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]

Undergraduate Programme in Microbiology

Regulations and Syllabus for

B.Sc., Microbiology

(With effect from the Academic Year 2020-21)

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PREAMBLE

Microbiology is a wide discipline of biology which encompasses five groups of microorganisms i.e. bacteria, protozoa, algae, fungi, and viruses. It studies their interaction with their environments as well as how these organisms are harnessed in human endeavour and their impact on society. The study has its extensions in various other conventional and advanced fields of biology by employing microbes as study models. Since the inception of microbiology as a branch of science, it has remained an ever-expanding field of active research, broadly categorized as pure and applied science. Knowledge of different aspects of Microbiology has become crucial and indispensable to the society. Study of microbes has become an integral part of education and human progress. 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 three-year B.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 undergraduate programme in Microbiology is the first level of college or university degree in the country as in several other parts of the world. After obtaining this degree, a microbiologist may enter into the job market or opt for undertaking further higher studies in the subject. After graduation 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 undergraduate 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 undergraduate degree in Microbiology is to make students knowledgeable about the various basic 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 through the laboratory work, 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 fundamentals 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 graduates 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 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 undergraduate degree will able to obtain:

PEO-1: The Under graduation course in Microbiology give wide knowledge and skilled students for both manpower in industrial sector, medical, agriculture and technology developments.

PEO-2: The academic knowledge, laboratory training preformed by the students during their course will be supportive in their career placement and development.

PEO-3: Sustain and compete with global competency, develop entrepreneurship skill, learn subject with social ethics and develop social equity with all gender.

PEO-4: The programme will deal with the increased human resource for skilled scientific work with for with wide research and developments knowledge.

PEO-5: The objective of this programme is to help the society by adding skilled employees with scientific ethics across the world.

PROGRAM OUTCOMES (POs)

PO-1: The students acquire detailed knowledge in the field of microbiology and expertise in handling various microbiological methods.

PO-2: Students will be able to communicate scientific information, concepts, experiments and significance, especially relating to microbiology.

PO-3: Students acquire knowledge on ethical issues and independently demonstrate lab experiments in competence with laboratory safety and standards.

PO-4: Students will be familiarizing to collect, analyze and interpret scientific data related to solving public issue for the welfare of the society.

PO-5: Apply knowledge and understanding of microbiological solution to solve problems in day to day life in concern with public health and safety, also applicable in all practical area of the subject.

PO-6: Mounting the students professional skills, based on current trend and future expectations in microbiological fields by offering Job oriented certificate courses, Value-added courses for career development and placements.

PO-7: Students can development proficient microbiological skills and competent to make a prospective career in industrial, medical as well as in microbiology research.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO-1: The undergraduate students will acquire fundamental and applied knowledge in history, classification, morphology and physiological characteristic of Bacteria, Fungi, Virus, algae and protozoa.

PSO-2: Become expertise in the use and application of various laboratory protocols for basic and advanced microbiological, immunologicl and molecular techniques with Good laboratory practices.

PSO-3: Understand the role of microorganism in Medical, Food, Pharmaceutical, Industrial, Soil, Agricultural and environmental microbiology.

PSO-4: Understand the epidemiological status, pathogenesis, immune response, diagnosis, treatment, prevention and control of microbial diseases in Human being, animal and plants.

PSO-5: Apply for career development, entrepreneurship, placement as skilled person in various field of life sciences, research and technology development.

PSO-6: Develop social responsibility through microbiological importance related to the betterment of environment and mankind at national and global prospective.

REGULATIONS

1. DURATION OF THE PROGRAME

1.1 Three years (six 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 Candidate for admission to the first year of B.Sc. Degree Course in Microbiology shall be required to have passed the Higher Secondary Examination with Biology or Botany or Zoology.

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 three academic years and passed the examinations of all the Six Semesters prescribed earning a minimum of **142 credits as per the distribution given in Regulation for** Part I, II, III, IV& V 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 Component	**Name of the Course**	**Credits allotted for Four Semester Language Papers ***
PART I	Tamil or Other Languages	**12**
PART II	English	**12**
PART III	Core Courses	**60**
	Allied Courses	**22**
	Project/ Three Elective Courses	**15**
PART IV	i. Basic Tamil/ Advanced Tamil/ NME	**04**
	ii. Soft Skill Courses	**12**
	iii. Environmental Studies	**02**
	iv. Value Education	**02**
PART V	Extension Activities	**01**
Total Credits		**142**

4.2 DETAILS OF COURSE OF STUDY OF PARTS I – V

4.2.1 PART I: Tamil and Other Languages: Tamil or Sanskrit (Classical language) at the option of candidates and according to the syllabus and text-books prescribed from time to time:

4.2.2 PART II: English: According to the syllabus and text-books prescribed from time to time

4.2.3 PART III: Core, Allied and Project/Three Elective Courses: As prescribed by the concerned Board of Studies

4.2.4 PART IV:

i. Basic Tamil/ Advanced Tamil/ NME:

a. Students who have not studied Tamil up to XII STD and have taken any Language other than Tamil in Part I shall take Basic Tamil comprising of Two Courses (level will be at 6th Standard).

b. Students who have studied Tamil up to XII STD and have taken any Language other than Tamil in Part I shall take Advanced Tamil comprising of Two Courses.

c. Students who have studied Tamil up to XII STD and also have taken Tamil in Part I shall take Non-Major Elective comprising of Two Courses.

ii. Soft Skill Courses

iii. Environmental Studies

iv. Value Education

4.2.5 PART V: Extension Activities:

Students shall be awarded a maximum of 1 Credit for Compulsory Extension Service. All the Students shall have to enroll for NSS /NCC/ NSO (Sports & Games) Rotract/ Youth Red Cross or any other Service Organizations in the College and shall have to put in compulsory minimum attendance of 40 hours which shall be duly certified by the Principal of the College before 31st March in a year. If a student lacks 40 hours attendance in the first year, he or she shall have to compensate the same during the subsequent years.

Those students who complete minimum attendance of 40 hours in one year will get 'half-a- credit and those who complete the attendance of 80 or more hours in Two Years will get 'one credit'. Literacy and Population Education and Field Work shall be compulsory components in the above extension service activities.

4.3 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 UG 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 for 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 Register for all subjects: Students shall be permitted to proceed from the First Semester up to Final Semester irrespective of their failure in any of the Semester Examination. For this purpose, Students shall register for all the arrear subjects of earlier semesters along with the current (subsequent) Semester Subjects.

6.2 Marks for Internal and End Semester Examinations for PART I, II, III, and IV

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

6.3 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

6.4 (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

6.4.1 Improvement of Internal Assessment Marks.

(a) Should have cleared end-semester University examination with more than 40% 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.

Question Paper Pattern for End Semester (University) Examination

SECTION–A			
10 questions out of 12 Questions	30 words	10 X 2	20 Marks
SECTION – B			
5 questions out of 7 Questions	200 words	5 X 5	25 Marks
SECTION – C			
3 questions out of 5 Questions	500 words	3 X 10	30 Marks
Total			**75 Marks**

6.6 PASSING MINIMUM

7.6.1 There shall be no passing minimum for Internal.

7.6.2 For external examination, passing minimum shall be 40% [Forty Percentage] of the maximum marks prescribed for the paper for each Paper/Practical/Project and Viva-Voce.

7.6.3 In the aggregate [External/Internal] the passing minimum shall be of 40%.

7.6.4 He/She shall be declared to have passed the whole examination, if he/she passes in all the papers and practical wherever prescribed as per the scheme of the examinations by earning **140 CREDITS** in PartI, II, III, IV & V. He/she shall also fulfil the extension activities prescribed earning a minimum of 1 credit to qualify for the Degree.

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

6.7.1 Eligibility: A Student who is having arrear of only one theory paper in the current final semester examination of the UG Degree programme alone is eligible to appear for the Instant Examinations.

6.7.2 Non-eligibility for one arrear paper: A Student who is having more than one arrear paper at the time of publication of results is not eligible to appear for the Instant Examinations.

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

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

6.8 RETOTALLING, REVALUATION AND PHOTOCOPY OF THE ANSWER SCRIPTS:

6.8.1 Re-totaling: All UG Students who appeared for their Semester Examinations are eligible for applying for re-totaling of their answer scripts.

6.8.2 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.

6.8.3 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.

6.9 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 PART I TAMIL / OTHER LANGUAGES; PART II ENGLISH AND PART III CORE SUBJECTS, ALLIED, ELECTIVES COURSES AND PROJECT: Successful Students passing the Examinations for the Part I, Part II and Part III courses and securing the marks (a) 60 percent and above and (b) 50 percent and above but below 60 percent in the aggregate shall be declared to have passed the examination in the **FIRST and SECOND** class respectively; all other successful candidates shall be declared to have passed the examination in the **THIRD Class.**

8. 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

8.1 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.

