Prizes and Medals.

5.8.5 Students who want to go to foreign Universities upto two semesters or Project Work with the prior approval of the Departmental/College Committee are allowed to get transfer of

credits and marks which will be converted into Grades as per the University norms and are eligible to get CGPA and Classification; they are not eligible for Ranking, Prizes and Medals.

5.9 Students are exempted from attendance requirements for online courses of the College and MOOCs.

6. EXAMINATION AND EVALUATION

6.1 Students shall register their names for the First Semester Examination after the admission in PG programs.

6.2 Students shall be permitted to proceed from the First Semester up to Final Semester irrespective of their failure in any of the Semester Examination and they should **register for all the arrear courses of earlier semesters along with the current (subsequent) Semester courses.**

6. 3 Marks for Internal and End Semester Examinations

Category	**Theory**	**Practical**
Internal Assessment	25	40
End semester (University) Examination	75	60

6.4 Procedure for Awarding Internal Marks

Course	**Particulars**	**Marks**
Theory Papers	Tests (2 out of 3)	10
	Attendance	05
	Seminars	05
	Assignments	05
	Total	**25**
Practical Papers	Attendance	05
	Test best 2 out of 3	30
	Record	05

	Total	**40**
Project	Internal Marks (best 2 out of 3 presentations)	20
	Viva-Voce	20
	Project Report	60
	Total	100

6.5 (i) Awarding Marks for Attendance (out of 5)

Below 60% = 0 marks,

60 % to 75% = 3 marks,

75 % to 90% = 4 marks

Above 90%= 5 marks

(ii) Conducting Practical and Project Viva-voce Examination:

By Internal and External Examiners

6.5.1 Improvement of Internal Assessment Marks.

(a) Should have cleared end-semester University examination with more than40% Marks in UG.

(b) Should have obtained less than 30% marks in the Internal Assessment

(c) Should be permitted to improve internal assessment within N+2 years where N is denoted for number of years of the programme.

(d) Chances for reassessment will be open only for 25% of all core courses in Colleges and only one chance per course will be given.

(e) The Principal will decide based on the request for reassessment and designate a faculty member of the department to conduct the examination and evaluation.

The reassessment may be based on a written test / assignment or any other for the entire internal assessment marks.

6.6 Question Paper Pattern for End Semester (University) Examination

PART A

(50 words): Answer 10 questions out of 12 Questions:

10 x 1 Marks = 10 marks

PART B

(200 words): Answer 5 questions out of 7 Questions:

5 x 5 Marks = 25 marks

PART C

(500 words): Answer 4 questions out of 6 Questions:

4 x 10 Marks = 40 marks

Total =75 Marks

6.7 PASSING MINIMUM

6.7.1 There shall be no Passing Minimum for Internal.

6.7.2 A Student who secures not less than 50 percent marks in the External Written Examination and the aggregate (i.e. Written Examination Marks and the Internal Assessment Marks put together) respectively of each paper shall be declared to have passed the examination in that subject.

6.7.3 A Student shall be declared to have passed Project Work and Viva-Voce respectively, if he/she secures a minimum 50 percent marks in the Project Work Evaluation and the Viva Voce each.

6.7.4 A Student failing in any subject will be permitted to appear for the examinations again on a subsequent occasion without putting in any additional attendance.

6.7.5 A Student who fails in either Project Work or Viva-Voce shall be permitted to redo the Project Work for evaluation and reappear for the Viva-Voce on a subsequent occasion, if so recommended by the Examiners.

6.7.6 A Student who successfully completes the Programme and passes the examinations of all the FOUR Semesters prescribed as per Scheme of Examinations earning **91 CREDITS** shall be declared to have qualified for the Degree.

6.8 INSTANT EXAMINATION: Instant Examinations is conducted for the students who appeared in the final semester examinations of the PG. Eligible criteria for appearing in the Instant Examinations are as follows:

6.8.1. Eligibility: A Student who is having arrear only in one theory paper in the final semester examination of the PG Degree program is eligible to appear for the Instant Examinations.

6.8.2. Non eligibility for one Arrear Paper: A Student who is having more than one arrear paper in the current appearance of Fourth Semester for PG Examinations is not eligible for appearing for the Instant Examinations.

6.8.3. Non eligibility for Arrear in other semester: Student having arrear in any other semester is not eligible and a candidate who is absent in the current appearance is also not eligible for appearing in the Instant Examinations and those Students who have arrear in Practical/Project are not eligible for the Instant Examinations.

6.8.4. Non eligibility for those completed the programe: Students who have completed their Program duration but having arrears are not eligible to appear for Instant Examinations.

6.9 RETOTALLING, REVALUATION AND PHOTOCOPY OF THE ANSWER SCRIPTS:

6.9.1 Re-totaling: PG Students not eligible for applying retotalling of their answer script.

6.9.2 Revaluation: All current batch Students who have appeared for their Semester Examinations are eligible for Revaluation of their answer scripts. Passed out candidates are not eligible for Revaluation.

6.9.3 Photocopy of the answer scripts: Students who have applied for

revaluation can download their answer scripts from the College Website after fifteen days from the date of publication of the results.

6.10 The examination and evaluation for MOOCs will be as per the requirements of the Courses and will be specified at the beginning of the Semester in which such courses are offered and will be notified by the College

7. CLASSIFICATION OF SUCCESSFUL STUDENTS

7.1 Students who secured not less than 60 % of aggregate marks (Internal + External) in the whole examination shall be declared to have passed the examination in the **First Class.** All other successful Students shall be declared to have passed in **Second Class**. Candidates who obtain 75% of the marks in the aggregate (Internal + External) shall be deemed to have passed the examination in **First Class with Distinction**, provided they pass all the examinations (theory papers, practical, project and viva-voce) prescribed for the course in the First appearance.

8. GRADING SYSTEM

8.1 Minimum Credits to be earned: For TWO year Program: **Best 91 Credits**: 75 Credits (Core and Elective, 16 Credits (Soft skills and Internship, Non-major Electives and Extra Disciplinary) (Autonomous Colleges can prescribed more than the Minimum Credits).

8.2 MARKS AND GRADES: The following table shows the marks, grade points, letter grades and classification to indicate the performance of the Student:

RANGE OFMARKS	GRADEPOINTS	LETTERGRADE	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
40-49	4.0-4.9	C	Satisfactory
00-39	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

8.2.2 Computation of Grade Point Average (GPA) in a Semester, Cumulative Grade Point Average (CGPA) and Classification

GPA for a Semester: = ∑iCiGi ÷ ∑iCi

That is, GPA is the sum of the multiplication of grade points by the credits of the coursesdivided by the **s**um of the credits of the courses in a semester.

8.2.3 CGPA for the entire programme: = ∑n∑iCniGni ÷∑n∑iCni That is, CGPA is the sum of the multiplication of grade points by the credits of the entire programme divided by thesum of the credits of the courses of the entire programme

Where,

Ci= Credits earned for course i in any semester,

Gi = Grade Points obtained for course i in any semester n = Semester in which such courses were credited.

8.3 Letter Grade and Class

CGPA	**GRADE**	**CLASSIFICATION OF FINAL RESULT**
9.5-10.0	O +	First Class - 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	C +	Re-appear

*** The candidates who have passed in the first appearance and within the prescribed semester of the PG Programme (Major, Allied and Elective courses alone) are eligible.**

9. RANKING

Students who pass all the examinations prescribed for the Program in the **FIRST APPEARANCE ITSELF ALONE** are eligible for Ranking / Distinction, provided in the case of Students who pass all the examinations prescribed for the Program with a break in the First Appearance due to the reasons as furnished in the Regulations 5 are only eligible for Classification.

10. CONCESSIONS FOR DIFFERENTLY-ABLED STUDENTS

10.1Dyslexia students: For students who are mentally disabled, having disability and mental retardation, who are slow learners, who are mentally impaired having learning disorder and seizure disorder and students who are spastic and cerebral Palsy, the following concessions shall be granted, Provided the request is duly certified by the Medical Board of the Government Hospital/ General Hospital/ District headquarters Hospitals.:

a. One-third of the time of paper as extra time in the examination

b. Leniency in overlooking spelling

c. Amanuensis for all PG programme provided the request is duly certified by the Medical Board of the Government Hospital/ General Hospital/ District headquarters Hospitals and they shall be declared qualified for the degree if they pass the other examinations prescribed for the degree.

10.2 Visually Challenged Students

a. Exempted from paying examination fees.

b. A scribe shall be arranged by the college and the scribe be paid as per the college decision.

11. MAXIMUM PERIODFOR COMPLETION OF THE PROGRAMS TO QUALIFY FOR A DEGREE

11.1 A Student who for whatever reasons is not able to complete the program within the normal period (N) or the Minimum duration prescribed for the programme, may be allowed two years period beyond the normal period to clear the backlog to be qualified for the degree. (Time Span = N + 2 years for the completion of programme.)

11.2 In exceptional cases like major accidents and child birth an extension of one year be considered beyond maximum span of time (Time Span = N + 2 +1 years for the completion of programme).

11.3 Students qualifying during the extended period shall not be eligible for **RANKING.**

COURSE STRUCTURE

FIRST SEMESTER

Course component	Name of the Subject	Hour allotment /week	Credits	Exam hour	Maximum Mark		
					Internal	External	Total
Hard Core 1 – theory	General Microbiology and Laboratory Animal Science	5	4	3	25	75	100
Hard Core 2 – theory	Immunology and Immunotechnology	5	4	3	25	75	100
Soft Core 1 – theory	Microbial Taxonomy and Diversity	4	4	3	25	75	100
Hard Core 1–	*General Microbiology,	6	4	6	40	60	100

Practical	Physiology and Immunology and Immunotechnology						
Elective 1 – theory	Metabolic Pathways	4	3	3	25	75	100
Elective 2 – theory	General regime of Intellectual Property Rights	4	3	3	25	75	100
Soft skills	Soft skills I	2	2	3	50	50	100
Total credits: 24							

SECOND SEMESTER

Course component	**Name of the Subject**	**Hour allotment /week**	**Credits**	**Exam hour**	**Maximum Mark**		
					Internal	**External**	**Total**
Hard Core 3 – theory	Virology	5	4	3	25	75	100
Hard Core 4 – theory	Systematic Medical Bacteriology	5	4	3	25	75	100
Soft Core 2 – theory	Mycology and Parasitology	4	4	3	25	75	100
Hard Core 2 – Practical	*Systematic Bacteriology, Mycology, Parasitology and virology	6	4	6	40	60	100
Elective 3 – theory	Bioinformatics & Biostatistics	4	3	3	25	75	100
Elective 4 – theory	Industrial and Pharmaceutical	4	3	3	25	75	100

	Microbiology						
Soft skills	Soft skills 2	2	2	3	50	50	100
Total credits: 24							

THIRD SEMESTER

Course component	**Name of the Subject**	**Hour allotment /week**	**Credits**	**Exam hour**	**Maximum Mark**		
					Internal	**External**	**Total**
Hard Core 5 – theory	Microbial Genetics	5	4	3	25	75	100
Hard Core 6 – theory	Genetic Engineering	5	4	3	25	75	100
Hard Core 7 – theory	Molecular Biology	5	4	3	25	75	100
Elective 5 – theory	Soil and Agricultural Microbiology	4	3	3	25	75	100
Hard Core 3– Practical	*Microbial Genetics, Molecular Biology & Genetic Engineering	5	4	6	40	60	100
Extra disciplinary Elective	Marketable Microbial Products	4	3	3	25	75	100
Internship	Internship**	-	2	-			100
Soft skills	Soft skills 3	2	2	3	50	50	100
Total credits: 26							

FOURTH SEMESTER

Course component	Name of the Subject	Hour allotment /week	Credits	Exam hour	Maximum Mark		
					Internal	External	Total
Hard Core 8 – theory	Food, Dairy and Environmental Microbiology	5	4	3	25	75	100
Elective 6 – theory	Research Methodology and Bioinstrumentation	4	3	3	25	75	100
Hard Core 4 – Practical	*Soil, Agricultural, Food and Environmental Microbiology	5	4	6	40	60	100
Hard Core Project viva voce	*Research Project	14	4	3	20	80	100
Soft skills	Soft skills 4	2	2	3	50	50	100
Total credits: 17							

***Practical Examinations will be conducted in even semester only**

** Internship will be carried out during the summer vacation of the second semester and the report will be evaluated by two examiners within the department of the College. The marks should be included in the third semester statement of marks

SYLLABUS FOR M.SC., MICROBIOLOGY

FIRST SEMESTER

HARD CORE 1 THEORY: GENERAL MICROBIOLOGY AND LABORATORY ANIMAL SCIENCE

COURSE OUTCOME

CO-1. Throw light on principles and working of microscope, staining methods and sterilization methods.

CO-2. Provide insights on bacterial anatomy, cultural techniques.

CO-3. Impart basic knowledge on structure and classification of fungi and algae.

CO-4. Explain the Laboratory animal handling, maintenance, breeding.