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.

8.2 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	
4.5 and above but below 5.0	C +	Third Class
4.0 and above but below 4.5	C	
0.0 and above but below 4.0	U	Re-appear

*****The Students who have passed in the first appearance and within the prescribed semester of the UG Programme (Major, Allied and Elective courses only) 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 **6** are only eligible for Classification.

10. CONCESSIONS FOR DIFFERENTLY-ABLED STUDENTS

10.1 Dyslexia students: For students, who are mentally disabled, learning 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:

i) Part I Foundation course Tamil or any other Language can be exempted.

ii) One-third of the time of paper may be given as extra time in the examination.

iii) Leniency in overlooking spelling mistakes, and

iv) Amanuensis for all courses 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 Hearing, Speaking Impaired & Mentally retarded: For students who are hearing and speaking impaired and who are mentally challenged, the following concessions shall be granted:

i) One Language paper either Part I Foundation course Tamil or any other Language or Part II English or its equivalent can be exempted

ii) Part IV Non-Major Elective (NME) or Basic Tamil or Advanced Tamil can be exempted.

10.3 Visually Challenged students:

i) Exempted from paying examination fees.

ii) A scribe shall be arranged by the College and the scribe be paid as per the College decision.

11. MAXIMUM PERIOD FOR COMPLETION OF TH 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

S. No	Course component	Name of course	Inst. hours	Credits	Exam hour	Theory/ Practical (External **:** Internal)	Max. marks
1	Part I	Language/ Tamil Paper I	4	3	3	75 : 25	100
2	Part II	English Paper I	4	3	3	75 : 25	100
3	Part III	Core Theory Paper I- **General Microbiology and Microbial Physiology**	6	4	3	75 : 25	100

4	Part III	**Core**: Paper I: *Practical: **General Microbiology and Microbial Physiology**	3	4	6	60 : 40	100
5	Part III	**Allied** :Paper I: **Allied Biochemistry I**	6	3	3	75 : 25	100
6	Part III	*Allied Practical I – **Allied Biochemistry I**	3	**Examination will be held in Semester II**			
7	Part IV	*Basic Tamil/Adv. Tamil/Non Major Elective	2	2	3	75 : 25	100
8	Part IV	**Skill based subject :** Soft skill I	2	3	3	50 : 50	100
Total credit: 22							

SECOND SEMESTER

S. No	Course component	Name of course	Inst. hours	Credits	Exam hour	Theory/ Practical External : Internal	Max. marks
1	Part I	Language/ Tamil Paper II	4	3	3	75 : 25	100
2	Part II	English Paper II	4	3	3	75 : 25	100
3	Part III	**Core**: Paper II: **Immunology**	6	4	3	75 : 25	100
4	Part III	***Core**: Practical II : **Immunology**	3	4	6	60 : 40	100
5	Part III	Allied Paper II – **Allied Biochemistry II**	6	3	3	75 : 25	100
6	Part III	***Allied** :Practical II: **Allied Biochemistry I and II**	3	4	3	60 : 40	100

7	Part IV	*Basic Tamil/Adv. Tamil/Non Major Elective	2	2	3	75 : 25	100
8	Part IV	**Skill based subject :** Soft skill II	2	3	3	50 : 50	100
Total credit: 26							

THIRD SEMESTER

S. No	Course component	Name of course	Inst. hours	Credits	Exam hour	Theory/ Practical External : Internal	Max. marks
1	Part I	Language/ Tamil Paper III	4	3	3	75 : 25	100
2	Part II	English Paper III	4	3	3	75 : 25	100
3	Part III	**Core**: Paper III: **Molecular Biology**	6	4	3	75 : 25	100
4	Part III	**Core**: *Practical III : **Molecular Biology**	3	4	6	60 : 40	100
5	Part III	Allied Paper III – **Bioinstrumentation**	6	3	3	75 : 25	100
6	Part III	***Allied** :Practical III: **Bioinstrumentation**	3	3	3	60 : 40	100
7	Part IV	**Skill based subject :** Soft skill III	2	3	3	50 : 50	100
Total credit: 23							

FOURTH SEMESTER

S. No	Course component	Name of course	Inst. hours	Credits	Exam hour	Theory/ Practical External : Internal	Max. marks

1	Part I	Language/ Tamil Paper IV	4	3	3	75 : 25	100
2	Part II	English Paper IV	4	3	3	75 : 25	100
3	Part III	**Core**: Paper IV: **Soil and Agricultural Microbiology**	6	4	3	75 : 25	100
4	Part III	**Core**: *Practical IV : **Soil and Agricultural Microbiology**	3	4	6	60 : 40	100
5	Part III	Allied Paper IV – **Biostatistics**	6	3	3	75 : 25	100
6	Part III	***Allied** :Practical IV: **Biostatistics**	3	3	3	60 : 40	100
7	Part IV	**Skill based subject :** Soft skill IV	2	3	3	50 : 50	100
8	Part IV	**Environmental Studies**	2	2	3	75 : 25	100
Total credit: 25							

FIFTH SEMESTER

S. No	Course component	Name of course	Inst. hours	Credits	Exam hour	Theory/ Practical External : Internal	Max. marks
1	Part III	**Core**: Paper V: **Medical Bacteriology**	6	4	3	75 : 25	100
2	Part III	**Core**: Paper VI: **Medical Mycology & Parasitology**	6	4	3	75 : 25	100
3	Part III	**Core**: Paper VII: **Medical Virology**	6	4	3	75 : 25	100

4	Part III	**Core**: *Practical V : **Bacteriology, Mycology, Parasitology & Virology**	4	4	6	60 : 40	100
5	Part III	Elective I : **Microbial Genetics and Genetic Engineering**	6	5	3	75 : 25	100
6	Part IV	**Value education**	2	2	3	75 : 25	100
Total credit: 23							

SIXTH SEMESTER

S. No	Course component	Name of course	Inst. hours	Credits	Exam hour	Theory/ Practical External : Internal	Max. marks
1	Part III	**Core**: Paper VIII: **Environmental Microbiology**	6	4	3	75 : 25	100
2	Part III	**Core**: Paper IX: **Food & Dairy Microbiology**	6	4	3	75 : 25	100
3	Part III	***Core**: Practical VI : **Environmental, Food & Dairy Microbiology**	5	4	6	60 : 40	100
4	Part III	**Elective II : Industrial and Pharmaceutical microbiology**	5	5	3	75 : 25	100
5	Part III	**Elective III**: **Biotechnology**	5	5	3	75 : 25	100
5	Part V	**Extension activities**	-	1			
Total credit: 23							

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

SYLLABUS FOR B.SC. DEGREE COURSE IN MICROBIOLOGY

FIRST SEMESTER

CORE – I THEORY: GENERAL MICROBIOLOGY & MICROBIAL PHYSIOLOGY

CO No.	Course Outcome
CO-1.	To study the origin of microbiology and scope. Classification, Microscopes - principles and application in microbiology field.
CO-2.	To learn structural organization of bacterial cells. Staining techniques – to stain the bacterial cell and differentiate form each other.
CO-3.	To isolate the aerobic and anaerobic microorganism using the culture methods. Sterilization process prevents the microbial contamination. Antimicrobial chemotherapy-study the antibiotic mechanism.
CO-4.	Identify bacteria by the physiological, morphological and biochemical methods. Identification through molecular and serological methods.
CO-5.	To learn Study the growth curve of bacteria in batch, continuous and synchronous culture. Basic nutritional requirements, the vegetative cell turns to spore by sporulation. To learn about cellular nutrient transport, fermentation and respiration mechanism.

UNIT I

History of microbiology, contributions – Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Flemming Edward Jenner, Francesco Redi. Spontaneous generation *vs* Biogenesis hypothesis. Classification – Three kingdoms, five kingdom, six kingdom and eight kingdom. Microscopy – simple, bright field, dark field, phase contrast, fluorescent, electron microscope – TEM & SEM.

UNIT II

Structure of Bacterial cell wall, cell membrane, capsule, flagella, pili, mesosomes, chlorosomes, phycobilisomes, spores and gas vesicles. Stains and staining methods.

UNIT III

Bacterial culture media and pure culture techniques. Anaerobic culture techniques. Sterility check of media. Sterilization– Physical moist heat - autoclaving, dry heat – Hot air oven, radiation – UV, Ionization, filtration – membrane filter and disinfection, antiseptic ; Antimicrobial agents – classification – according to mode of action.

UNIT IV

Methods of bacterial identification- morphological, physiological, biochemical, Molecular taxonomical and serological methods.

UNIT V

Physiology of microbial growth and nutrition. Batch – continuous - synchronous cultures; Growth Curve and measurement method (turbidity, biomass and cell count). Nutritional requirements. Transport of nutrients by active and passive transport. Respiration. Fermentation. Photosynthesis - oxygenic and anoxygenic.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Jayaram Paniker C. K. and Ananthanarayan R. (2017). Textbook of Microbiology. (10th Edition). Universities Press (India) Pvt. Ltd.
2. Chan E.C.S., Michael J. Pelczar, Jr.,Noel R. Krieg (2010). Microbiology. (5th edition). Mc. Graw Hill. Inc, New York.
3. 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.
4. 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.

5. David White, James Drummond, and Clay Fuqua (2011). The physiology and biochemistry of Prokaryotes, Oxford University Press, Oxford, New York.
6. Larry Mc Kane.and Judy Kandel (1996). Microbiology-Essentials and applications. (2nd edition). Mc Fraw Hill Inc, Newyork.
7. Michael T. Madigan, John M. Martinko, Jack Parker (2009) Biology of Microorganisms.(12th edition).Prentice Hall International Inc, London.
8. Bernard D. Davis. Renato Dulbecco. Herman N. Eisen.and Harold, S. Ginsberg. (1990).Microbiology (4th edition). J.B.Lippincott company, New York.
9. Alexopoulus C.J. and C W. Mims. (1993). Introductory Mycology (3rd edition).Wiley Eastern Ltd, New Delhi.
10. Elizabeth Moore - Landecker. (1996). Fundamentals of the fungi. (4th edition). Prentice Hall International, Inc, London.
11. Heritage,J. Evans E.G.V. and Killington, R.A. (1996). Introductory Microbiology. Cambridge University Press.
12. Nester, E.W., Roberts, C.V. and Nester, M.T. (1995). Microbiology, A human perspective. IWOA, U.S.A.
13. Salle, A.J. (1996). Fundamental principles of Bacteriology.(7th edition).Tata McGraw - Hill publishing company Ltd, New Delhi.

14. Caldwell, D.R. (1999). Microbial Physiology and metabolism, Wm. C. Brown Publishers, U.S.A.
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.

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)
3. Prescott's Microbiology, McGraw-Hill Education; 10th Edition (2017). ISBN-10: 0073402400
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.

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/

CORE- I -PRACTICAL: GENERAL MICROBIOLOGY AND MICROBIAL PHYSIOLOGY

CO No.	Course Outcome
CO-1.	To practice sterilization methods. Learn to prepare media and their quality control.
CO-2.	To learn streak plate, pour plate and serial dilution. Pigment productions.
CO-3.	To understand Microscopy methods, different Staining techniques and motility test.
CO-4.	Observation of different type of algae, isolation of fungi, Size measurement and Antimicrobial assay.
CO-5.	To demonstrate biochemical test for bacteria and culture maintenance techniques

UNIT I

Laboratory rules and Precautions. Cleaning of glass wares, Sterilization principle and methods – Flaming. Moist heat (Autoclave); dry heat (Hot air oven) and filtration (membrane filter and filter disk) methods. Media preparation: liquid media,

solid media, agar slants, agar plates. Culture medium: basal, enriched, selective media preparation - quality control of media, growth supporting properties, sterility check of media.

UNIT-II

Pure culture techniques: streak plate, pour plate, decimal dilution. Culture characteristics of microorganisms: growth on different media, growth characteristics and description. Demonstration of pigment production (bacteria and algae).

UNIT-III

Microscopy: light microscopy, bright field microscopy, dark field microscopy. Motility demonstration: hanging drop, wet mount preparation, dark field microscopy, semi solid agar, Craigie's tube method. Staining techniques: smear preparation, simple staining, Gram's staining, acid fast staining, staining of Metachromatic granules, Endospore and capsular Staining.

UNIT-IV

Morphology of microorganisms: morphological variations in algae, morphology of fungi, slide culture technique. Antibiotic sensitivity testing: Disc diffusion test-quality control with standard strains. Micrometry: Demonstration of size of yeast and fungal filaments.

UNIT-V

Physiology characteristics: IMViC test, H2S, TSI, Oxidase, catalase, urease test. Carbohydrate fermentation test, maintenance of pure culture, paraffin method, stab culture, maintenance of mold culture.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text 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. Mukesh Kumar (2018). Practical Manual for Undergraduates Microbiology. (3rd Edition). Jain Brothers.
4. Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India.
5. Mahon C and Lehman DC (2019). Textbook of Diagnostic Microbiology. (6th Edition). Elsevier Publisher.
6. Banu N and Pavithra (2015). Laboratory Manual on Cell Biology and Microbiology. Sara Book Publication.
7. Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS

Reference Books:

1. Atlas.R (1997). Principles of Microbiology, 2ndedn, Wm.C.Brown publishers.
2. Lim D. (1998). Microbiology, 2nd edn, WCB McGraw Hill Publications.
3. Wheelis M, (2010). Principles of Modern Microbiology, 1st edn. Jones and Bartlett Publication.
4. Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India.

5. Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS

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

ALLIED: PAPER I – THEORY – ALLIED BIOCHEMISTRY – I

CO No.	Course Outcome
CO-1.	To learn the basic of classification and significance of carbohydrates.

CO-2.	To Understand occurrence and properties of polysaccharides.
CO-3.	Learn the molecular structures of 20 amino acids, differentiating essential and non-essential amino acids, biologically important modified amino acids and their functions.
CO-4.	Recognize the structural level organization of proteins, 3D structure of proteins, its functions and denaturation.
CO-5.	To learn the Heterocyclic Compounds classification and biological importance, chemical nature and significance.

UNIT I

Carbohydrates - Monosaccharides and Disaccharides: Definition and classification of carbohydrates, linear and cyclic forms (Haworth projection) for glucose, fructose, mannose and disaccharides (maltose, lactose, sucrose). Physical properties – Steroisomerism, Optical isomerism, mutarotation. Chemical properties of sugar.

UNIT II

Carbohydrates – Polysaccharides: Occurrence and Properties - Polysaccharides (Starch, Glycogen, Cellulose, Chitin, Pectin) and Mucopolysaccharides - Hyaluronic acid, heparin, Chondroitin sulphate, Dermatan sulphate.

UNIT III

Amino acids - Amino acids, various classifications, amphoteric nature, isoelectric point. Reactions of carboxyl and amino groups.

UNIT IV

Proteins - Proteins- classification - biological functions, physical properties - ampholytes, isoionic point, salting in and salting out, denaturation, nature of peptide bond. Secondary structure, α-helix and β-pleated sheet, tertiary structure, various forces involved - quaternary structure. Deamination, transamination and urea cycle.

UNIT V

Heterocyclic Compounds - Heterocyclic rings of biological importance - pyridine, pyrrole, pteridine, thiazole, imidazole and indole with examples. Porphyrins: Porphyrin nucleus and classification of prophyrins, important metalloporphyrins occurring in nature, Chemical nature and significance of bile salts and bile pigments

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Voet.D & Voet. J.G (2010). Biochemistry, (4th ed), John Wiley & Sons, Inc.
2. Lubert Stryer (2010). Biochemistry (7^{th} ed), W.H.Freeman.
3. Satyanarayana U and Chakrapani U (2014). Biochemistry. (4th Edition). Made Simple Publisher.
4. Jain J L, Sunjay Jain and Nitin Jain (2016). Fundamentals of Biochemistry. (7th Edition). S Chand Company.
5. Nelson DL and Cox M (2017). Lehninger Principles of Biochemistry. (7th Edition). WH Freeman.
6. Ramadevi K (2016). Ambika Shanmugam's Fundamentals of Biochemistry for Medical Students. (8th Edition). Wolters Kluwer India Pvt Ltd.

Reference Books:

1. Rodwell VW, Bender D, Botham KM, Kennelly PJ and Weil PA (2018). Harper's Illustrated Biochemistry. (31st Edition). McGraw-Hill Education.

2. Koolman J and Roehm K (1996). Color Atlas of Biochemistry. (3rd Edition). Thieme Publishing Group.
3. Rastogi VB and Aneja KR (2019). Zubay's Principles of Biochemistry. (5th Edition). Medtech Publisher.
4. Berg JM, Tymoczko and Stryer L (2011). Biochemistry. (7th Edition). W. H. Freeman.

Journals:

1. **Biomed Research International:** https://www.hindawi.com/journals/bmri/
2. **Journal of Medical Biochemistry:** https://content.sciendo.com/view/ journals/jomb/jomb-overview.xml
3. **Indian Journal of Medical Biochemistry:** https://www.ijmb.in/journal Details/IJMB

Web Resources:

1. http://med.wikidot.com/biochemistry-online-links
2. http://oli.stanford.edu/biochemistry
3. http://med.wikidot.com/biochemistry-online-links
4. http://oli.stanford.edu/biochemistry

NON-MAJOR ELECTIVE: THEORY – CELLULAR ORGANIZATION

CO No.	Course Outcome
CO-1.	By the end of the course, the students are able to understand the structural organization, types and functions of cell membranes
CO-2.	Understand the structural organization and functions of various cell organelles.
CO-3.	Know about the organization of genes, genome and chromosomes including the gene expression strategies.
CO-4.	BeFamiliar with the regulation, stages and control of cell cycle.
CO-5.	Be acquainted with the growth, physiological characteristics microbial

	cell and strategies of cell division.