CO-5. Demonstrate the use of laboratory animals for pathogenicity, hypersensitivity, antibody production and disposal of used animals

UNIT I

Microscopy – Its principles and applications in the field of Microbiology including the following: Dark field, Phase contrast, Fluorescence microscopy, Transmission electron microscopy, Scanning electron microscopy, Confocal microscopy and Scanning probe microscopy. Staining methods – Simple, differential and special staining methods. Sterilization and disinfection methods and their quality control**.**

UNIT II

Bacterial Anatomy - Structure, properties of cellular components of bacteria. Sporulation. Growth and nutrition – culture medium and its types. Measurement of

growth- Growth curve and its kinetics. Enumeration of cells. Pure culture techniques.

UNIT III

Introduction to structure and classification of Fungi - Characteristics of Zygomycetes, Ascomycetes, Basidiomycetes and Dueteromycetes. Structure, general properties and classification of Viruses. Classification of Protozoa - classical 1980; official system & 1993 Cavalier- Smith. Distinguishing characteristics of Ciliates, Flagellates, Sporozoan, Heliozoans, Amoeba.

UNIT IV

Laboratory Animal Science - Modern methods of care, management, breeding and maintenance of laboratory animals. Detailed account on nutrition, handling and application of laboratory animals - rabbits, mice, rats, guinea pigs, hamsters, fowl.

UNIT V

Breeding, handling and uses of Gnotobiotic animals. Transgenic animal models. Disposal of animal house wastes and used animals. Pathogenicity testing, Antibody production, Toxin/toxoid Testing, Hypersensitivity testing using animal models.

MAPPING OF CO WITH PSO

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	S	L	N	L	N	N	N
CO 2	S	S	S	M	N	N	L
CO 3	S	L	L	M	M	N	L
CO 4	L	S	L	L	S	L	S
CO 5	S	S	L	L	M	L	S

S- Strong; M-Medium; L-Low

Reference Books:

1. Gerard J. Tortora, Berdell R. Funke, Christine L. Case (2015) Microbiology: An Introduction (12th Edition).PEARSON, London, United Kingdom
2. Joanne Willey, Linda Sherwood and Christopher J. Woolverton (2013) Prescott's Microbiology, McGraw-Hill Education; 10th Edition (2017). ISBN-10: 0073402400
3. Prescott L.M. Harley J.P. and Klein D.A. (2003). Microbiology (5th edition) McGraw Hill, New York.
4. J. Webster and R.W.S. Weber (2007). Introduction to Fungi. (3rd edition).Cambridge University press, Cambridge.
5. Schaechter M and Leaderberg J (2004). The Desk encyclopedia of Microbiology. Elseiver Academic press, California.

Text Books:

1. Jayaram Paniker C. K. and Ananthanarayan R. (2017). Textbook of Microbiology. (10th Edition). Universities Press (India) Pvt. Ltd.
2. Bernard D. Davis. Renato Dulbecco. Herman N. Eisen.and Harold, S. Ginsberg. (1990).Microbiology (4th edition). J.B.Lippincott company, New York.
3. Alexopoulus C.J. and C W. Mims. (1993). Introductory Mycology (3rd edition).Wiley Eastern Ltd, New Delhi.
4. Elizabeth Moore - Landecker. (1996). Fundamentals of the fungi. (4th edition). Prentice Hall International, Inc, London.
5. Heritage,J. Evans E.G.V. and Killington, R.A. (1996). Introductory Microbiology. Cambridge University Press.
6. Holt, J.S., Kreig, N.R., Sneath, P.H.A and Williams, S.T. Bergey's Manual of Determinative Bacteriology (9th Edition), Lippincott, Williams & Wilkins, 2000.
7. Larry Mc Kane.and Judy Kandel (1996). Microbiology-Essentials and applications. (2nd edition). Mc Fraw Hill Inc, Newyork.
8. Michael T. Madigan, John M. Martinko, Jack Parker (2009) Biology of Microorganisms.(12th edition).Prentice Hall International Inc, London.

9. Nester, E.W., Roberts, C.V. and Nester, M.T. (1995). Microbiology, A human perspective. IWOA, U.S.A.
10. Chan E.C.S., Michael J. Pelczar, Jr.,Noel R. Krieg (2010). Microbiology. (5th edition). Mc. Graw Hill. Inc, New York.
11. Salle, A.J. (1996). Fundamental principles of Bacteriology.(7th edition).Tata McGraw - Hill publishing company Ltd, New Delhi.
12. Caldwell, D.R. (1999). Microbial Physiology and metabolism, Wm. C. Brown Publishers, U.S.A.
13. Lansing M. Prescott, John P. Harley and Donald A. Klein. (2004). Microbiology.(6th edition). McGraw - Hill company, New York.

A. G. Moat, J. W. Foster and M. P. Spector (2002). Microbial Physiology (4th Edition). John Wiley & Sons, New York.

14. David White, James Drummond, and Clay Fuqua (2011). The physiology and biochemistry of Prokaryotes, Oxford University Press, Oxford, New York.
15. Ketchum, P.A. (1984) Microbiology: Concepts and Applications. John Wiley and Sons, New York.
16. Mandelstam, J., McQuillen, K. and Dawes, L. (1992) Biochemistry of Bacterial Growth, 3rd Edn. Blackwell Scientific Publications, Oxford.
17. Moat, A.G. and Foster, J.W. (1995) Microbial Physiology, 3rd Edn. John Wiley and Sons, New York.
18. Gottschalk, G. (1986) Bacterial Metabolism, 2nd Edn. Springer-Verlag, New York.
19. Ingraham, J.L. and Ingraham, C.A. (2000) Introduction to Microbiology, 2nd Edn. Books / Cole Thomson Learning, UK.
20. Schelegel, H.G. (1993) General Microbiology,7th Edn. Cambridge University Press, Cambridge.
21. Dubey RC (2000). Textbook of Microbiology. S. Chand, Limited.

Journals:

1. BMC Microbiology: https://bmcmicrobiol.biomedcentral.com/
2. Applied and Environmental Microbiology: https://aem.asm.org/

3. Frontiers in Microbiology: https://www.frontiersin.org/journals/microbiology.

Web Resources:

1. http://sciencenetlinks.com/tools/microbeworld/
2. https://www.microbes.info/
3. https://www.asmscience.org/VisualLibrary
4. https://www.asmscience.org/VisualLibrary
5. https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404
6. https://www.boundless.com/microbiology
7. https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635
8. https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf
9. https://microbiologyinfo.com/top-and-best-microbiology-books/

HARD CORE 2 THEORY: IMMUNOLOGY AND IMMUNOTECHNOLOGY

COURSE OUTCOME

CO-1. Introduce basic concepts in Immunology.

CO-2. Imparts the basic knowledge on antigens, immunoglobulins and its purification techniques.

CO-3. Provide insights to hypersensitivity, autoimmunity and transplantation immunology.

CO-4. Gains knowledge on tumor immunology, vaccines and immunization schedule.

CO-5. Evaluate the reactions between various antigens and antibodies and apply the knowledge in diagnosing diseases and disorders.

UNIT I

History and scope of immunology. Types of immunity – Innate, acquired, passive and active. Cells and organs involved in immune system. Cytokines and its receptors. Physiology of immune response - Humoral and cell mediated immune response.

UNIT II

Antigen and its properties. Adjuvants. Immunoglobulin - structure, types, and functions. Antibody production – regulation and diversity. Monoclonal antibodies. Complement and its role in immune responses.

UNIT III

Hypersensitivity – types and manifestations. Autoimmunity. Major histocompatibility complex – structure and types. Transplantation immunology- Types of graft, mechanism of graft rejection. HLA tissue typing.

UNIT IV

Tumor immunology. Vaccines - Principles and types. Immunization - its rationale schedules and importance in public health.

UNIT V

Antigen – antibody reactions. Agglutination- Bacterial, Heam and Passive agglutination reactions with examples. Precipitation reactions with examples. Precipitation reaction on gels - Immunodiffusion – ODD and SRID. Immuno electrophoresis – Counter immuno electrophoresis, serum electrophoresis and rocket electrophoresis. Enzyme immunoassays – Radio immuno assay. Immuno histopathology. Immuno fluorescence, Immuno peroxidase test.

MAPPING OF CO WITH PSO

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	L	S	L	M	M	L	L
CO 2	M	S	L	M	M	L	M
CO 3	M	S	L	L	M	L	M
CO 4	M	S	L	M	M	L	M
CO 5	M	S	L	M	L	L	M

S- Strong; M-Medium; L-Low

Reference Books:

1. Jenni P, Sharon S, Patricia J, Judith AO (2018) Kuby Immunology, 8th Edn. H.W.Freeman and Company, New York.
2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt (2017) Roitt's Essential Immunology. (13th Edition). WILEY Blackwell Scientific Publications, Oxford.
3. Lydyard P, Whelan A and Fanzer MW (2011) BIOS Instant notes in Immunology. (3rd Edition). CRC Press.
4. Talwar GP (1983). Microscopic Immunoassays and Applications, Vikas International Students Edition, Vikas Publishing House Pvt. Ltd.

Text Books:

1. Jayaram Paniker C. K. and Ananthanarayan R. (2017). Textbook of Microbiology. (10th Edition). Universities Press (India) Pvt. Ltd.
2. Chapel, H, Mansel H, Siraj M and Neil S (2014). Essentials of Clinical Immunology. (4th Edition). John Wiley and Sons Ltd
3. Tizard, R.I. (1994) Immunology: An Introduction. Saunders College Publishing, Philadelphia.
4. Elgert, K.D. (2009) Immunology: Understanding the Immune System. (2nd Edition). Wiley – Blackwell, New York.
5. Donald M. Weir, John Steward. (1993). Immunology VII edition. ELBS, London.
6. Hue Davis (1997). Introductory Immunology (First Edition). Chapman & Hall Publisher, London.

7. Paul (1998). Fundamental Immunology, II Edition, Raver Press, New York.
8. Peter J. Delves, Ivan M. Roit (eds) (1998) Academic Press – Encyclopedia of Immunology – 2nd edition.
9. Ridklad, M. Aydl (1995). Immunology, II Edition, Baltimore, Hong Kong, NMS Publication.
10. David Male Jonathan Brostoff David Roth Ivan Roitt (2012) Immunology (8th Edition). Saunders.
11. Jacqucline S, Williams and Wilkins A. (1998) Basic Immunology - Warerly Company.
12. Janeway, Charles, Travers, Paul, Walport, Mark, Shlomchik, M (2004). Immunobiology. (6th edition). Garland Science
13. Mark Peakman, Diego Vergani. (2009) Basic and clinical immunology. (2nd Edition) Longman Asia Ltd., Hong kong.
14. Clark WR (1991). The experimental foundations of modern immunology. (4th Edition) John Wiley and Sons Inc. New York.
15. Hay FC and Westwood OMR. (2002) Practical Immunology, 4th edition, Blackwell Scientific Publishers, Oxford, London.
16. Miller L.E, Luke H.R, Peacock J.E and Tomar R.H (1990). Manual of Laboratory Immunology, 2nd edition, Lea and Febiger - London.
17. Talwar GP (ed). (1983) A handbook of Practical Immunology, Vikas Publishing House Pvt. Ltd.
18. Brawshaw L.J. (1988). Laboratory Immunology, Sandders College Publishing.

Journals:

1. **Neuroscience:** https://www.sciencedirect.com/topics/neuroscience/hematopoiesis
2. **Frontiers in Immunology:** https://www.frontiersin.org/articles/10.3389/fimmu.2015.00257/full
3. **Neuroscience:** https://www.sciencedirect.com/topics/neuroscience/cytokines
4. **Medicine and Dentistry:** https://www.sciencedirect.com/topics/medicine-and-dentistry/hypersensitivity

5. **Medicine and Dentistry:** https://www.sciencedirect.com/topics/medicine-and-dentistry/transplantation
6. **Web Resources:**
7. https://www.immunology.org/public-information/immunology-related-activities-and-resources/immunology-resources-links
8. https://www.aai.org/Education/Teaching-Resources
9. https://study.com/academy/topic/immunology.html

SOFT CORE 1-THEORY: MICROBIAL DIVERSITY AND TAXONOMY

COURSE OUTCOME

CO-1. Introduce basic concepts in Biodiversity.

CO-2. Learn classification and applications of extremophiles including thermophiles, archaebacteria and methanogens.

CO-3. Get insight on extremophiles including alkaliphiles, acidophiles, halophiles, barophiles.

CO-4. Gains basic knowledge on microbial taxonomy and systematic of classification.

CO-5. Get familiar with bacterial classification using Bergey's manual.

UNIT I

Biodiversity: Introduction to microbial biodiversity- ecological niche. Types – Bacterial, Archaeal and Eucaryal.

UNIT II

Thermophiles: classification, Extremely Thermophilic Archaebacteria and its applications. Methanogens: Classification, Habitats, applications.

UNIT III

Alkaliphiles and Acidophiles - Classification, discovery basin, cell walls and membranes- purple membrane, compatible solutes. Osmoadaptation/ halotolerance. Applications of halophiles. Barophiles - Classification and its applications.

Halophiles - Classification, discovery basin, cell walls and membranes - purple membrane, compatible solutes.

UNIT IV

Taxonomy, systematics, identification: Taxonomical hierarchy - binomial nomenclature. Systems of classification- phenetic, numerical taxonomy - similarity matrix, dendrograms with examples; phylogenetic with examples. Five kingdom, six kingdom and eight kingdom systems.

UNIT V

Classification of bacteria according to Bergey's Manual of systematic bacteriology 9^{th} edition (up to level of section); characteristics of major sections. classification of archaea, photosynthetic bacteria, Enterobacteriaceae, Mollicutes.