UNIT I

Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

UNIT II

Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids,vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.

UNIT III

Organization of genes and chromosomes: Operon, unique and repetitive DNA, interruptedgenes, gene families, structure of chromatin and chromosomes, heterochromatin,euchromatin, transposons.

UNIT IV

Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle,regulation and control of cell cycle.

UNIT V

Microbial Physiology: Growth yield and characteristics, strategies of cell division, stress response.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Alberts, B. etal (2014) Molecular Biology of the Cell 6th Edition, Garland publishing
2. De Robertis, E.D.P and E.M.F DeRobertis Jr (1987). Cell biology, 8th edition. Waverly Pvt. Ltd., NewDelhi.
3. Lodish, H. et al. (2012) Molecular cell biology, 7th Edition, W.H Freeman.
4. Gupta, P.k. (2008). Cytology. Genetics and evolution, 6th Edition., Rastogi Publication, Meerut.
5. Jain J.L (2007). Fundamentals of Biochemistry,S.Chand publishers.
6. Satyanarayan,U (2014). Biochemistry (4th ed), Arunabha Sen Books & Allied (P) Ltd, Kolkata.
7. Pollard, T.D and W. C. Earnshaw (2008), Cell biology 2nd edition, Saunders Elsevier.
8. Ajoy Paul., 2011. Text Book of Cell and Molecular Biology-. Books and Allied (P) Ltd, Kolkata. Third Edition.
9. Aminul Islam., 2011. A Text Book of Cell Biology-. Books and Allied (P) Ltd, Kolkatta. First edition.
10. Ajoy Paul., 2011. Text Book of Genetics- from Genes to Genomes- Books and Allied (P) Ltd, Kolkata. Third Edition.

Reference Books:

1. Karp, G. (2013) Cell and Molecular biology: concepts and experiments. 7th edition, John Wiley & sons
2. Benda, C, (1902). Die mitochondria, Ergebn. Anat 12: 743.

3. Reginald H Garrett and Charles M Grisham, 5th edition. Biochemistry, Brooks Cole publishers. 2012.
4. Watson J.D, Tania A.B, Stephen P.B, Alexander G, Michael L, Richard L.(2017) Molecular Biology of the Gene, 7th edition, Pearson Education
5. Murray A. W and T. Hunt (1993). The cell cycle. Oxford university press, Oxford, UK.
6. Getzen berg, R.H.and E.E.Bittar, Cell Structure and Signalling, Elsevier Science.

Journals:

1. Microbial Genetics - Plos One: https://journals.plos.org/plosone/browse/microbial_genetics
2. Journal of Genetic Engineering and Biotechnology: https://www.journals.elsevier.com/journal-of-genetic-engineering-and-biotechnology
3. Genetics and Molecular Biology: https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/lineweaver-burk-plot

Web Resources:

1. https://www.ncbi.nlm.nih.gov/books//
2. https://www.edx.org/learn/genetic-engineering
3. https://www.britannica.com/science/genetic-engineering

SECOND SEMESTER

CORE PAPER-II –THEORY: IMMUNOLOGY

CO No.	Course Outcome
CO-1.	To know about History, scope of immunology, also types blood group, immunity and hematopoiesis.
CO-2.	To learn about cells and organs of immune system, types of immunity

	and complement pathways.
CO-3.	To learn about antigen, haptens, adjuvants, immunoglobulin structure and functions.
CO-4.	Understand hypersensitivity reaction, and vaccines.
CO-5.	To know antigen and antibody reaction and transplantation, tumor immunology.

UNIT-I

History of Immunology, scope of Immunology. Immunohaematology: Blood groups - Blood transfusion. Types of immunity - innate and acquired immunity, factors contributing to innate and acquired immunity. Hematopoiesis.

UNIT-II

Structure and function of immune system: cells of immune system, Lymphoid tissues, primary and secondary lymphoid organs. Humoral and cell-mediated immune response, Complement system - Mode of activation, classical pathway and alternate.

UNIT-III

Antigen - types, properties. Hapten, adjuvants, autoantigens, carriers – types. Immunoglobulins: Structure, types, and their function - Theory of antibody production. Clonal selection theory, MHC. cytokines

UNIT-IV

Hypersensitivity reactions; antibody mediated – type 1, type 2, type 3 and cell mediated type 4 – delayed type hypersensitivity, Monoclonal Antibody - Hybridoma Technology. Vaccines. Immunization schedule.

UNIT-V

Antigen-antibody interaction general and chemical property (*in-vitro)*: Agglutination, Precipitation, complement fixation, ELISA, RIA, Flowcytometry and Fluorescence immunoblotting. Skin tests, Autoimmunity, Transplantation Immunology - Graft acceptance and rejection. Tumor Immunology - Leukemia

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Chapel, H, Mansel H, Siraj M and Neil S (2014). Essentials of Clinical Immunology. (4th Edition). John Wiley and Sons Ltd
2. Elgert, K.D. (2009) Immunology: Understanding the Immune System. (2nd Edition). Wiley – Blackwell, New York.
3. Hue Davis (1997). Introductory Immunology (First Edition). Chapman & Hall Publisher, London.
4. Paul (1998). Fundamental Immunology, II Edition, Raver Press, New York.
5. Ridklad, M. Aydl (1995). Immunology, II Edition, Baltimore, Hong Kong, NMS Publication.
6. David Male Jonathan Brostoff David Roth Ivan Roitt (2012) Immunology

(8th Edition). Saunders.
7. Jacqucline S, Williams and Wilkins A. (1998) Basic Immunology - Warerly Company.
8. Janeway, Charles, Travers, Paul, Walport, Mark, Shlomchik, M (2004). Immunobiology. (6th edition). Garland Science
9. Mark Peakman, Diego Vergani. (2009) Basic and clinical immunology. (2nd Edition) Longman Asia Ltd., Hong kong.

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.

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

Web Resources:

1. https://www.immunology.org/public-information/immunology-related-activities-and-resources/immunology-resources-links
2. https://www.aai.org/Education/Teaching-Resources
3. https://study.com/academy/topic/immunology.html

CORE II- PRACTICAL: IMMUNOLOGY

CO No.	Course Outcome
CO-1.	Learn various serological techniques including agglutination and precipitation reactions.
CO-2.	To practice the Complement fixation test and ELISA.
CO-3.	To practice the enumeration of blood cells and isolation of lymphocytes.
CO-4.	To learn antibody production, Arthurs reaction and anaphylactic reaction.
CO-5.	To understand the immediate and delayed hypersensitivity reaction.

UNIT-I

Collection of human peripheral, serum and plasma seperation. Blood groups and typing - Coombs's test. Latex Agglutination reactions: Slide and Tube methods - ASO, RA, CRP, HCG, WIDAL. RBC agglutination - IHA, TPHA Bacterial. Precipitation reaction in Gel - Outchelony double diffusion, Single Radial Immuno diffusion.VDRL, RPR.

UNIT-II

Complement fixation test. Titration of amboceptor and complement (demonstration only). Immunofluorescene, (Demonstration only), ELISA.

UNIT-III

Isolation of Buffy coat from peripheral blood, Isolation and separation of lymphocytes (T cells, B cells), Enumeration of different cell types, Perpheral blood cell counts, absolute cell counts.

UNIT-IV

Antibody productions in rabbits against sheep RBC and its titration (Demonstration). Anaphylactic reactions in guinea pigs. Arthus reaction in rabbits, (Demonstration).

UNIT-V

Skin tests, both immediate and delayed hypersensitivity reactions to egg proteins, bacterial, fungal antigens.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Roitt R.I. (2005). Essential Immunology.10thedn. Blackwell Scientific Publishers.
2. Tizard, R and ISaunders. (2010). Immunology-An Introduction. 4thedn. College Publishing, Philadelphia.
3. Nairn, R., and Helbert, M. (2005). Immunology for Medical Students. 2ndedn. Mosby International limited.
4. Pelczar M.J., Chan E.C.S. and Kreig N.R. (2007) Microbiology 7th edn, McGraw-Hill New York
5. Ananthanarayan and Jayaram Panicker. (2009). Textbook of Microbiology

8thedn Orient Longman.

Reference Books:

1. Hay FC and Westwood OMR. (2002) Practical Immunology, 4th edition, Blackwell Scientific Publishers, Oxford, London.
2. Miller L.E, Luke H.R, Peacock J.E and Tomar R.H (1990). Manual of Laboratory Immunology, 2nd edition, Lea and Febiger - London.
3. Talwar GP (ed). (1983) A handbook of Practical Immunology, Vikas Publishing House Pvt. Ltd.
4. Brawshaw L.J. (1988). Laboratory Immunology, Sandders College Publishing.
5. Kuby, J. (2007). Immunology. 2nd edn. H.W.Freeman and company. New York.
6. Janeway C, Travers P, Walport M, Shlomchik M. (2001). Immunobiology .6thedn, Garland Science

Journals:

1. **Indian Journal of Dermatology:** https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3312652/
2. **Neuroscience:** https://www.sciencedirect.com/topics/neuroscience/hematopoiesis
3. **Frontiers in Immunology:** https://www.frontiersin.org/articles/10.3389/fimmu.2015.00257/full.
4. **Neuroscience:** https://www.sciencedirect.com/topics/neuroscience/cytokines
5. **Medicine and Dentistry:** https://www.sciencedirect.com/topics/medicine-and-dentistry/hypersensitivity
6. **Medicine and Dentistry:** https://www.sciencedirect.com/topics/medicine-and-dentistry/transplantation

Web Resources:

1. https://www.mechanobio.info /Development
2. https://www.cell.com/ trends / immunology.
3. https://microbiologybook.org/mayer/ab-ag-rx.htm

4. https://www.ebi.ac.uk/interpro/potm/2005_2/Page2.htm
5. http://www.immunopaedia.org.za/immunology/archive/type-i-iv-hypersensitivity- reactions/immune-complex-formation/hypersensitivity-reactions

ALLIED-- Paper II- BIOCHEMISTRY- II

CO No.	Course Outcome
CO-1.	To study the classification, function and chemical properties of lipids
CO-2.	To understand the types and structure of DNA and RNA.
CO-3.	Learning kinetics of enzyme catalysed reactions and enzyme inhibitions and regulatory process, Enzyme activity, Enzyme Units, Specific activity.
CO-4	To know the sources, biological importance and deficiencies of vitamins
CO-5	To learn about mineral types function and toxicity.

UNIT I

Lipids - Fats - function, classification, simple lipids, fatty acids (saturated and unsaturated), compound lipids, derived lipids, properties- saponification, rancidity, reduction, oxidation, halogenation. Functions of phospholipids, Cholesterol – biological importance, chemical properties.

UNIT II

Nucleic acids - Purine and pyrimidine bases, nucleosides, nucleotides, polynucleotides, DNA structure, various types, properties- absorbance, effect of temperature. Different types of RNA structure and function, Genetic code.

UNIT III

Enzymes - definition, units of enzyme activity, enzyme nomenclature, specificity, isoenzymes, factors affecting enzyme activity- substrate concentration, pH,

temperature. Michaelis and Menten equation. Lineweaver- Burk plot, Enzyme inhibition, competitive, uncompetitive and non competitive inhibition

UNIT IV

Vitamins - definition and types of vitamins. Sources, requirement, biological functions, deficiency symptoms of water soluble vitamins, B1, B2, B3, B6, B12 and Vitamin-C. Sources, requirement, biological functions, deficiency symptoms of fat soluble vitamins - A, D, E and K- Deficiency diseases.

UNIT V

Minerals - sources, requirement, physiological functions, deficiency and toxicity of calcium, sodium, potassium, iron, magnesium, copper, manganese, selenium, iodine and zinc.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. David L.Nelson and Michael M.Cox (2012). Lehninger Principles of Biochemistry (6^{th} ed) W.H. Freeman.

2. Voet.D & Voet. J.G (2010). Biochemistry, (4th ed), John Wiley & Sons, Inc.

3. Lubert Stryer (2010). Biochemistry, (7^{th} ed), W.H.Freeman

4. Satyanarayan,U (2014). Biochemistry (4^{th} ed), Arunabha Sen Books & Allied (P) Ltd, Kolkata.

5. Jain J.L (2007). Fundamentals of Biochemistry,S.Chand publishers.

Reference Books:

1. Koolman J and Roehm K (1996). Color Atlas of Biochemistry. (3rd Edition). Thieme Publishing Group.
2. Berg JM, Tymoczko and Stryer L (2011). Biochemistry. (7th Edition). W. H. Freeman.
3. Reginald H Garrett and Charles M Grisham, 5th edition. Biochemistry, Brooks Cole publishers. 2012.
4. Denise R Ferrier. Biochemistry, 6th edition, LWW publishers. 2013.
5. AmbikaShanmugam. Fundamentals of Biochemistry for Medical students.Nagaraj and Company Pvt ltd, India. 1998.
6. Thomas M Devlin. Textbook of Biochemistry with Clinical Correlations, 7th edition, Wiley publisher. 2010.

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/

ALLIED- I & II- BIOCHEMISTRY PRACTICALS (I & II)

CO No.	Course Outcome
CO-1.	Estimation of ascorbic acid and glycine
CO-2.	They acquire knowledge in the Identification of carbohydrate and amino acids with suitable tests
CO-3.	Colorimetric estimation of protein and phosphorous.
CO-4.	Preparation of starch from potatoes and casein from milk.

UNIT I : Volumetric analysis

a. Estimation of ascorbic acid using 2, 6 – dichlorophenol indophenol as link solution.

b. Estimation of Glycine by formal titration.

UNIT II: Qualitative analysis

a. Qualitative analysis of carbohydrates- glucose, fructose, galactose, lactose, maltose and sucrose.

b. Qualitative analysis of amino acids – arginine, cysteine, tryptophan and tyrosine.

UNIT III: Quantitative analysis: (demonstration)

a. Colorimetric estimation of protein by Biuret method.

b. Colorimetric estimation of phosphorus.

UNIT IV: Biochemical preparations

a. Preparation of casein from milk.

b. Preparation of starch from potato.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Varley's practical clinical biochemistry, Alan. H. Gowen clock, 6th Edition, 1988, CBS publishers & distributors, India.
2. Laboratory manual and Practical biochemistry, T.N.Pattabiraman, 4th Edition, 2010, All India Publisher's & Distributors limited, New Delhi.
3. Practical text book of biochemistry for MBBS students, D.M.Vasudevan, 1st Edition, 2007, Jaypee brothers, New Delhi.
4. An introduction to practical biochemistry, David. T. Plummer, 3rd Edition, 1998, Tata Mc.Grawhill education private limited, New Delhi.

References Books:

1. Medical Laboratory Technology-Kanai L. Mukherjee, Tata McGraw Hill., Vol. I, II, III.
2. Clinical Chemistry - Ranjana Chawla.
3. Laboratory manual in Biochemistry - Jayaraman.
4. Biochemical methods - S.Sadasivan and Manickam.

Journals:

1. **ACS:** https://pubs.acs.org/doi/abs/10.1021/ja01414a033
2. **American Chemical Society**: https://pubs.acs.org/doi/abs/10.1021/i560156a015
3. **ACS:** https://pubs.acs.org/doi/abs/10.1021/ed028p480

Web Resources:

1. https://www.biochemden.com/anthrone-method-carbohydrate-determination/

2. http://www.jbc.org/content/20/3/217.full.pdf
3. https://vlab.amrita.edu/?sub=3&brch=63&sim=156&cnt=1
4. https://info.gbiosciences.com/blog/protein-estimation-methods

NON-MAJOR ELECTIVE - DIVERSITY OF LIFE FORMS - COURSE OUTCOME

CO No.	Course Outcome
CO-1	By the end of the course, the students are able to know the fundamental of taxonomy and systemic classification organisms
CO-2	Be familiar with the structural organization of organisms
CO-3	Know about the important criteria used for classification of plants, animals and microorganisms
CO-4	Know about the natural habitat, geographic origins and migrations of species in Indian subcontinent.
CO-5	Understand the functioning of host parasite relationships.

UNIT I

Principles and Methods of Taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of plants, animals and microorganisms.

UNIT II

Levels of Structural Organization: Unicellular, colonial and multicellular forms; levels of organization of tissues, organs and systems; comparative anatomy.

UNIT III

Outline Classification of Plants, Animals and Microorganisms: Important criteria used for classification in each taxon; classification of plants, animals and microorganisms; evolutionary relationships among taxa.

UNIT IV

Natural history of Indian Subcontinent: Major habitat types of the subcontinent, geographic origins and migrations of species; common Indian mammals, birds; seasonality and phenology of the subcontinent.

UNIT V

Organisms of Health and Agricultural Importance: Common parasites and pathogens of humans, domestic animals and crops.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.
2. Raven, P.H et al (2006) Biology 7th edition Tata McGrawHill Publications, New Delhi
3. Sharma, OP (2002) Textbook of Thallophytes, Tata McGraw Hill Publishing Co. New Delhi.