MAPPING OF CO WITH PSO

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	S	L	M	M	S	L	L
CO 2	S	L	M	M	M	L	M
CO 3	S	L	M	M	M	L	M
CO 4	S	M	M	M	S	M	L
CO 5	S	M	M	M	M	M	L

S- Strong; M-Medium; L-Low

Reference Books:

1. Atlas, R.M. 2000. Microbiology Fundamentals and Application, Macmillan Publish Company, New York.

2. Dubey, R.C. and Maheswari, D.K. 2013. A text book of Microbiology, Revised S. Chand and Company Ltd, NewDelhi.

3. Kreig, N.R. 1984. Bergeys Manual of Systematic Bacteriology Vol I: Sneath, P.H.A., Ed 1986, Vol II: Staley, J.T. Ed., 1989. Vol III, William, S.T., Ed., 1989, Vol IV William and William, Baltimore.

4. Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D. 2000. Twelth Edition, Biology Microorganisms, Prentice Hall, New Jerry.

5. Mark Wheelis, 2010. Principles of Modern Microbiology, Jones & Bartlett India Pvt. Ltd., New Delhi.

6. Pelczar, M.J., Schan, E.C. and Kreig, N.R.2010. Microbiology – An application based approach, Fifth Edition, Tata McGraw Hill Publishing Company Limited, New Delhi.

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

8. Stanier, R., Lingraham, Y., Wheelis, M.L. and Painter, R.P. 1986. General Microbiology, Fifth Edition, Macmillan, London.

9. Tortora G.J., Funke, B.R.and Case, C.L. 2009. Microbiology, Ninth Edition, Dorling Kindersely (India) Pvt. Ltd., Noida.

Journals:

1. BMC Microbiology: https://bmcmicrobiol.biomedcentral.com/
2. Applied and Environmental Microbiology: https://aem.asm.org/
3. Frontiers in Microbiology: https://www.frontiersin.org/journals/microbiology.

Web Resources:

1. http://sciencenetlinks.com/tools/microbeworld/
2. https://www.microbes.info/
3. https://www.asmscience.org/VisualLibrary
4. https://www.asmscience.org/VisualLibrary
5. https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404
6. https://www.boundless.com/microbiology
7. https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635
8. https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf

9. https://microbiologyinfo.com/top-and-best-microbiology-books/

HARD CORE 1 – PRACTICALS: GENERAL MICROBIOLOGY, PHYSIOLOGY AND IMMUNOLOGY AND IMMUNOTECHNOLGY

COURSE OUTCOME

CO-1. Gain knowledge on the application of different microscope and microscopic techniques to demonstrate the morphology by staining techniques.

CO-2. Learn the preparation and uses of various culture media.

CO-3. Learn the techniques used for the enumeration of microbes in various samples and isolation of pure cultures.

CO-4. Gains knowledge on immunological techniques including method of bacterial antigen preparation and raising polyclonal antisera in experimental animals.

CO-5. Be acquainted with the techniques applied for the preparation and purification of immunoglobulins.

UNIT I

Microscopic Techniques: Light microscopy: Hay infusion broth. Wet mount to show different types of microbes, hanging drop. Dark field microscopy – motility of spirochetes. Washing and cleaning of glass wares: Sterilization methods: moist heat, dry heat, and filtration. Quality control check for each method. Staining techniques - Simple staining, Gram's staining, Acid fast staining, Metachromatic granule staining, Cell wall, Spore, Capsule, Flagella.

UNIT II

Media Preparation: Preparation of liquid, solid and semisolid media. Agar deeps, slants, plates. Preparation of basal, enriched, selective and enrichment media. Preparation of Biochemical test media, media to demonstrate enzymatic activities.

UNIT III

Microbial Physiology: Purification and maintenance of microbes. Streak plate, pour plate, and slide culture technique. Aseptic transfer. Direct counts – total cell count, Turbidimetry. Viable count - pour plate, spread plate. Bacterial growth curve. Anaerobic culture methods.

UNIT VI

Agglutination & Hemagglutination reactions: Latex Agglutination - RF, ASLO, CRP. Blood grouping, RH –Typing / IHA/ RPHA. Precipitation reactions in gels: SRID - Single radial immunodiffusion. Double immunodiffusion. Immuno electrophoresis and staining of precipitation lines. ELISA technique – HbsAg / or other Viral Markers. Preparation of Bacterial Antigens (Crude preparation) by homogenization or sonication

UNIT V

Preparation of Lymphocytes from peripheral blood by density gradient centrifugation. Purification of Immunoglobulins: Ammonium sulphate precipitation. Separation of IgG by chromatography using DEAE cellulose or Sephadex.

MAPPING OF CO WITH PSO

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	S	M	M	M	L	N	L
CO 2	M	S	M	M	L	L	L
CO 3	M	S	M	S	M	L	L
CO 4	M	S	L	L	S	M	L
CO 5	M	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

Reference books:

1. Cappuccino J G and Welsh CT (2017). Microbiology: A Laboratory Manual (11th Edition). Pearson Education, Noida
2. Aneja KR (2018). Laboratory Manual of Microbiology and Biotechnology. (1st Edition). Bio-Green Publisher.
3. Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS Publishers.

Journals:

1. JBS: https://www.jbsoweb.com/admin/php/uploads/31_pdf.pdf Chemistry: https://www.sciencedirect.com/topics/chemistry/sterilization-and-disinfection
2. ASM: https://www.asm.org/getattachment/2594ce26-bd44-47f6-8287-0657aa9185ad/Kirby-Bauer-Disk-Diffusion-Susceptibility-Test-Protocol-pdf.pdf

Web Resources:

1. http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection-methods-and-principles-microbiology/24403.
2. https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635
3. https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf
4. https://microbiologyinfo.com/top-and-best-microbiology-books/

5. https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology
6. https://courses.lumenlearning.com/microbiology/chapter/staining-microscopic specimens/
7. https://www.cdc.gov/infectioncontrol/guidelines/disinfection/sterilization/index.html
8. https://www.britannica.com/science/bacteria/Growth-of-bacterial-populations
9. http://www.preservearticles.com/biology/what-are-the-methods-of-measuring-microbial-growth/2847

ELECTIVE 1-THEORY: METABOLIC PATHWAYS

COURSE OUTCOME

CO-1. Imparts the fundamentals of Enzyme – mechanism, inhibition of enzyme action and metabolic channelling in living organism.

CO-2. Gain knowledge on the generation of energy source.

CO-3. Demonstrate the concepts of carbohydrate metabolism

CO-4. Demonstrate the concepts of Lipid metabolism

CO-5. Discuss the biosynthetic pathways of peptidoglycan, aminoacids, purines and pyrimidines.

UNIT I

Enzymes – nomenclature, components - Mechanism of enzyme reactions - Factors influencing enzymatic activity - Inhibition of enzyme action - Metabolic channeling – Control of enzyme activity – Regulation of enzyme synthesis.

UNIT II

Principles of Bio energetics - Oxidation –reduction reactions - Generation of energy –Substrate Level and oxidatitive phosphorylation - Electron transport chain.

UNIT III

Carbohydrate catabolism – Glycolysis – Pentose phosphate pathway – ED pathway – The Kreb`s cycle – Energy yield in glycolysis and aerobic respiration – Anaerobic respiration – Lactic acid fermentation – Alcohol fermentation.

UNIT IV

Lipid Metabolism – Oxidation of lipids; biosynthesis of fatty acids; triglycerides; phospholipids; sterols. Protein and amino acid catabolism – Oxidation of inorganic molecules – Photophosphorylation.

UNIT V

Bio chemical pathways of energy use – Photosynthetic fixation of CO_2. Biosynthesis of peptidoglycan. Biosynthesis of amino acids - proline, arginine, aspartic acid and histidine- Interconversions - threonine, isoleucine and methionine; isoleucine,valine and leucine; serine and lysine; Aspartate and pyruvate. Bio synthesis of purines and pyrimidines.

MAPPING OF CO WITH PSO

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	S	L	S	S	L	M	N
CO 2	M	L	M	M	M	L	L
CO 3	M	L	S	S	M	L	L
CO 4	M	L	M	M	M	L	L
CO 5	M	L	M	M	L	L	L

***S- Strong; M-Medium; L-Low**

Reference books:

1. David, A. B. 2003. Nutritional biochemistry of Vitamins, Cambridge.

2. Deb, A.C. 2006. Fundamentals of Biochemistry, New Central Book Agency Pvt. Ltd., Kolkata.

3. Donald Voet and Judith G. Voet, 2011. Biochemistry. Third Edition, John Wiley and Sons, Inc. New York.

4. Stryer, L. 2010. Biochemistry, Seventh Edition, W.H. Freeman and Company, New York.

5. Satyanarayana, U. and Chakrapani, U. 2013. Biochemistry, Fourth Edition Book and Allied Pvt. Ltd., Kolkata.

6. Jain, J.L. 2008. Fundamentals of Biochemistry, Fifth Edition, S. Chand and Company Ltd, NewDelhi.

7. Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D. 2000. Twelth Edition, Biology Microorganisms, Prentice Hall, New Jerry.

8. Moat, A.G. and Foster, W.2002. Microbial Physiology, Fourth Edition, John Wiley and Sons, New York.

9. Nelson, D.L. and Cox, M.M. 2012. Lehingers's Principles of Biochemistry, Sixth Edition, Mac Millan worth Publishers, New Delhi.

10. Srivastava, M.L. 2008. Microbial Biochemistry, Narosa Publishing House, New Delhi.

Journals:

1. **Agricultural and Biological Sciences:** https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/phospholipid
2. **PMC:** https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3293468/
3. **Genetics and Molecular Biology:** https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/lineweaver-burk-plot

Web Resources:

1. http://med.wikidot.com/biochemistry-online-links
2. http://oli.stanford.edu/biochemistry
3. https://www.diabetes.org/nutrition/understanding-carbs/types-carbohydrates
4. https://chemed.chem.purdue.edu/genchem/topicreview/bp/1biochem/carbo5.html
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4224210/
6. https://www.mayoclinic.org/diseases-conditions/vitamin-deficiency-anemia/symptoms-causes/syc-20355025
7. https://www.ncbi.nlm.nih.gov/books/NBK21177/

ELECTIVE 2-THEORY: GENERAL REGIME OF INTELLECTUAL PROPERTY RIGHTS

Course outcome:

CO-1. Imparts the fundamentals of Intellectual property rights

CO-2. Discuss the international protection of IPR.

CO-3. Throw light on Patent process

CO-4. Provide insight on the copy rights

CO-5. Explains the trade mark and its content

UNIT -I

Introduction to intellectual property – Meaning of intellectual property. Nature of intellectual property. Concept of property – Extrapolation to intellectual property. Theories justifying protection of property – Western theories, Marxian theory, Indian theory. Forms of intellectual properties- Patents, Copy right, Trademark, Industrial designs, Geographical indications, protection of new plant varieties and farmers right, protection of bio diversity. Commercial exploitation of intellectual property.

UNIT-II

International protection of intellectual property rights-International conventions and covenants for the protection of intellectual property (a) International of protection of

patents (b) International protection of copy rights (c) International protection of trade marks.WTO and intellectual property rights, WIPO.

UNIT-III

Patents - Introduction to patents, acquisition of patent rights, Infringement of patent, commercialization of inventions - (a) what is a license (b) term of a license agreement, pharmaceutical protection.

UNIT-IV

Copy right - introduction to copy right, authorship and owner ship, right conferred on copy right owner, infringement of copy right.

UNIT-V

Trademarks-overview of trademarks, meaning and content of trademarks, registration of trademarks, rights of registered trademark owners, infringement of trade mark

MAPPING OF CO WITH PSO

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	L	L	L	M	L	L	S
CO 2	L	L	L	M	L	L	S
CO 3	L	L	M	M	L	L	S
CO 4	L	L	M	M	L	L	S
CO 5	L	L	M	M	L	L	S

S- Strong; M-Medium; L-Low

Text books:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.

Reference books:

1. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.

SECOND SEMESTER

HARD CORE 3- THEORY: VIROLOGY

COURSE OUTCOME

CO-1. Impart basic knowledge on discovery, properties and diagnosis of virus.

CO-2. Explains the viruses of bacteria, their lifecycle and uses.

CO-3. Discuss the various plant viruses and the infections caused by them.

CO-4. Provide insight the pathogenesis and clinical feature of human viruses.

CO-5. Impart knowledge regarding the epidemiology, diagnosis, prevention and related implications of human viral diseases and emerging viral infections.

UNIT I

Brief outline of virology - discovery of virus - general properties of viruses - general methods of diagnosis. Viroids, Prions, Satellite RNAs and Virusoids.

UNIT II

Bacterial viruses - ΦX 174, M13, MU, T4, lambda, Pi; structural organization, lifecycle and phage production. Lysogenic cycle - typing and application in bacterial genetics.

UNIT III

Plant viruses - transmission of plant viruses – TMV general characters - morphology – replication - RNA as its initiator of infection. Cauliflower mosaic virus. Mycophages. Cyanophages – LPP group, Lyngbya, Plectonema and Phormidium phages.

UNIT IV

DNA Viruses - Pox viruses, Herpes viruses, Adeno viruses, Papova viruses and Hepadna viruses; RNA Viruses- Picorna, Orthomyxo, Paramyxo, Toga and other arthropod borne viruses, Rhabdo, Rota, HIV and other Hepatitis viruses.

UNIT V

Epidemiology, Diagnosis and Treatment of Viral Diseases; Viral Vaccines and Antiviral agents. Study on recent viral outbreaks in humans (SARS, Swine flu, Nipah, Ebola, Dengue and Chikun gunya).

MAPPING OF CO WITH PSO

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	S	M	M	M	M	L	L
CO 2	S	M	M	M	M	L	M
CO 3	S	M	S	L	M	L	M
CO 4	S	S	L	M	M	L	M
CO 5	M	S	L	L	M	L	M

S- Strong; M-Medium; L-Low

Reference books:

1. Burrell C, Howard C, Murphy F (2016) Fenner and White's Medical Virology 5th edition Academic Press.
2. White D.E, Fenner F.J. (1994) Medical Virology 4th Edition, Academic Press.
3. Mishra B (2017) Textbook of Medical Virology, CBS Publishers.
4. Flint J.S, Racaniello V.R, Krug R (1999) Principles of Virology: Molecular Biology, Pathogenesis, and Control 4th edition , ASM Press.
5. Mahy B, Regenmortel M (2009) Desk Encyclopedia of Human and Medical Virology 1st edition, Academic Press.
6. Dimmock N.J, Easton A.J, Leppard K.N. (2007) Introduction to Modern Virology, 6th edition, John Wiley and Sons Ltd.
7. Carter J, Saunders V (2013) Virology Principles and Applications 2nd edition. John Wiley & Sons.

Journals:

1. International Journal of Medical Microbiology: https://www.journals.elsevier.com/international-journal-of-medical-microbiology/
2. Indian Journal of Medical Microbiology: http://www.ijmm.org/
3. Virology Journal: https://virologyj.biomedcentral.com/
4. BMC Infectious Diseases: https://bmcinfectdis.biomedcentral.com/
5. PLOS ONE: https://journals.plos.org/plosone/
6. Journal of Biomedical Science: https://jbiomedsci.biomedcentral.com/

Web Resources:

1. http://www.virology.net/
2. https://microbiologyonline.org/

HARD CORE 4 THEORY: SYSTEMATIC MEDICAL BACTERIOLOGY

COURSE OUTCOME

CO-1. Impart knowledge on clinical conditions of various syndromes, differentiate normal microflora from pathogens, analyse the structure and factors contributing to pathogenicity.

CO-2. Provide insights on host parasite relationship, acquire the skill of sample collection, transport and processing for bacterial identification, prophylaxis of bacterial disease and their standard rule.

CO-3. Gains knowledge on bacterial diseases caused by Gram positive bacteria and spore formers.

CO-4. Detect the etiology and virulence factors of Gram negative bacterial diseases

CO-5. Get the conceptual knowledge about zoonotic disease, nosocomial infection and hospital waste management.

UNIT I

Philosophy and General approach to clinical conditions of various syndromes – general and specific syndromes. Indigenous normal microbial flora of human body. General attributes and virulence factors of bacteria causing infections.

UNIT II

Host Parasite relationships – Nonspecific host immune mechanisms. Ground rules for collection and dispatch of clinical specimens for microbiological diagnosis. Antimicrobial agents, types and mode of action, CLSI recommendations.

UNIT III

Morphology, classification, cultural characteristics, pathogenicity, pathology, laboratory diagnosis, prevention and treatment of diseases caused by *Staphylococci*, *Streptococci*, *Pneumococci*, *Neisseriae* (Gonococci & Meningococci), *Corynebacterium*, *Mycobacterium*, *Clostridium*, *Bacillus*.

UNIT IV

Studies on *Salmonella*, *Shigella*, *Vibrios*, *Brucella*, *Spirochetes*, *Rickettsiae*, *Chlamydiae*, *Mycoplasmas* and *Ureoplasmas*.

UNIT V

Zoonotic diseases and their control – Hospital acquired infections – Hospital Infection control committee – functions – Hospital waste disposal.

MAPPING OF CO WITH PSO

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	S	M	L	L	L	L	M
CO 2	L	M	L	L	L	L	M
CO 3	S	S	L	L	L	L	M
CO 4	S	S	L	L	L	L	M
CO 5	L	M	M	L	L	L	S

***S- Strong; M-Medium; L-Low**

Reference Books:

1. Anathanarayan R and JeyaramPanikers C.K. 2013. Text Book of Microbiology. Ninth Edition. Jain book depot, New Delhi.

2. AroraD.R. ,BrijBalaArora. Textbook of Microbiology. 2015. CBS. Chennai.

3. AwetzMelnick and Adelberg's Medical Microbiology, 21st Century. 2010. Appleton & Lange.

4. Bhattacharjee R.N. Introduction to Microbiology. 2015. First Edition. Kalyani Publishers, New Delhi.

5. Connie R Mahon. 2010. Textbook of Diagnostic Microbiology. 3rd edition. Pearson.

6. David Greenwood, Richard Slack, John Peutherer. Medical Microbiology. 2012. Churchill Livingstone.

7. Jesse Russell, Ronald Cohn. Medical Microbiology. 2012. Book on Demand Ltd.
8. Myra Wilkinson. Medical Microbiology. 2011. Scion Publishing Ltd
9. Patrick Murray & Ken Rosenthal & Michael Pfalle. Medical Microbiology. 8th Edition. 2015. Academic Press, New York.

Journals:

1. Journal of Clinical Pathology: https://jcp.bmj.com/
2. Frontiers in Medicine: https://www.frontiersin.org/journals/medicine
3. Journal of Bacteriology: https://jb.asm.org/
4. Journal of Medical Bacteriology: http://jmb.tums.ac.ir/index.php/jmb

Web Resources:

1. https://microbiologyonline.org/
2. http://www.bioedonline.org/lessons-and-more/resource-collections/micromatters-microbiology/
3. https://microbiologysociety.org/members-outreach-resources/education-outreach-resources.html

SOFT CORE 2-THEORY: MYCOLOGY AND PARASITOLOGY

COURSE OUTCOME

CO-1. Gain knowledge on history of mycology, taxonomy and classification of fungi

CO-2. Learn characteristics of superficial mycoses and systematic fungal infections.

CO-3. Be familiar with techniques of handling the fungal clinical specimens and its toxins.

CO-4. Predict the importance of protozoans in causing human infections

CO-5. Provide insights on Helminth parasites, trematode parasite, nematode parasites and infection in AIDS patients.

UNIT I

Historical introduction to mycology - Morphology, Taxonomy, Classification of fungi, Structure and cell differentiation of fungi. Lichens – ascolichens, basidiolichens, deuterolichens. Fungi as insect symbiont.

UNIT II

Dermatophytes and agents of superficial mycoses. Yeasts of medical importance. Dimorphic fungi causing systematic mycoses. Dimatiaceous fungi, opportunistic hyaline hyphomycetes, agents of zygomycosis. Fungi causing Eumycotic mycetoma.

UNIT III

Detection and recovery of fungi from clinical specimens. Newer methods in diagnostic mycology. Immunity to fungal infections. Mycotoxins. Antifungal agents - testing methods and quality control.

UNIT IV

Introduction to Medical parasitology – classification, host-parasite relationships. Epidemiology, life cycle, pathogenic mechanisms, lab diagnosis, treatment, etc. for the following: Protozoa causing human infections – Entamoeba, Aerobic and Anaerobic amoebae. *Toxoplasma, Cryptosporidium, Leishmania, Trypanasoma, Giardia,* Trichomonas, *Balantidium.*

UNIT V

Classification, life cycle, pathogenicity, laboratory diagnosis and treatment for the following parasites: Helminths: cestodes – *Taenia solium, T.saginata, T. echinococcus*. Trematodes – *Fasciola hepatica, Fasciolo psisbuski, Paragonimus, Schistosomes*. Nematodes: *Ascaris, Ankylostoma, Trichuris, Trichuris, Trichinella, Enterobius, Strongyloides, Wuchereria*. Other parasites causing infections in immunocompromised hosts and AIDS.

MAPPING OF CO WITH PSO

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	S	M	M	L	M	L	M
CO 2	M	S	M	L	L	L	M
CO 3	L	M	L	L	L	L	M
CO 4	M	M	L	L	M	L	L
CO 5	M	M	L	L	M	L	L

***S- Strong; M-Medium; L-Low**

Reference books:

1. Chander J (2018) Textbook of Medical Mycology 4th edition Jaypee Brothers Medical Publishers.
2. Reiss E, Shadomy H.J, Lyon G.M. (2011) Fundamental Medical Mycology, Wiley-Blackwell.
3. Kibbler C.C, Barton R, Gow N.A.R, Howell S, MacCallum D.M, Manuel R.J (2018) Oxford Textbook of Medical Mycology Oxford University Press.
4. Alexopoulos C.J, Mims C.W. (2007) Introductory Mycology, 4th edition Wiley.
5. Abyaneh M.R, Ghahfarokhi M.S, Rai M (2015) Medical Mycology: Current Trends and Future Prospects CRC Press.
6. Dube H.C (2012) An Introduction to Fungi: 4th Edition, Scientific Publishers.
7. Paniker C.J.K, Ghosh S (2018) Paniker's Textbook of Medical Parasitology 8th edition Jaypee Brothers Medical Publishers.
8. Baveja V, Baveja C.P (2019) Medical Parasitology, 4th edition Arya Publishing Company.
9. Sastry A.S, Bhat S. (2018) Essentials of Medical Parasitology, 2nd edition Jaypee Brothers Medical Publishers.
10. Procop G.W, Koneman E.W (2016) Koneman's Color Atlas and Textbook of Diagnostic Microbiology 7th edition, Lippincott Williams and Wilkins.

Journals:

1. Parasites and Vectors: https://parasitesandvectors.biomedcentral.com/
2. The American Society of Tropical Medicine And Hygiene: https://www.ajtmh.org/
3. Clinical Microbiology: https://www.longdom.org/clinical-microbiology.html
4. Pathogens and Global Health: https://www.tandfonline.com/loi/ypgh20
5. Journal of Fungi: https://www.mdpi.com/journal/jof
6. Journal of Clinical Microbiology: https://jcm.asm.org/
7. Medical Mycology: https://academic.oup.com/mmy

Web Resources:

1. https://microbionotes.com/category/parasitology/
2. https://microbiologynotes.com/
3. http://www.biologydiscussion.com/parasites/classification-of-parasites-parasitology/62036

HARD CORE 2 – PRACTICAL: SYSTEMATIC BACTERIOLOGY, MYCOLOGY, PARASITOLOGY AND VIROLOGY

COURSE OUTCOME

CO-1. Get skilled on different methodologies in collection and transport of clinical specimens. Identification of bacterial pathogens from clinical specimens through cultural characterisation and biochemical test

CO-2. Learn various antibiotic susceptibility testing procedures.

CO-3. Practical skills on microscopical examination, cultivation and identification of fungal pathogens.

CO-4. Get familiarize at the examination of parasites in clinical specimens.

CO-6. Learn the methods used for isolation of bacteriophages and various viral serological and cell culture techniques.

UNIT I

Collection and transport of clinical specimens - Prerequisites - Proforma - Methodologies. Direct examinations – wetfilms / stainings for faeces (*V.cholerae*, *Shigella*, *Salmonella*) pus, #putum, throat/ear/nasal/wound swabs, CSF and other body fluids. Simple, differential and special staining methods. Cultivation methods - Transport media - Isolation methods – Basal, differential enriched, selective media & special media for the pathogenic bacteria. Biochemical identification. Tests for the respective bacteria up to species level.

UNIT II

Antibiotic sensitivity tests -Stokes & Kirby Bauer methods - Disc diffusion - Dilution -Agar dilution & broth dilution -MBC/MIC - Quality Control for antibiotics and standard strains.

UNIT III

KOH preparation of skin / nail scrapings for fungi and scabies mites. Examination of hair infection under UV light. LPCB mount. Special stains for fungi - Gomori, PAS and Methanamine silver stain for sections. Cultivation of fungi and their identification - *Mucor*, *Rhizopus*, *Aspergillus*, *Penicillium*, *Candida*, *Trichophyton*, *Microsporum*, *Epidermophtyon* - Slide culture method - Germ tube method, Sugar assimilation / fermentation tests for yeast.

UNIT IV

Examination of parasites in clinical specimens - Ova/cysts in faeces - Direct and concentration methods – formal ether and zinc sulphate methods - saturated salt solution method. Blood smear examination for malarial parasites. Thin smear by Leishman's stain - Thick smear by J.B. stain. Wet film for Microfilariae. Identification of common arthropods of medical importance - spotters of Anopheles, Glossina, Phelbotomus, Aedes, etc. Ticks and Mites.

UNIT V

Isolation and characterization of bacteriophage from natural sources – phage titration - T4. Study of virus infected plants. Isolation of viruses - chick embryo. Spotters of viral inclusions and CPE - stained smears. Viral serology – ELISA, Western Blotting. Cell culture techniques.