4. Fritsch F.E. 1935, 45 (Vol. I & II) The structure and reproduction of the Algae. Vikas Publishing House Ltd. Delhi

Reference books:

1. Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
2. Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7 th Edition, Thomson Books/Cole
3. Kochhar, S.L. (2009) Economic Botany: In the Tropics 3rd edition. Mac Millan Publishers India Ltd.
4. Smith, T.M. and Smith, R.C. (2006) Elements of Ecology Ist editon Pearson Publications

Journals:

JOURNAL OF BIOLOGICAL SCIENCES:

https://scialert.net/jhome.php?issn=1727-3048

JOURNAL OF BIOGEOGRAPHY:

https://onlinelibrary.wiley.com/journal/13652699

Web resources:

DRONSTUDY.COM:

https://www.dronstudy.com/book/diversity-in-living-organisms-chapter-notes/

STUDOCU:

https://www.studocu.com/en/document/queens-university/diversity-of-life-i/lecture-notes/diversity-of-life-i-lecture-notes-biology-201/440048/view

THIRD SEMESTER

CORE - PAPER III - THEORY: MOLECULAR BIOLOGY

CO No.	Course Outcome

CO-1.	Understand the chemical components of DNA and various forms of DNA. Know about the organization of prokaryotic and eukaryotic genome.
CO-2.	Understand the DNA replication, repair and recombination in prokaryotes with that of eukaryotes.
CO-3.	To know about RNA synthesis and processing and function of different types of RNA.
CO-4.	To know about protein synthesis and inhibition factors of protein synthesis.
CO-5. .	To Understand prokaryotic and eukaryotic gene expression and control of gene expression

UNIT I

Introduction to molecular biology- Central dogma, DNA structure, various forms (A, B, Z & H), Stability of nucleic acid structures; prokaryotic and eukaryotic genome organizations.

UNIT II

DNA replication in prokaryotes: Meselson-Stahl experiment, Enzymes and proteins involved - role of DNA polymerases I, II, III, gyrase, topoisomerases, helicase, ligases and SSB proteins. mechanism of replication- Initiation, elongation and termination, rolling circle and theta replication, fidelity of replication, Inhibitors of replication.

UNIT III

RNA synthesis and processing in prokaryotes: Structure and function of different types of RNA, RNA polymerase, formation of initiation complex, elongation and termination. Processing of tRNA and rRNA in *E.coli*, transcription activators and repressors.

UNIT IV

Protein synthesis in prokaryotes: Ribosome, formation of initiation complex, initiation factors elongation and elongation factors, termination, genetic code, inhibition factors of protein synthesis. Eukaryotic replication, transcription and translation.

UNIT V

Control of gene expression at transcriptional and translation level in prokaryotes: Promoters activity, Repressors activity, Catabolite Repression, Dual Positive and Negative control. Regulation of Translation - Gene location, Antisense RNA, Efficiency of m-RNA to bind with ribosome, Codon preference, Stringent Response, Attenuation

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Gupta P.K. (2017) Cell and Molecular Biology, 5th Edition, Rastogi Publications.
2. Mukherjee S. (2016). The Gene: An Intimate History, Scribner Publishers.
3. Brown, T.A. (2016). Gene Cloning and DNA Analysis: An Introduction. 7th edition. Wiley-Blackwell, Oxford, UK
4. Weaver R.F (2004) Molecular Biology. McGraw-Hill

5. Rastogi V.B. (2016) Principles of Molecular Biology. Medtech Publisher.

Reference Books:

1. Craig N, Green R, Greider C, Storz G, Wolberger C, Cohen-Fix O. (2014). Molecular Biology: Principles of Genome Function 2nd Edition, Oxford University Press, USA
2. Macinski, G.M. (2015). Freifelder's Essentials of Molecular Biology, 4th Edition, Jones & Bartlett Publishers.
3. Alberts B, Johnson A.D, Lewis J, Morgan D, Raff M, Roberts K , Walter P (2014). Molecular Biology of the Cell , 6th Edition, W. W. Norton & Company.
4. Freifelder D. (2004). Molecular Biology, 2nd edition. Narosa Publishing House.
5. Karp G, Iwasa J, Marshall W (2019) Karp's Cell and Molecular Biology: Concepts and Experiments, 8th Edition Wiley
6. Burrel, M.M. (1993). Enzymes of Molecular Biology, Humana Press.
7. Blackburn G.M, Gait M.J, Loakes D, David M.W (2005). Nucleic acids in chemistry and biology, 3rd Edition, Royal Society of Chemistry.
8. Watson JD, (2017). Molecular Biology of the Gene, 7th Edition, Pearson.
9. Lewin, B. (2000). Lewin's Genes XII. Oxford University Press, Oxford.
10. Tropp BE (2012) Principles of Molecular Biology, Jones and Bartlett Publishers
11. Clark D.P, Pazdernik N.J, (2012) Molecular Biology, 2nd Edition Academic Cell.
12. Lundblad RL, Macdonald F (2018) Handbook of Biochemistry and Molecular Biology, 5th Edition CRC Press.
13. Primrose SB, Twyman R (2013) Principles of Gene Manipulation and Genomics 7th Edition Wiley-Blackwell Publisher.

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/

CORE III PRACTICAL: MOLECULAR BIOLOGY

CO No.	Course Outcome
CO-1.	Practice to estimate DNA and RNA
CO-2.	Learn to isolate Plasmid, Genomic and Chromosomal DNA.
CO-3.	Learn to isolate RNA and antibiotic resistant mutants.
CO-4.	Acquire Knowledge in protein by Lowry's method.
CO-5.	Acquire Knowledge in DNA molecular size determination.

UNIT I

Estimation of DNA by diphenylamine method, Estimation of RNA by orcinol method.

UNIT II

Isolation of Plasmid DNA by alkalilysis method. Isolation of genomic DNA from prokaryotes.

UNIT III

Isolation of RNA from yeast.

Isolation of antibiotic resistant mutants.

UNIT IV

Estimation of protein by Lowry's method.

UNIT V

DNA molecular size determination.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Reference Books:

1. Hames, B.D. and Rickwood, D. (1990). Gel Electrophoresis – A Practical Approach, Oxford University Press, New York.
2. Sambrook, J and Russell, D.W. (2001). Molecular Cloning – A Laboratory Manual, 3rd Edition, Vol I, II, III, Cold Spring Harbour Laboratory Press, New York.
3. Westermeier, R. (1993). Electrophoresis in Practice, VCH, Federal Republic of Germany.
4. Wilson, K. and Walker (1995). Practical Biochemistry, Principle and Techniques, IV Edition, Cambridge University Press.
5. Saxena J, Baunthiyal M, Ravi I (2012). Laboratory Manual of Microbiology, Biochecmisry and Molecular Biology Scientific Publisher.
6. Carson S, Miller H, Srougi M, Witherow D.S (2019) Molecular Biology Techniques, 4th Edition, Academic Press

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/

ALLIED III THEORY: BIOINSTRUMENTATION

CO No.	Course Outcome
CO-1.	By the end of the course, the student should be able to learn about the principle, application and uses of various laboratory equipments
CO-2.	Learn the principles, types and application of different chromatography techniques
CO-3.	Understand the mechanisms, types and application of electrophoresis techniques
CO-4.	Know about the mechanisms, uses and different types of spectrophotometer
CO-5.	Understand the principle and application of radioisotopes in the field biology.

UNIT I

Basic laboratory Instruments

Common laboratory equipment –anaerobic incubator – Biosafety Cabinent - Principle and working of pH meter, Laminar-air flow. Centrifugation: Types (low speed, high speed and ultracentrifuge), principles and their applications- Lyophilizer - Flow cytometry.

UNIT II

Chromatographic techniques

Theory, principles, detection methods and applications of paper, thin layer, gel filtration - ion exchange and molecular sieve chromatography.

UNIT III

Electrophoretic techniques

Basic principles of electrophoresis, theory and application of paper, agarose gel electrophoresis, SDS-PAGE, Blotting methods.

UNIT IV

Spectroscopy

Spectroscopic techniques, principle, mechanism and applications of basic calorimeter, UV, Visible, NMR, Fluorescence spectrophotometer,

UNIT V

Radioisotopic techniques

Use of radioisotopes in life sciences, radioactive labeling, principle and application of tracer techniques, detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger- Muller and Scintillation counters, autoradiography and its applications.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books

1. Sharma B.K. (2014) Instrumental Method of Chemical Analysis Krishna Prakashan Media (P) Ltd.
2. Chatwal G.R, Anand S.K. (2014) Instrumental Methods of Chemical Analysis. Himalaya Publishing House.
3. Mitchell G.H. (2017) Gel Electrophoresis: Types, Applications & Research. Nova Science Publishers Inc.
4. Holme D, Peck H (1998) Analytical Biochemistry 3rd edition, Prentice Hall.
5. Jayaraman J (2011). Laboratory Manual in Biochemistry – 2ndedn- Wiley Eastrn Ltd., New Delhi.