MAPPING OF CO WITH PSO

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	S	S	S	L	L	L	L
CO 2	M	M	M	L	L	L	L
CO 3	S	M	M	M	L	L	L
CO 4	M	M	M	L	L	L	L
CO 5	S	S	M	L	L	L	L

S- Strong; M-Medium; L-Low

Reference books:

1. Patrick Murray, R. and Ellen Jo Baron (2007) Manual of Clinical Microbiology, 9th Edition,Vol 1. ASM Press, Washington.

2. James G. Cappuccino and Natalie Sherman (2014) Microbiology A laboratory Manual, 10th edition - Pearson Education.

3. Benson, J.H. (1996) Microbiological Applications: A Laboratory Manual in General Microbiology 7th edition, Wn. C. Brown Publication IOWK, USA.

4. James, G.C. and Sharman, N. (1997) Microbiology: A laboratory Manual, 4thEdition, The Benjamin/ Cummings Publishing Company, International USA.

5. Patrick R. Murray, Ken S. Rosenthal, Micheal A. Pfaller (2005) Medical Microbiology, 5th Edition, Elsevier/Mosby, Philadelphia.

6. Holt, J.S., Krieg, N.R., Sneath, P.H.A. and Williams, S.S.T. (1994) Bergey's Manual of Determinative Bacteriology, 9thEdn. Williams & Wilkins, Baltimore.

7. Finegold, S.M. (2000) Diagnostic Microbiology, 10th Edition, C.V. MosbyCompany,St. Louis.

Journals:

1. Neuroscience: https://www.sciencedirect.com/topics/neuroscience/dna-viruses
2. Microbiology:https://www.sciencedirect.com/topics/immunology-and-microbiology/rna-viruses

Web Resources:

1. https://viralzone.expasy.org/656
2. https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology.
3. https://courses.lumenlearning.com/microbiology/chapter/staining-microscopic specimens/
4. https://www.cdc.gov/infectioncontrol/guidelines/disinfection/sterilization/index.html
5. https://www.britannica.com/science/bacteria/Growth-of-bacterial-populations

ELECTIVE-3-THEORY: BIOINFORMATICS AND BIOSTATISTICS

COURSE OUTCOME

CO-1. Effectively use internet in biological database searching, sequence analysis and similarity searching.

CO-2. Learn about PCR, primer synthesis, DNA sequencing methods, analyse gene libraries for whole genome analysis, Next generation sequencing and concepts of QSAR

CO-3. Apply statistical methods, graphical representations, probability theory and distributions for presenting biological data.

CO-4. Expertise in correlation, regression, chi-test, F- test and T-test.

CO-5. Learn the various sampling methods and ANOVA.

UNIT I

Overview of bioinformatics - database types. Genomics and human genome project. Computational tools for sequence analysis and similarity searching. Pair wise and multiple sequence alignment.

UNIT II

DNA Primer synthesis. Polymerase chain reaction. Sequencing – Maxam gilbert method, Sanger method. Next generation sequencing, Whole genome sequencing, DNA micro array. QSAR studies**.**

UNIT III

Nature and scope of statistical methods and their limitations, classification, tabulation and applications of life science. Measures of averages, dispersion.

UNIT: IV

Correlation and regression- Sampling distribution- Test of significance based on t-test, chi-square and F-test for mean and variance.

UNIT: V

Sampling methods- simple, random, stratified, systematic and cluster sampling procedures. Sampling and non-sampling errors- Analysis of variances- one way and twoway classifications.

MAPPING OF CO WITH PSO

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	M	L	L	L	S	S	L
CO 2	M	L	L	L	M	S	L
CO 3	L	L	L	L	L	S	L
CO 4	L	L	L	L	L	S	L
CO 5	L	L	L	L	L	S	L

***S- Strong; M-Medium; L-Low**

Reference books:

1. Wayne W. Daniel, Biostatistics : A foundation for Analysis in the Health Sciences, 8th Edition, Wiley, 2004.

2. Prem S. Mann, Introductory Statistics, 6th Edition, Wiley, 2006.

3. John A. Rice, Mathematical Statistics and Data Analysis, 3rd Edition, John A. Rice, Duxbury Press, 2006.

4. Campbell and Heyer, Discovering Genomics, Proteomics, & Bioinformatics, 2nd Edition, Benjamin Cummings, 2002.

5. Cynthia Gibas and Per Jambeck, Developing Bioinformatics Computer Skill, 1st Edition, O'Reilly Publication, 2001.

6. S.C. Rastogi, Namita Mendiratta, 2013. Bioinformatics – methods and Applilcations.4th edition, PHI learning Private Ltd.,

7. P. S. S. Sundar Rao, J. Richard. 2012. Introduction to biostatistics and research methods. PHI Learning Pvt. Ltd.,

8. Irfan A. Khan, Khan Irfan A. 1994. Fundamentals of Biostatistics. Ukaaz publishers.

Journals:

Statistical Methods in Medical Research: https://journals.sagepub.com/home/smm

Biostatistics: https://academic.oup.com/biostatistics

Statistical Applications In Genetics And Molecular Biology: https://www.degruyter.com/view/ j/sagmb?lang=en

Web Resources:

https://www.easybiologyclass.com/biostatistics-free-lecture-notes-online-tutorials-ppts-and-mcqs/

http://www.biologydiscussion.com/biostatistics-2/statistics-definition-characteristics-and-classes-biostatistics/47440.

http://sphweb.bumc.bu.edu/otlt/MPHModules/BS/BS704_BiostatisticsBasics/BS704_BiostatisticsBasics_print.html

ELECTIVE-4-THEORY: INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY

COURSE OUTCOME

CO-1. Gains knowledge on isolation, preservation of industrially important microbes, media formulation, preparation strategies and types of fermentation.

CO-2. Acquire knowledge on fermentor and production of therapeutic and diagnostic products.

CO-3. Understand the biology of industrially important microbes. Learn the modern fermentation techniques for production of biofuels, biochips and seaweed cultivation.

CO-4. Provides knowledge on the production of commercial primary metabolites.

CO-5. Enable to know the production of secondary metabolite and new products of commercial value. Get an idea on good manufacturing and good laboratory practice.

UNIT I

Isolation, preservation and improvement of industrially important microorganisms. Raw materials and media design for Fermentation processes. Sterilization. Development of inoculums for industrial fermentations. Types of fermentation-Batch, continuous, dual or multiple, surface, submerged, aerobic and anaerobic.

UNIT II

Fermenter – Design and types. Instrumentation and control - aeration and agitation. Recovery and purification of fermentation products. Enzyme and cell immobilization. Production of recombinant proteins having therapeutic and diagnostic applications - Vaccines, Insulin, Interferon, Somatotropin, Single cell protein.

UNIT III

Biology of industrial microorganisms - Streptomyces, Yeasts (Saccharomyes, Hansenela) Spirulina and Penicillium. Mushroom cultivation. Biosensors and Biochips.

UNIT IV

Production of primary metabolites - Alcohols (Ethanol and Butanol), Beverages (Beer and Wine), Aminoacids (Glutamic acid and Lysine), Organic acids (Citric acid and acetic acid), enzymes (Protease, amylase and lipase)

UNIT V

Production of secondary metabolites - Antibiotics (Penicillin and Streptomycin); Vitamins (Riboflavin and Cyanocobalamin), Steroids.; Biopolymers (Xanthan gum and PHB); Bio preservatives (Nisin), Good manufacturing and good laboratory practices.

MAPPING OF CO WITH PSO

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	S	L	M	S	L	L	L
CO 2	L	L	M	S	S	M	M
CO 3	M	L	M	S	M	S	L
CO 4	L	L	M	M	M	M	M
CO 5	L	L	M	M	M	M	M

***S- Strong; M-Medium; L-Low**

Reference book:

1. Casida, L.E.J.R. Industrial Microbiology. 2016. Second Edition. New Age International (P) Ltd., Publishers. New Delhi, India.
2. Crueger, W. and Crueger, A. 2000. Biotechnology: A Test Book of Industrial Microbiology, Second Edition, Panima Publishing corporation, New Delhi.
3. Flickinger, M.C. and Drew, S.W. 1999. Encyclopaedia of Bioprocess Technology Fermentation, Biocatalysis and Bioseperation Vil. V., John Wiley and Sons Publications.
4. Joe, M.M.. P K Sivakumar & K. Sukesh. An Introduction to Industrial Microbiology. S. Chand Publishing 2010.
5. Kalaichelvan, P.T. and Arul Pandi, I. 2007. Bioprocess Technology, MJP publishers, Chennai.
6. Patel A.H. Industrial Microbiology. Edition: Second, 2016. Laxmi Publications (P) Ltd. New Delhi, India
7. Peppler, H.., and Pearman, D. 1979. Microbial Technology, Vol.I, Academic Press, New York.
8. Prescott, L.M., Harley, J.P. and Helin, D.A. 2008. Microbiology, Fifth Edition, McGraw Hill, New Delhi.
9. Stanbury, P.F, Whitaker, A. and Hall, S.J. 1995 (Reprint 1999). Principles of Fermentation Technology, Second Edition, Aditya Book (P) Ltd., New Delhi.
10. Waites, M.J., Morgan, N.L., Rockey, J.S. and Higton, G. 2001. Industrial Microbiology: An Introduction, Blackwell Science, London.

Journals:

1. **Journal of Pharmaceutical Microbiology:** http://pharmaceutical-microbiology.imedpub.com/
2. **Pharmaceutical Microbiology:** http://www.imedpub.com/scholarly/pharmaceutical-microbiology-journals-articles-ppts-list.php

3. **Industrial Microbiology:** https://www.nature.com/subjects/industrial-microbiology

Web Resources:

1. https://www.sciencedaily.com/
2. https://www.biozone.co.nz/
3. https://ib.bioninja.com.au/options/untitled/b1-microbiology-organisms/fermenters.html
4. https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/penicillin.html

THIRD SEMESTER

HARD CORE 5-THEORY: MICROBIAL GENETICS

COURSE OUTCOME

CO-1. Discuss the significance of principles of genetics and genetic material

CO-2. Know about the organization genetic material and gene regulations.

CO-3. To learn on the types, properties of plasmids widely used in gene cloning and methods of gene transfer.

CO-4. Analyse the impact of mutation, repair mechanism and detection of mutation.

CO-5. Get insight knowledge on genetic recombination, transposons and gene mapping in bacteria, yeast and viruses.

UNIT I

Introduction to genetics: Mendelian principles – dominance, segregation, independent assortment, extension of mendelian principles – codominance, incomplete dominance. Historical perspectives of microbial genetics. Nucleic acid as genetic information carriers: experimental evidence.

UNIT II

DNA – types, structure and properties topology, super helicity, linking number. Organization of genes and chromosomes, Operon – Positive regulation. Structure of chromatin and chromosomes - unique and repetitive DNA, heterochromatin, euchromatin.

UNIT III

Plasmids. types and properties. Structure of Col E1, F1 and Ti plasmids. Plasmid amplification. Gene transfer mechanisms: Transformation, conjugation and transduction.

UNIT IV

Mutation and Mutagenesis – mechanisms, biochemical basis, mutagens. Molecular basis of spontaneous and induced mutations. Reversion and suppression. Environmental Mutagenesis and toxicity testing; Carcinogenecity - chemical carcinogenesis and their testing. Isolation of Mutants. Mismatch amplification mutation assay (MAMA- PCR).

UNIT V

Molecular recombination - Mechanism, control and models. Transposons. Transposition; regulatory sequences and transacting factors. Genetic mapping in *E. coli* and Yeast. Genetic systems of yeast and Neurospora. Genetics Mapping in M13 and lambda phage.

MAPPING OF CO WITH PSO

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	M	L	L	L	S	M	L
CO 2	L	L	L	L	S	M	L
CO 3	L	L	L	L	S	M	L
CO 4	L	L	M	L	S	L	M
CO 5	M	L	L	M	S	S	M

***S- Strong; M-Medium; L-Low**

Reference books:

1. Benjamin Lewin, 2000. Genes VIII, Oxford University Press, New York.
2. David Freifelder. D. 2008. Microbial Genetics, Eighteenth Edition, Narosa Publishing House, New Delhi.
3. Freifelder, D. 2000. Molecular Biology, Second Edition, Narosa Publishing house. New Delhi.
4. Jeyanthi, G.P. 2009. Molecular Biology, MJP Publishers, Chennai.
5. Kornberg, A. and Baker, A. 1992. DNA Replication, Second Edition, W.H. Freeman & Company, New York.
6. Lewin B. 2000. Gene VII, Oxford University Press Oxford.
7. Singer, M. and Paul Berg, 1991. Genes & Genomes, University Science Books, California.
8. Stanley R. Maloy, John E.C. and Freifelder, D. 2008. Microbial Genetics, Narosa Publishing House, New Delhi.
9. Stryer, L. 2010. Biochemistry, Seventh Edition, W.H. Freeman and Company, New York.
10. Turner, P.E., McLennan, A.G., Bates, A.D. and White, M.R.H. 1999. Instant Notes in Molecular Biology, Viva Books Ltd., New Delhi.

Journals:

1. Journal of Molecular Biology: https://www.journals.elsevier.com/journal-of-molecular-biology
2. Molecular and Cell Biology: https://mcb.asm.org/

3. Microbiology and Molecular Biology Reviews: https://mmbr.asm.org/

Web Resources:

1. https://www.easybiologyclass.com/molecular-biology-online-tutorials-lecture-notes-study-materials/
2. https://www.shomusbiology.com/molecular-biology1.html
3. https://www.onlinebiologynotes.com/

HARD CORE 6- THEORY: GENETIC ENGINEERING

COURSE OUTCOME

CO-1. Provides knowledge on the various enzymes used in genetic engineering.