Reference Books:

1. Wilson K, Goulding K.H (1991) A Biologist's Guide to Principles and Techniques of Practical Biochemistry, 3rd edition Cambridge University Press.
2. 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.
3. Pavia D.L. (2012) Spectroscopy, 4th edition Cengage.
4. Miller J.M. (2007) Chromatography: Concepts and Contrasts, 2nd edition, Wiley-Blackwell.
5. Skoog A.,West M. (2014). Principles of Instrumental Analysis – 14thedn- W.B.Saunders Co., Philadephia.
6. N.Gurumani. (2006). Research Methodology for biological sciences- 1stedn - MJP Publishers.
7. Ponmurugan. P and Gangathara PB (2012). Biotechniques. 1st edn- MJP 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. https://norcaloa.com/BMIA 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
5. http://www.rsc.org/learn-chemistry/collections/spectroscopy/introduction.

ALLIED III – Paper III : PRACTICAL III (BIOINSTRUMENTATION)

CO No.	Course Outcome
CO-1.	By the end of the course, the student should be able to learn about the principle pH titration and draw the pKa values of acids
CO-2.	Learn about the separation of biomolecules using chromatography techniques. Understand the mechanisms and uses of electrophoresis techniques. Know about the principle and application of UV spectrophotometer
CO-3.	To Know about the quantitative estimation various chemicals using gas chromatography. Understand the principle and uses of PCR, sequencer, flow cytometry and fermenter
CO-4. .	Learn the calibration of pH meter. Learn the calibrate the weighing balance.
CO-5.	To Assess the quality of Autoclaving.

UNIT I

Studies on pH titration curves of amino acids/ acetic acid and determination of pKa values and Handerson-Hasselbach equation.

UNIT II

Separation of bacterial lipids/amino acids/sugars/ by TLC or Paper Chromatography, Separation of serum protein by horizontal submerged gel electrophoresis. Study of UV absorption spectra of macromolecules (protein, nucleic acid, bacterial pigments).

UNIT III

Quantitative estimation of hydrocarbons/pesticides/organic Solvents /methane by Gas chromatography. (Demonstration), Demonstration of PCR, DNA sequencer, Fermenter, Flow cytometry

UNIT IV

Experiment method for Calibration of $_{P}$H meter using standard buffer solutions. Laboratory methods to calibrate the weighing balance.

UNIT V

Experimental procedure for assessment of Autoclaving quality in laboratory standard.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Mitchell G.H. (2017) Gel Electrophoresis: Types, Applications & Research. Nova Science Publishers Inc.\
2. Keith Wilson and John Walker 2002 practical biochemistry – Principles and techniques. Fifth edn. Cambridge Univ. Press.
3. P. Asokan 2002. Analytical biochemistry – Biochemical techniques. First edition – Chinnaa publications, Melvisharam, Vellore
4. Rodney Boyer, 2001. Modern Experimental Biochemistry. III Ed. Addison Wesley Longman Pte. Ltd, Indian Branch, Delhi, India.
5. Chatterjea, M. N., & Shinde, R. (2011). *Textbook of medical biochemistry*. Wife Goes On.
6. Lehninger, A. L. (2004). *Lehninger Principles of Biochemistry: David L. Nelson, Michael M. Cox*. Recording for the Blind & Dyslexic.
7. Instrumental Methods of Analysis. 6th Edition by H.H. Willard, L.L. Merritt Jr. and others. 1986. CBS Publishers and Distributors.
8. Instrumental Methods of Chemical Analysis. 1989 by Chatwal G and Anand, S.Himalaya Publishing House, Mumbai.
9. A Biologists Guide to Principles and Techniques of Practical Biochemistry. 1975 by Williams, B.L. and Wilson, K.

References Books:

1. N. Gurumani 2010 Research Methodology for Biological Sciences. MJP Publishers, Chennai.
2. Chatwal G.R, Anand S.K. (2014) Instrumental Methods of Chemical Analysis. Himalaya Publishing House
3. David T. Plummer 1988. An introduction to practical biochemistry, Tata Mc Graw Hill pub. Co. Ltd, New Delhi.
4. J. Jeyaraman 1981. Laboratory Manual in Biochemistry. New Age International publishers, New Delhi.
5. S. Palanichamy and M. Shunmugavelu 2009. Research methods in biological sciences. Palani paramount publications, Palani.
6. K. Kannan 2003 Hand book of Laboratory culture media, reagents, stains and

buffers Panima publishing corporation, New Delhi.

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.wikiscales.com/articles/electronic-analytical-balance/
2. https://study.com/academy/lesson/what-is-chromatography-definition-types-uses.html
3. http://www.rsc.org/learn-chemistry/collections/spectroscopy/introduction.
4. http://www.biologydiscussion.com/biochemistry/centrifugation/centrifuge-introduction- types-uses-and-other-details-with-diagram/12489

FOURTH SEMESTER

CORE IV THEORY : SOIL AND AGRICULTURAL MICROBIOLOGY

CO No.	Course Outcome
CO-1.	Upon successful completion of this course, the student should be able to understand types, structure, formation of soil and microbial flora
CO-2. .	Understand the role soil microflora in biogeochemical cycle in the environments
CO-3.	Know about the mechanism and responsibility of microbial interaction with microbes, plant, animal and insects.
CO-4.	Be familiar with the role of microorganism as biofetrilizer and know about the types and mode of action of biopesticides,
CO-5.	Know about defense mechanism, etiology, epidemiology and management various plant diseases caused by microorganisms

UNIT I

Soil microbiology - quantitative and qualitative micro flora of different soils-role of microbes in soil fertility-tests for soil fertility - soil structure, soil formation - characterization of soil types and importance.

UNIT II

Biogeochemical cycles-role of micro organisms in carbon, phosphorus, sulphur and iron cycles. Nitrogen cycle; ammonification- nitrification- de-nitrification- nitrogen fixation, organic matter decomposition.

UNIT III

Microbial interactions between microorganisms – Neutralism, Commensalism, symbiosis, Ammensalism, Parasitism, predation and competition. Interrelation between soil microbes and plants -Rhizoplane, rhizosphere, phyllosphere, spermosphere, mycorrhizae. Microbial association with insects- - symbiosis between microbes and insects.

UNIT IV

Bio-fertilizers (Azotobacter, Rhizobium, cyanobacteria, azolla and VAM), Biopesticides – *Bacillus thuringiensis, Psuedomonas fluroscence - 84, Trichoderma viridae, Bavaria bassiana,* Nuclear Polyheadrosis Virus.

UNIT V

Principles of plant infection and defense mechanisms. Symptoms, Etiology, Epidemiology and Management of the following plant diseases: Bacterial disease – Citrus canker, blight of paddy, Fungal disease- Red rot of sugarcane, Black stem rust of wheat, Tikka leaf spot of ground nut, Wilt of cotton, Viral Disease – TMV, Vein clearing disease.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Subbarao N.S. (2017) Soil Microbiology, 5th edition, Medtech publisher.
2. Paul E.A (2014) Soil Microbiology, Ecology and Biochemistry, 4th edition, Academic Press.
3. Rangaswami G (1992) Agricultural Microbiology, 2nd edition, Prentice Hall India Learning Private Limited.
4. Trivedi P.C. (2010) Agricultural Microbiology, Pointer Publishers.
5. Subbarao N.S. (2017). Advance in Agriculture Microbiology, Medtech Publisher.
6. Verma D.K, Srivastav P.P (2017) Microorganisms in Sustainable Agriculture, Food, and the Environment. 1st edition Apple Academic Press.
7. Subbarao N.S. (2017) Bio-fertilizers in Agriculture and Forestry Medtech Publisher.
8. Pandey, S.N. and Sinha, B.K (2005) Plant Physiology,4th edition Vikas Publishing House, New Delhi.

Reference Books:

1. Hakeem K.R, Akhtar M.S.,Abdullah S.N.A, (2016) Plant, Soil and Microbes, Volume 1: Implications in Crop Science, Springer.
2. Alef K, Nannipieri P (1995) Methods in Applied Soil Microbiology and Biochemistry, Academic Press.
3. Subbarao N.S. (2018)Soil Microbiology : Soil Microorganisms & Plant Growth, Oxford & Ibh Publishing Co Pvt Ltd.
4. Pareek R.P (2018) Agricultural Microbiology, Scientific Publishers India.

Journals:

1. **Soil Microbiology:** https://www.nature.com/subjects/soil-microbiology
2. **European Journal of Soil Biology:** https://www.journals.elsevier.com/european-journal-of-soil-biology
3. **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.