CO-2. Deals with the vectors used in genetic engineering.

CO-3. Enable to gain sound knowledge on the gene cloning using various microbes and gene transfer methods.

CO-4. Acquire knowledge on analysis of recombinant DNA using PCR and blotting techniques.

CO-5. Learn the techniques of protoplast fusion, DNA finger printing techniques and discuss the application of Genetic Engineering in the field of Agriculture and medicine towards scientific research**.**

UNIT I

Principles and methods in genetic engineering: Host cell restriction - restriction modification. Restriction enzymes - types and applications, restriction mapping; Enzymes used in genetic engineering - Nucleases, Ribonucleases, DNA ligases, Taq DNA Polymerases, Methylases, Topoisomerases, Gyrases and Reverse transcriptase.

UNIT II

Vectors - Plasmid vectors: pSC101, pBR322, pUC series and Ti plasmid based vectors. Bacteriophage vectors: Lambda phage based vectors and M13 based

vectors. Phagemids, Cosmids. Viral vectors: Vaccinia, Retroviral, SV40 and Baculoviral system; Bacterial and yeast artificial chromosomes.

UNIT III

Cloning techniques. Genomic DNA and cDNA library Construction. Screening methods. Cloning in *E. coli*, *Bacillus*, *Pseudomonas*, *Streptomyces* and yeast. Reporter genes. Methods of gene transfer - transformation, transfection; electroporation, microinjection and biolistics.

UNIT IV

Analysis of Recombinant DNA. Polymerase chain reaction. Principles and techniques of nucleic acid hybridization and cot curves - Southern, Northern, Western, South-Western, Dot and Slot blotting.

UNIT V

Protoplast fusion. DNA finger printing - RFLP, RAPD and AFLP techniques. Pulsed field gel electrophoresis (PFLG) and Multilocus sequence typing (MLST). Applications of genetic engineering in agriculture, health and industry.

MAPPING OF CO WITH PSO

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	L	M	L	M	S	M	L
CO 2	M	L	L	M	S	M	L
CO 3	M	L	M	M	S	S	M
CO 4	M	M	L	L	S	S	L
CO 5	M	M	L	L	S	S	S

S- Strong; M-Medium; L-Low

Reference Books:

1. Brown, T.A. 2000. Gene Cloning, Fourth Edition, Chapman and Hall Publication, USA.
2. Glick, B.K. and Pasternak, J.J. 2002. Molecular Biotechnology Principles and Applications of Recombinat DNA, ASM Press, Washington**.**
3. Hammong, J., Mc Garvey, P. and Springer, V.Y. 2000. Plant Biotechnology.
4. Lewin B. 2000. Genes VII, Oxford University Press, Oxford, UK.
5. Primrose, S.B. and Twyman, R.M. 2009. Principles of Gene manipulation and Genomics, Seventh Edition, Blackwell publishing, UK.
6. Stryer, L. 2010. Biochemistry, Seventh Edition, W.H. Freeman and Company, New York.
7. Susan, R.B. 2008. Biotechnology, Cengage Learning Pvt. Ltd., New Delhi.
8. Thieman, W.J. and Palladino, M.A. 2009. Introduction to Biotechnology, Dorling Kindersley India Pvt. Ltd., Noida.
9. Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz , J.A. and Weiner, A. M. 1998. Molecular Biology of the Gene, Fourth Edition, The Benjamin Cummings Publishing Company Inc., Tokyo.
10. Young, M.M. 1992. Plant Biotechnology, Pergmen Press, Oxford London.

Journals:

1. Microbial Genetics And Genomics: https://www.mdpi.com/journal/genes/sections/MGG

2. Microbial Genetics – Plos One: https://journals.plos.org/plosone/browse/microbial_genetics
3. Journal of Genetic Engineering and Biotechnology: https://www.journals.elsevier.com/journal-of-genetic-engineering-and-biotechnology.

Web Resources:

1. https://www.genome.gov/about-genomics/teaching-tools/Genomics-Education-Websites
2. https://www.edx.org/learn/genetic-engineering
3. https://www.britannica.com/science/genetic-engineering https://www.kullabs.com/classes/subjects/units/lessons/notes/note-detail/8863

HARD CORE 7 – THEORY: MOLECULAR BIOLOGY

COURSE OUTCOME

CO-1. Gain complete knowledge on biomolecules, Nucleic acids

CO-2. Discuss the detail view on DNA replication, recombination, damage and repair mechanisms.

CO-3. Learn about RNA synthesis and processing and RNA transport.

CO-4. Understand the process of protein synthesis, inhibition factors and post translation modification of protein.

CO-5. Get an idea on control of gene expression at transcription, translation level and gene silencing.

UNIT I

Composition, structure and function of biomolecules (carbohydrates, lipids, proteins and nucleic acids). Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds). Conformation of nucleic acids (A-, B-, Z-, DNA). Stability of protein and nucleic acid structures.

UNIT II

DNA replication – Different enzyme and protein involved in initiation, elongation and termination - fidelity of replication - extra-chromosomal replications. DNA damage and repair mechanisms.

UNIT III

RNA synthesis and processing: Transcription factors and machinery, RNA polymerases - formation of initiation complex, elongation and termination. RNA processing - RNA editing. Post transcriptional modification. Transcription activators and repressors.

UNIT IV

Protein synthesis - formation of initiation complex, elongation and termination – machineries and their regulation - Genetic code- translational proof-reading- translation inhibitors - Post-translational modification of proteins.

UNIT V

Control of gene expression at transcription and translation level - Regulation of phages, viruses, prokaryotic and eukaryotic gene expression - Role of chromatin in regulating gene expression

MAPPING OF CO WITH PSO

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	M	M	L	L	S	M	L
CO 2	M	L	M	L	S	M	L
CO 3	M	L	M	L	S	M	L
CO 4	M	L	M	L	S	M	L
CO 5	M	M	M	M	S	M	L

S- Strong; M-Medium; L-Low

Reference Books:

1. Benjamin Lewin, 2000. Genes VIII, Oxford University Press, New York.

2. David Freifelder. D. 2008. Microbial Genetics, Eighteenth Edition, Narosa Publishing House, New Delhi.
3. Freifelder, D. 2000. Molecular Biology, Second Edition, Narosa Publishing house. New Delhi.
4. Jeyanthi, G.P. 2009. Molecular Biology, MJP Publishers, Chennai.
5. Kornberg, A. and Baker, A. 1992. DNA Replication, Second Edition, W.H. Freeman &Company, New York.
6. Lewin B. 2000. Gene VII, Oxford University Press Oxford.
7. Singer, M. and Paul Berg, 1991. Genes &Genomes, University Science Books, California.
8. Stanley R. Maloy, John E.C. and Freifelder, D.2008. Microbial Genetics, Narosa Publishing House, New Delhi.
9. Stryer, L. 2010. Biochemistry, Seventh Edition, W.H. Freeman and Company, New York.
10. Turner, P.E., McLennan, A.G., Bates, A.D. and White, M.R.H. 1999. Instant Notes in Molecular Biology, Viva Books Ltd., New Delhi.

Journals:

1. Journal of Molecular Biology: https://www.journals.elsevier.com/journal-of-molecular-biology
2. Molecular and Cell Biology: https://mcb.asm.org/
3. Microbiology and Molecular Biology Reviews: https://mmbr.asm.org/

Web Resources:

1. https://www.easybiologyclass.com/molecular-biology-online-tutorials-lecture-notes-study-materials/
2. https://www.shomusbiology.com/molecular-biology1.html
3. https://www.onlinebiologynotes.com/

ELECTIVE-5--THEORY – SOIL AND AGRICULTURAL MICROBIOLOGY

COURSE OUTCOME

CO-1. Understands about soil microorganisms, interactions between microbes, microbes and plants.

CO-2. Get insight knowledge on various biogeochemical cycles.

CO-3. Learn about biofertilizers, biopesticides and bioremediation of problem soils.

CO-4. Discuss about the symptoms, etiology and management of various plant diseases.

CO-5. Apply knowledge on plant disease management, sanitation methods and also about disease forecasting.

UNIT I

Characteristics and classification of soils; Soil Microorganisms; Interactions between microorganisms - Mutualism, commensalism, ammensalism, synergism, parasitism, predation, competition. Interaction of microbes with plants - Rhizosphere, Root exudates and Rhizosphere effect. Phyllo sphere and mycorrhizae.

UNIT II

Symbiotic and asymbiotic Nitrogen fixation – mechanism and genetics of Nitrogen Fixation. Biogeochemical cycles - carbon, nitrogen, phosphorus, sulfur. Microbial transformation of minor nutrients. Decomposition of organic matter. Formation of fulvic acid and humic acids.

UNIT III

Biofertilizers - Rhizobium, Azotobacter, Azospirillum, VAM, Phosphobacteria, Azolla and Cyanobacteria. Role of bio-fertilizers in agriculture and forestry. Enzymes of microbial origin and their role in release of available plant nutrients. Biopesticides. Bioremediation of problem soils.

UNIT IV

Plant pathogens and classification of plant diseases. Principles of plant infection - entry of pathogen in to host, colonization of host, role of enzymes, toxins and growth regulatory substances. Defense mechanisms in plants. Symptoms, Etiology, Epidemiology and management of the following plant diseases – Tobbaco mosaic

disease, Bunchy top of banana, Bacterial blight of paddy; Angular leaf spot of cotton, Downy mildew of bajra, Head smut of sorghum, Leaf rust of coffee, Blight of maize/sorghum, Leaf spot of paddy, Grassy shoot of sugar cane, Leaf roll of potato, Late blight of potato.

UNIT V

Plant disease management – exclusion, evasion, eradication, crop rotation. Sanitation - physical, chemical and biological control. Plant disease forecasting. Biotechnological approaches to disease management.

MAPPING OF CO WITH PSO

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	S	M	S	M	L	L	L
CO 2	S	M	S	L	L	L	M
CO 3	S	M	S	M	L	L	M
CO 4	M	S	S	M	M	L	L
CO 5	M	M	M	L	M	M	L

***S- Strong; M-Medium; L-Low**

Reference books:

1. Goyal, M.R. (2018) Sustainable Biological System for Agriculture, APP Apple Academic Press, ISBN: 978-1-77188-614-7.
2. Borkar, S.G. (2015) Microbes as Bio-fertilizers and their Production Technology (Woodhead Publishing India in Agriculture), WPI Publishing, ISBN:
   9380308574.
3. Shagufta (2012) Biofertilizer Technology, 1st Edition, Published at Delhi.
4. Trivedi, P.C. (2008) Biofertilizers, Neha Publishers & Distributors. ISBN 8171325424

5. Burns, R.C. and Hardy, R.W.F. (1975) Nitrogen fixation in bacteria and higher plants, Springer - Verlag, Bertin.
6. VarmaAjit (1998) Mycorrhiza Manual, Springer Publications.
7. Mark Coyne (1999) Introduction to Soil Microbiology (Laboratory Manual), 99th Edition, Delmar Publications.
8. Subba Rao, N.S. (1995) Soil Microorganisms and plant growth, Oxford and IBH, New york.
9. Tilak, K.V.B.R. (1990) Bacterial Biofertilizers, IARI Publications, New Delhi.
10. Tirdale, Nelson, S.L., Werver, L. and Becton, J.D. (1985) Soil fertility and fertilizers, Macmillan Publishing Co., New York.
11. Totawat, K.L., Somani, L.L., Sharma, R.A. and Maloo, S.R. (2004)Biofertilizer
Technology, Agrotech Publishing Academy. Udaipur, Rajasthan.
12. Subba Rao, N.S. (1995) Biofertilizer in agriculture and forestry, Oxford and IBH, New york.

Journals:

13. Soil Microbiology: https://www.nature.com/subjects/soil-microbiology
14. European Journal of Soil Biology: https://www.journals.elsevier.com/european-journal-of-soil-biology
15. Agricultural and Biological Sciences Journals: https://www.elsevier.com/life-sciences/agricultural-and-biological-sciences/journals

Web Resources:

1. www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635.
2. https://microbiologyinfo.com/top-and-best-microbiology-books/

3. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/biogeochemical-cycle
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3588038/
5. www.microbiologyonline.org.uk.

HARD CORE 3- PRACTICAL: MICROBIAL GENETICS, MOLECULAR BIOLOGY AND GENETIC ENGINEERING

COURSE OUTCOME

CO-1. Learn the techniques for isolation of plasmid and genomic DNA, estimation of DNA by chemical and U-V method.

CO-2. Know the techniques for isolation of RNA from yeast, estimation of RNA by chemical and U-V method and isolation of antibiotic resistant auxotrophic mutants.

CO-3. Get hands on training on protein estimation, determination molecular weight of protein, 2D-Gel electrophoresis, Isoelectric focusing, Separation of amino acids by TLC and paper chromatography.

CO-4. Gains experimental knowledge on separation of proteins using chromatography. Immobilization of enzymes and whole cells. Western blotting. Protoplast and spheroplast isolation. Induction of beta-galactosidase activity in E. coli using IPTG.

CO-5. Acquire knowledge on the lab skills for competent cell preparation, transformation, PCR, Native PAGE and Restriction analysis.

UNIT I

Isolation of genomic DNA from bacteria and demonstration in agarose gel electrophoresis. Isolation of plasmid DNA by alkali lysis method. Estimation of DNA by diphenyl amine method. Determination of Tm value of DNA. Quantitation of nucleic acids by UV Spectrophotometer.

UNIT II

Isolation of RNA from yeast. Estimation of RNA by orcinol method. Induced mutagenesis - Isolation of antibiotic resistant auxotrophic mutants.

UNIT III

Estimation of proteins by Lowery et al method. SDS-PAGE. 2D-Gel electrophoresis. Isoelectric focussing. Separation of amino acids by TLC and paper chromatography.

UNIT IV

Separation of proteins using Gel filtration and Ion exchange chromatography. Immobilization of enzymes and whole cells. Western blotting. Protoplast and spheroplast isolation. Induction of beta-galactosidase activity in *E. coli* using IPTG.

UNIT V

Preparation of competent cells. Transformation and Blue-White selection for transformants. DNA amplification by PCR. Separation of PCR amplified product on PAGE and determination of product size. Restriction mapping / Restriction analysis.

MAPPING OF CO WITH PSO

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	M	L	M	M	S	M	L
CO 2	M	L	M	L	S	M	L
CO 3	M	L	M	L	S	M	L
CO 4	M	L	M	L	S	M	L
CO 5	M	L	M	L	S	M	L

S- Strong; M-Medium; L-Low

Reference books:

1. Ausubel, F.M., Roger, B., Robert E. Kingston, David A. Moore, Seidman J.G., John A. Smith. and Kelvin, S. 1992. Third Edition, Short Protocols in Molecular Biology, Jolm Wiley &Sons Inc., New York.
2. Berger, S.L. and Kimmel, R. 1987. Guide to Molecular Cloning Techniques, Academic Press, Inc., New York.
3. Brown, T.A. 1998. Molecular Biology Lab Fax 11 Gene Analysis, Academic Press, London. 5. Cappuccino, J.H. and Sherman, N 2007. Microbiology – A Lab Manual, seventh Edition, The Benjamin Publishing Company, Singapore.
4. Malov, S.R. 1990. Experimental Techniques in Bacterial Genetics, Jones and Bartlett Publishers, Boston.
5. Miller, J.H. 1992. A Short Course in Bacterial Genetics: A Lab Manual &Hand Book for *E. coli* and related Bacteria. Cold spring Harbor Lab press, Cold Spring Harbour.
6. Rajamanickam, C. Experimental protocols in basic molecular biology, Osho Scientific Publications, Madurai.
7. Sambrook, I., Fritsch, E.F. and Maniatis, T. 1989. Second Edition, Molecular Cloning 1, 2, 3 - A Laboratory Manual, Cold Spring Laboratory Press, USA.

Journals:

1. Journal of Molecular Biology: https://www.journals.elsevier.com/journal-of-molecular-biology
2. Molecular and Cell Biology: https://mcb.asm.org/
3. Microbiology and Molecular Biology Reviews: https://mmbr.asm.org/

Web Resources:

1. https://www.easybiologyclass.com/molecular-biology-online-tutorials-lecture-notes-study-materials/
2. https://www.shomusbiology.com/molecular-biology1.html
3. https://www.onlinebiologynotes.com/

EXTRA DISCIPLINARY (ELECTIVE) –THEORY: MARKETABLE MICROBIAL PRODUCTS

COURSE OUTCOME

1. Acquire the knowledge about Spirullina and its cultivation
2. Gain in depth knowledge about edible mushroom and its cultivation
3. Acquire a thorough understanding of the importance of probiotics in human health and their production on a large scale
4. Get an awareness of the availability of natural pigment and its application, Bio fertilizers and their application
5. Imbibe knowledge on the various marketing strategy

UNIT- I

Morphology and structure of *Spirullina maxima* and *Spirullina platensis*. Biochemical composition, phycobiliprotein, beta carotene and UV Protecting pigments. Methods of cultivation - Freshwater, marine and hyper saline – photobioreactors, plate method, tubular, annular and plate airlift. Tank construction, Race way pond – open and closed - construction, Scale-up cultivation. Contaminants identification and processing.Harvesting, drying and packaging.Uses & Application of Spirulina.

UNIT-II

Mushroom fungi – *Agaricus sp*., *Calocybe sp*., *Pleurotus sp*., and *Volvariella sp*., biochemical composition, nutrient value, compounds and flavanoids. Cultivation – Tropical and temperate types, growth media preparation - compost, waste recycling, isolation, spawn production; spawn running, harvesting and packing. Construction Page 66 of 75 cultivation shed - Small scale and large scale production setup. Diseases and control measures. Medicinal properties

UNIT-III

Introduction probiotics, mechanism of probiotics, Probiotic microorganism- Bacteria and Yeast Structure and cultural characteristics of Lactobacillus sp., Saccharomyces sp. Nutritional sources, yeast propagation. Cultivation and fermentation techniques: Raw materials, Fermentor design, construction, production, microbial growth requirements, quality testing, stability during storage, packing. Commercial Probiotic dairy products, Health benefits.Safety of probiotics in legal status.

UNIT-IV

Microbial pigments – allophycocyanin, phycocyanin, phycoerythrin, chlorophyll (Bacterial and cyanobacterial), Pigment proteins applications – medical, industrial and textile, extraction methods. biological nutrient management – organic manures, Biofertilizers – soil improvement, structure and cultural characteristics of *Rhizobium sp.*, *Azotobacter sp.*, *Azospirillumsp.*, *Nostoc sp*. Cultivation – raw material, fermentor design, mass production, harvesting, macro quality analysis, grading, Packaging and post harvest management.

UNIT-V

Bioentrepreneurship: Taking decision on starting a venture; Assessment of feasibility of a given venture/new venture; Assessment of market demand for potential product(s) of interest; Market conditions, segments; Prediction of market changes; Identifying needs of customers including gaps in the market, packaging the product; Market linkages, branding issues; Developing distribution channels; Pricing/Policies/Competition; Promotion/ Advertising; Services Marketing. Approach a bank for a loan; Sources of financial assistance; Making a business proposal/Plan for seeking loans.

MAPPING OF CO WITH PSO

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	M	L	M	M	S	M	L
CO 2	M	L	M	L	S	M	L
CO 3	M	L	M	L	S	M	L
CO 4	M	L	M	L	S	M	L
CO 5	M	L	M	L	S	M	L

S- Strong; M-Medium; L-Low

References:

1. Trivedi P.C. 2001. Algal biotechnology.

2. Dubey, R.C. 2018. Text book of Biotechnology. S.Chand& company Ltd., New Delhi.

3. Whitton, B. A. and potts, M. (2000). The ecology of cyanobacteria: their diversity in time and space. Kluwer Academic publisher, Dordrecht. Page 67 of 75

4. Fritsch, F.E. (1935) The Structure and Reproduction of the Algae ; Volume 1, First Edition . Cambridge University Press

5. Fritsch F. E. (1952) The Structure and Reproduction of the Algae ; Volume 2, First Edition. Cambridge University Press.

6. Desikachary, T. V. (1959) Cyanophyta. Indian council Agricultural Research, New Delhi. Pp686.

7. Boergeson,F.(1938). Contributions to the South Indian marine algal flora.III. J. Indian Bot.Soc.17:205 -242.

8. Khattar, J.I.S., Singh, D.P., Kaur, (2009) Algal Biology and Biotechnology, - Microalgae: A source of natural colours, Edition: 1, I. K. International Publishing House Pvt. Ltd. New Delhi,

9. Antonia Herrero and Enrique Flores(2008) The Cyanobacteria: Molecular biology, genomics and Evolution, Caister Academic Press, Spain.

10. Leela, S.S and Jyothi Kumar,2010. Algal BioProcessTechology, 1st Edition, New age International Publishing house, New Delhi.

11. Laura Barsanti, Paolo Gualtieri. 2014 Algae: Anatomy, Biochemistry, and Biotechnology, Second Edition. CRC Press.London.

12. Venkatataman, G.S.91962). Algal Biofertilizer and Rice cultivation, 8th Edition, Today and Tomorrow Publishers, New Delhi.

13. Lee Y K, Salminen S 2009. Handbook of Probiotics and Prebiotics . A John Willey and Sons Inc. Publication

14. Salminen. S and Wright , A. V. 1998. Lactic Acid Bacteria, Marcel Dekker

15. Glenn R. G. Marcel R. 2008. Handbook of Prebiotics CRC press

16. Sandholm T. M. Saarela M. 2003. Functional Dairy Products CRC Woodhead Publishing Ltd

17. Probiotics in Foods and Beverages—Strategic Assessment of the Indian Market. Frost & Sullivan (2009).

18. Hand book of Organic Farming and Biofertilizers - A.C.Gaur

19. Organic Farming : Theory and Practice - S.P.Palaniappan and K.Aannadurai

20. Hand Book Of Biofertilizers&Vermiculture, Engineers India Research Inc., Jan (2007)-332 pages Page 68 of 75

21. Atlas, R. M and Bartha, R (1998) Microbial Ecology – Fundamentals and Applications, Addison, Wesly Longman Inc.

22. Vessey, 2003. Plant growth-promoting Rhizobacteria as biofertilizers. Plant and Soil, 255: 571-586.

23. Dubey, R.C. and Maheshwari, D.K., 1999. Text book of Microbiology. S. Chand &Cmpany Limited.

24. Desikachary TV, Sundaralingam VS. Affinities and interrelationships of the Characeae. Phycologia. 1962 May 1;2(1):9-16.

25. Venkataraman, G.S., 1981. Blue-green algae for rice production: a manual for its promotion (No. 46). Food & Agriculture Org.

26. NitalBahl, 2002. Handbook on mushroom 4 thedn. Vijay primlani for oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

27. Hand book of mushroom cultivation, 1999. TNAU publications.

28. Chang T. S. and Hayes W. A., 1978. The Biology and cultivation of Edible Mushrooms. Academic press, Newyork.

29. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
30. Neeraj, P., &Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
31. International Encyclopaedia of Laws: Intellectual Property (Kluwer Law International, 1997) (looseleaf). I,MON K 1401 .I5828 (1997) vols. 1-5.
32. V.K.Ahuja, Law relating to Intellectual Property rights, 2nd Edition, (2013) LexisNexis.
33. Arora, Manish, Guide to Trademarks, (2007) 2nd ed., Delhi, Universal Publications

Web Resources:

1.https://www.agrifarming.in/growing-spirulina
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6463069/
3 .https://www.wincloveprobiotics.com/quality/production-process
4. https://www.frontiersin.org/articles/10.3389/fnut.2019.00007/full

FOURTH SEMESTER

HARD CORE 8-THEORY - FOOD, DAIRY AND ENVIRONMENTAL MICROBIOLOGY

COURSE OUTCOME

CO-1. Discuss on the factors influencing microbial growth, food spoilage causing microorganisms and food preservation techniques.

CO-2. Learn about dairy products, fermented food, milk borne diseases and food sanitation.

CO-3. Get insight knowledge on air microorganisms, air borne diseases and air sanitation methods.

CO-4. Discuss about the methods involved in solid and liquid waste management.

CO-5. Provide knowledge on the ability of microorganisms mitigate environmental pollution.

UNIT I

Food Microbiology: Occurrence of microorganisms in food - Factors influencing microbial growth - extrinsic and intrinsic. Principles and methods of food preservation - high Temperature, low Temperature, drying, irradiation and chemical preservatives. Food borne diseases - Bacteria, Fungi, Viruses, Algae and Protozoa. Spoilage of fruits, vegetables, meat, poultry, fish and sea foods.

UNIT II

Dairy Microbiology: Microflora of milk - sources of contamination. Spoilage and preservation of milk and milk products. Fermented foods - Sauerkraut, Pickles, Buttermilk, Yogurt and Cheese. Probiotics and Prebiotics. Milk borne diseases. Food sanitation - food control agencies and their regulations.

UNIT III

Microbiology of air: Occurrence - number and kinds of microbes in air. Distribution and sources of air borne organisms - aerosol and droplet nuclei. Assessment of air quality -Air Sanitation - Airborne diseases. Microbiology of water: Aquatic habitats - their microflora and fauna - lake, ponds, river, estuary and sea. Biology and ecology of reservoirs and influence of environmental factors on the aquatic biota.

UNIT IV

Environmental Microbiology: Waste treatment - Wastes – types and characterization. Treatment of solid wastes - composting, vermiform composting, silage, pyrolysis and saccharifications. Bio-gas. Treatment of liquid wastes - primary, secondary - trickling, activated sludge and oxidation pond - tertiary - disinfection.

UNIT V

Bioremediation, Degradation of Xenobiotic compounds: Simple aromatics, chlorinated polyaromatic petroleum products, pesticides and surfactants.

Biodeterioration of materials - paper, leather, wood, textiles and paint. Metal corrosion - Bioaccumulation of heavy metals. Biofouling and Bioleaching.

MAPPING OF CO WITH PSO

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	M	M	S	M	M	M	M
CO 2	M	L	S	S	M	M	M
CO 3	M	L	S	L	L	L	M
CO 4	M	L	S	M	L	L	M
CO 5	M	L	S	M	M	L	M

***S- Strong; M-Medium; L-Low**

Reference books

1. Adams, M.R. and Moss, M.O. 2008. Food Microbiology, RSC Publishing, Cambridge, UK.

2. Benwart, G.J. 1987. Basic Food Microbiology, CBS Publishers & Distributors, New Delhi.

3. Blackburn C. de W. 2006, Food spoilage microorganisms, Woodhead Publishing, Cambridge, UK

4. Deak, T. and Beuchat, L.R. 1996. Hand Book of Food Spoilage yeasts, CRC

5. Frazier, W.C., and Westhoff, D.C. 1988. Food Microbiology (Reprint 1995), Tata McGraw Hill Publishing Ltd., New Delhi.

6. Garbutt, J. 1997. Essentials of Food Microbiology, Arnold – International Students edition, London. 7. Jay J.M. 2000. Modern Food Microbiology. 6th Edition. 2000. Chapman & Hall, New York.

8. Prescott, L.M., Harley, J.P. and Helin, D.A. 2008. Microbiology, Fifth Edition, McGraw Hill, New York.

9. Ray. B. 2000. Fundamental Food Microbiology. 2nd Edition. CRC Press. New York. USA.Press, New York.

10. Robinson R.K. (ed.). 2002. Dairy microbiology handbook, 3 rd edn., Wiley Interscience.

11. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.

Journals:

1. Food Microbiology: https://www.journals.elsevier.com/food-microbiology
2. BMC Microbiology: https://bmcmicrobiol.biomedcentral.com/
3. Applied and Environmental Microbiology: https://aem.asm.org/
4. Frontiers in Microbiology: https://www.frontiersin.org/journals/microbiology

Web Resources:

1. http://milkfacts.info/Milk%20Microbiology/Milk%20Microbiology%20Page.htm
2. https://www.microbes.info/resources/3/environmental-microbiology
3. https://www.edx.org/learn/microbiology

ELECTIVE 6 – THEORY: RESEARCH METHODOLOGY AND BIOINSTRUMENTATION

COURSE OUTCOME

CO-1. Understand the objective of research and study various methodologies on research process.

CO-2. Learn about the importance, components and framing research report.

CO-3. Know about various molecular biological methods applied in the study of gene mutation and gene expression and analysis of bimolecular compounds.

CO-4. Understand the components, mechanism and application of histochemical and immunotechniques.

CO-5. Know the components, principle and application of microscopic and radiolabeling techniques.

UNIT I

Research Methodology – Meaning, objectives and types of research. Research approaches - research Process. Defining the research problem - research design. Sampling – types and design. Data collection - methods - processing and analysis of data. SPSS and other statistical packages**,** Response surface methodology, Testing of Hypothesis. Fundamentals of Bioethics.

UNIT II

Writing the Research Report (Thesis and publications): Components of research report - Title, Authors, Addresses, Abstract, Keywords, Introduction, Materials and Methods, Results, Discussion, Summary, Acknowledgements and Bibliography.

UNIT III

Molecular biology methods:*In vitro* mutagenesis and detection techniques. Gene knock out in bacterial and eukaryotic organisms. Methods for analysis of gene expression - RNA and protein level - micro arraybased techniques. Isolation, separation and analysis of protein, carbohydrate and lipid molecules.

UNIT IV

Detection of molecules in living cells - FISH and GISH. Biophysical methods: Analysis of biomolecules by Spectroscopy UV/visible. infrared, Energy Dispersive Spectroscopy, Inductively coupled plasma atomic emission spectroscopy, Atomic absorption spectroscopy, FTIR, NMR, S- X-ray diffraction, and surface plasma resonance methods.

UNIT V

Radiolabeling techniques: Radioisotopes used in biology – properties, detection and measurement. Molecular imaging of radioactive material and safety guidelines.

MAPPING OF CO WITH PSO

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	L	L	L	L	L	S	S
CO 2	L	L	L	L	L	S	S
CO 3	M	M	M	L	S	M	M
CO 4	M	M	M	M	S	M	L
CO 5	M	M	M	M	S	M	L

***S- Strong; M-Medium; L-Low**

Reference books:

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition

2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.

3. Research Methodology – C.R.Kothari

4. Willard, H.H., Merritt, L.L. Jr., Dean, J.A., and Settle, F.A. Jr. (1988). Instrumental methods of analysis, 7th edition. United States: N. p.

5. Sharma B.K. (2014) Instrumental Method of Chemical Analysis Krishna Prakashan Media (P) Ltd.

6. Chatwal G.R, Anand S.K. (2014) Instrumental Methods of Chemical Analysis. Himalaya Publishing House.

7. Wilson K, Goulding K.H (1991) A Biologist's Guide to Principles and Techniques of Practical Biochemistry, 3rd edition Cambridge University Press.

8. Pavia D.L. (2012) Spectroscopy, 4th edition Cengage.

9. Mitchell G.H. (2017) Gel Electrophoresis: Types, Applications & Research. Nova Science Publishers Inc.

10. Miller J.M. (2007) Chromatography: Concepts and Contrasts, 2nd edition, Wiley-Blackwell.

11. Holme D, Peck H (1998) Analytical Biochemistry 3rd edition, Prentice Hall.

HARD CORE 4- PRACTICAL: SOIL, AGRICULTURAL, FOOD AND ENVIRONMENTAL MICROBIOLOGY

COURSE OUTCOME

CO-1. Learn the different methods for isolation and enumeration of biologically significant soil and water microorganisms.

CO-2. Learn about mushroom cultivation, understand the causes, symptoms and management of plant diseases.

CO-3. Get skilled on the quality assurance of milk and microbiological assessment of food substances.

CO-4. Understand the mechanism and application of enzymes produced by soil microorganisms.

CO-5. Learn the methods applied in physicochemical and microbiological analysis of potable water.

UNIT I

Isolation and enumeration of soil microorganisms (fungi, bacteria and actinomycetes). Isolation of phosphate solubilizer from soil. Isolation of Nitrogen fixers - Rhizobium from root nodule and Azotobacter from rhizosphere. Screening of antagonistic bacteria in soil by agar overlay method. Isolation of Cyanobacteria and Photosynthetic bacteria from soil/water.

UNIT II

Estimation of foliar infection by Stoyer's method. Cultivation of oyster mushroom. Study of the following diseases: Tobacco mosaic; Bacterial blight of paddy; Downy mildew of bajra; Powdery mildow of cucurbits; Head smut of sorghum, Leaf rust of coffee; Leaf spot of mulberry, Red rot of sugarcane, Root knot of mulberry.

UNIT III

Detection of number of bacteria in milk by breed count. Determination of quality of milk sample - methylene blue reduction test and Resorzurin method. Detection of number of bacteria in milk - standard plant count. Isolation of yeast and molds from spoiled nuts, fruits, and vegetables. Bacteriological examination of specific foods – curd, raw meat, fish, Ice cream.

UNIT IV

Extracellular enzyme activities - phosphatase. Quantification of microorganisms in air-solid and liquid impingement techniques.

UNIT V

Physical, chemical and microbial assessment of water and potability test for water. Physical and chemical - colour, pH, alkalinity, acidity, COD, BOD, anions and cations. Microbiological - MPN index - presumptive, completed and confirmatory tests.

MAPPING OF CO WITH PSO

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	S	S	S	M	L	L	L
CO 2	S	M	S	M	L	L	L
CO 3	S	M	S	M	L	L	L
CO 4	S	M	S	M	L	L	L
CO 5	S	M	S	M	L	L	L

S- Strong; M-Medium; L-Low

Reference books

1. Cappuccimo, J. and Sherman, N (2002) Microbiology: A Laboratory manual, 6th edition. Pearson Education Publication. New Delhi.

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.
4. Mathur, N. and Singh, A. (2007) Industrial Microbiology: A Laboratory Manual, Pointer publishers.30
5. Arnold L. Demain, Julian E. Davies, Ronald M. Atlas, Gerald Cohen, Charles L. Hershberger, Wei-Shou Hu, David H. Sherman, Richard C. Willson and David Wu, J.H. (1999) Manual of Industrial Microbiology and Biotechnology, 2nd Edition.
6. Lorian, V. (1991) Antibiotics in Laboratory Medicine. Williams and Wilkins.
7. Sadasivam, S. and Manickam, A. (1996) Biochemical Methods. New Age International (P) Limited, Publishers.

Journals:

1. Medical Instrumentation: http://www.hoajonline.com/medicalinstrumentation
2. International Journal of Biological Instrumentation: https://www.vibgyorpublishers.org/journals/ International-Journal-of-Biological-Instrumentation.php

Web Resources:

1. http://www.biologydiscussion.com/biochemistry/centrifugation/centrifuge-introduction- types-uses-and-other-details-with-diagram/12489
2. https://www.watelectrical.com/biosensors-types-its-working-and-applications.
3. http://www.wikiscales.com/articles/electronic-analytical-balance/
4. https://study.com/academy/lesson/what-is-chromatography-definition-types-uses.html

HARD CORE - PROJECT AND VIVA VOCE

OBJECTIVE OF THE COURSE

To impart advanced practical knowledge in conducting a research project.

To plan and design statistically, retrieve relevant literature, organize and conduct, process the data, photograph relevant observations, evaluate by statistical programmes. Present the project in any regional/national conference/seminar during the Second year of the course and submit for final semester Examinations. The work has to be conducted in department under the guidance of the project supervisor. Interdisciplinary collaborations from external departments / institutions can be organized only for essential areas of the project. The method of valuation of project report submitted by the candidate is outlined as follows:

Internal	(2 out of 3 presentations)	-	20 Marks
Viva		-	20 Marks
Project Report		-	60 Marks

* All Practical Examinations will be conducted in even semester only.

ELECTIVE (OPTINAL) – THEORY: MICROBIAL BIONANOTECHNOLOGY

COURSE OUTCOME

CO 1 To understand the bases for Introduction to bionanotechnology

CO 2 To learn a broad foundational knowledge of molecular nanotechnology.

CO 3To acquires knowledge on the types, Characterization and function of nanoparticles.

CO 4 To impart understanding on Nanoparticle based Drug Delivery.

CO 5 To learn about the advantages and disadvantages of nanoparticles.

UNIT-I

History - bionanotechnology - concept and future prospects - application in Life Sciences. Terminologies - nanotechnology, bionanotechnology, nanomedicine, nanowires, quantum Dots, nanocomposite, nanoparticles.

UNIT- II

Molecular nanotechnology - nanomachines - collagen. Uses of nanoparticles - cancer therapy - manipulation of cell and biomolecules. Cytoskeleton and cell organelles. Types of nanoparticles production - physical, chemical and biological. Microbial synthesis of nanoparticles.

UNIT-III

Nanoparticles - types, functions - Silver, Gold and Titanium. Physical and chemical properties of nanoparticles. Characterization of nanoparticles - UV-Vis spectroscopy, Electron Microscopy - HRTEM, SEM, AFM, EDS, XRD.

UNIT-IV

Uses of nanopartcles in biology: Drug delivery - protein mediated and nanoparticle mediated. Uses of nanoparticles in MRI, DNA and Protein Microarrays. Nanotechnology in health sectors. Toxicology in nanoparticles - Dosimetry.

UNIT-V

Advantages of nanoparticles - drug targeting, protein detection, MRI, development of green chemistry - commercial viability of nanoparticles. Disadvantages - health risk associated with nanoparticles, inadequate knowledge on nanoparticles research.

MAPPING OF CO WITH PSO

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	S	S	S	M	L	L	L
CO 2	S	M	S	M	L	L	L
CO 3	S	M	S	M	L	L	L
CO 4	S	M	S	M	L	L	L
CO 5	S	M	S	M	L	L	L

S- Strong; M-Medium; L-Low

Text Books

1. Parthasarathy, B.K. (2007). Introduction to Nanotechnology, Isha Publication.
2. Pradeep T. (2017). A Textbook of Nanoscience and Nanotechnology, McGraw Hill Education.
3. Varghese T, Balakrishna K.M. (2012). Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials. Atlantic.
4. Elisabeth Papazoglou and Aravind Parthasarathy (2007). Bionanotechnology. Morgan & Claypool Publishers.

References Books:

1. Bernd Rehm (2006). Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures. Horizon Scientific Press.
2. David E. Reisner, Joseph D. Bronzino (2008). Bionanotechnology: Global Prospects. CRC Press.
3. Ehud Gazit (2006). Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial College Press.
4. Owens F.J, Poole C.P. (2007) Introduction to Nanotechnology, Wiley.
5. Regan F.A.M, Chapman J, Sullivan T. (2012) Nanoparticles in Anti-Microbial Materials: Use and Characterisation. Royal Society of Chemistry.

Journals:

Journal of Nanotechnology https://www.hindawi.com/journals/jnt/

Nanotechnology https://iopscience.iop.org/journal/0957-4484

International Journal of Nanotechnology

https://www.inderscience.com/jhome.php?jcode=ijnt

Nanomaterials and Nanotechnology https://journals.sagepub.com/home/nax

Web Resources:

Nanowerk https://www.nanowerk.com/

Azonano https://www.azonano.com/

Nanotechnow http://www.nanotech-now.com/current-months-press.htm

Nanogov https://www.nano.gov//

Nanotech Magazine https://www.nanotechmag.com/