CORE IV –PRACTICAL: SOIL AND AGRICULTURAL MICROBIOLOGY

CO No.	Course Outcome
CO-1.	By the end of the course, the student should be able to learn different methods for the isolation and enumeration of soil microorganisms
CO-2.	Understand the mechanisms and application of enzymes produced by soil microorganisms
CO-3.	Know about the role and methods used for the isolation and identification of *Rhizobium* and *Azotobacter.*
CO-4.	Know about the methods used for isolation and identification of nitrogen fixing algae and its antagonistic effects.

CO-5.	Understand the causes, symptoms, control and treatment of various plant diseases caused by microorganisms.

UNIT I

Methods to study soil microorganisms - Isolation and enumeration of Bacteria, Fungi, Bacteriophages, Algae, Protozoa etc., Microbiological test for fertility - Bacterial and Fungal

UNIT II

Microbiological demonstration of soil enzymes – Amylase, Protease, Lipase, Gelatinase etc.

UNIT III

Isolation and identification of root nodule bacteria- Rhizobium (symbiotic), demonstration of rhizobium in the root nodule (CS of root nodule) Isolation and identification of Azotobacter (Asymbiotic).

UNIT IV

Isolation and identification of nitrogen fixing Cyanobacteria-Anabaena, Nostoc etc., Demonstration of Azolla. Demonstration of antagonistic activity –bacterial and fungal.

UNIT V

Study of the following diseases: Tobacco mosaic; Bacterial blight of paddy; Downy mildew of bajra; Powdery mildew of cucurbits; Head smut of sorghum; Leaf rust of coffee; Leaf spot of paddy, Red rot of sugar cane, Root knot of mulberry.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. P. C. Trivedi (2010) Agricultural Microbiology, Pointer Publishers (January 1, 2010), ISBN-10: 8171326153
2. Eldor A. Paul (2014) Soil Microbiology, Ecology and Biochemistry, Fourth Edition,
3. Ramanathan, and Muthukaruppan SM (2005) Environmental Microbiology. OmSakthi Pathipagam, Annamalai Nagar.
4. Bagyaraj, D.J. and A. Manjunath. 1990. Mycorrhizal symbiosis and plant growth, Univ. of Agricultural Sciences, Bangalore, India.
5. Pandey, S.N. and Sinha, B.K (2005) Plant Physiology,3rd Edn.Vikas Publishing House, New Delhi
6. Mukherji, S. and Gosh, A.K. (2004) Plant Physiology .Tata McGraw Hill Publishers, New Delhi.
7. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology. Wassworth Publication. Co.. Belmont

Reference Books:

1. Alef K, Nannipieri P (1995) Methods in Applied Soil Microbiology and Biochemistry, Academic Press.
2. Pareek R.P (2018) Agricultural Microbiology, Scientific Publishers India.
3. Hakeem K.R, Akhtar M.S.,Abdullah S.N.A, (2016) Plant, Soil and Microbes, Volume 1: Implications in Crop Science, Springer.
4. Subbarao N.S. (2018)Soil Microbiology : Soil Microorganisms & Plant Growth, Oxford & Ibh Publishing Co Pvt Ltd.

Journals:

1. **PMC:** https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3938205/
2. **International Journal of Microbiology:** https://www.hindawi.com/journals/ijmicro/2012/693982/
3. **Biomed Research International:** https://www.hindawi.com/journals/bmri/2019/3638926/

Web Resources:

1. www.life.umd.edu/classroom/bsci424/BSCI223WebSiteFiles/LectureList.htm
2. www.microbiologyonline.org.uk
3. https://microbiologyinfo.com/top-and-best-microbiology-books/
4. https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404
5. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/biogeochemical-cycle.
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3588038/.
7. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/biofertilizer.
8. https://www.nature.com/subjects/soil-microbiology.

PART III – THEORY: ALLIED - PAPER IV – BIOSTATISTICS

CO No.	Course Outcome
CO-1.	To study the types of biological data, Populations, samples from populations, random sampling, parameters and statistics.
CO-2.	Students will be able differentiate between the mean, the median, and the mode
CO-3.	To learn about the probability and distribution.
CO-4.	To understand the testing of hypothesis.

CO-5.	Familiar in recognize correlation and regression analysis.

UNIT I

Introduction: To study the types of biological data, Populations, samples from populations, random sampling, parameters and statistics.

UNIT II

Measures of Central Tendency: Mean; median; mode; geometric mean; harmonic mean. Measures of Dispersion: Range; variance; standard deviation, coefficient of variation; standard error.

UNIT III

Probability: Mathematical probability and statistical probability; Laws of probability; addition law and multiplication law; conditional probability. Probability Distribution: Normal distribution; binomial distribution and poisson distribution.

UNIT IV

Testing for goodness of fit: Chi-square test for goodness of fit; statistical significance; statistical errors in hypothesis testing; chi-square test for contingency tables; heterogeneity chi-square test. Test of hypothesis: Normal deviation test, tests for proportions, t-test.

UNIT V

Simple linear regression and correlations: Simple linear regression; testing the significance of a regression; comparison of two slopes; correlation coefficient – hypothesis testing about correlation coefficients; comparison of two correlation co-efficients; rank correlation; intraclass correlation.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books

1. Vittal P.R. (2002) Mathematical statistics, Margham Publications.
2. Gupta S.C. (2014) Fundamentals of Mathematical Statistics. Sultan Chand & Sons.
3. Gupta S.P. (2014) Statistical Methods. Sultan Chand & Sons.
4. Banerjee PK (2007) Introduction to Bio-Statistics 3rd edition S Chand
5. Antonisamy B , Premkumar P.S, Christopher S (2017) Principles and Practice of Biostatistics Elsevier India.

Reference Books

1. Miller I, Miller M. (2014) John E. Freund's Mathematical Statistics with Applications, Pearson.
2. Daniel W.W, Cross C.L. (2014) Biostatistics: Basic Concepts and Methodology for the Health Sciences, 10th edition, Wiley
3. Rastogi V.B. (2015) Biostatistics 3rd edition Medtech.
4. Bailey N.T.J. (2000) Statistical Methods in Biology 3rd edition Cambridge University Press

Journals:

1. **Statistical Methods in Medical Research:** https://journals.sagepub.com/home/smm
2. **Biostatistics:** https://academic.oup.com/biostatistics
3. **Statistical Applications In Genetics And Molecular BIOLOGY:** https://www.degruyter.com/view/ j/sagmb?lang=en

Web Resources:

1. https://www.easybiologyclass.com/biostatistics-free-lecture-notes-online-tutorials-ppts-and-mcqs/
2. http://www.biologydiscussion.com/biostatistics-2/statistics-definition-characteristics-and-classes-biostatistics/47440.
3. http://sphweb.bumc.bu.edu/otlt/MPHModules/BS/BS704_BiostatisticsBasics/BS704_BiostatisticsBasics_print.html

PART III : ALLIED PRACTICAL - IV – BIOSTATISTICS

CO No.	Course Outcome
CO-1.	To familiarize in calculating mode, median and mean.
CO-2.	Learn to Compute and interpret a correlation and coefficients in a linear regression analysis
CO-3.	Understand what the parameter means in Binomial and Poisson and learn to know how to compute the probability using the PMF for both Binomial and Poisson distribution
CO-4.	Students will be able to identify an appropriate significance test and to know and apply the significance test.
CO-5.	Understand the basics of experimental design, including the definition of the experimental unit, response, variable, factor(s), and level(s) of a basic experiment, and the role of randomization and replication to permit causal inference.

UNIT I

Frequency distribution – Univariate – Bivariate; Measure of central tendency

UNIT II

Measure of dispersion; Correlation, Regression

UNIT III

Fitting distribution – Binomial – Poison – Method of least squares

UNIT IV

Tests of significance – T – F; Tests of significance – Chi-square – Attributes

UNIT V

ANOVA; Design of experiments – CRO, RBD, LSD

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books

1. Vittal P.R. (2002) Mathematical statistics, Margham Publications.
2. Gupta S.C. (2014) Fundamentals of Mathematical Statistics. Sultan Chand & Sons.
3. Gupta S.P. (2014) Statistical Methods. Sultan Chand & Sons.
4. Banerjee PK (2007) Introduction to Bio-Statistics 3rd edition S Chand
5. Antonisamy B , Premkumar P.S, Christopher S (2017) Principles and Practice of Biostatistics Elsevier India.

Reference Books

1. Miller I, Miller M. (2014) John E. Freund's Mathematical Statistics with Applications, Pearson.
2. Daniel W.W, Cross C.L. (2014) Biostatistics: Basic Concepts and Methodology for the Health Sciences, 10th edition, Wiley

3. Rastogi V.B. (2015) Biostatistics 3rd edition Medtech.
4. Bailey N.T.J. (2000) Statistical Methods in Biology 3rd edition Cambridge University Press

Web Resources:

1. https://www.easybiologyclass.com/biostatistics-free-lecture-notes-online-tutorials-ppts-and-mcqs/
2. http://www.biologydiscussion.com/biostatistics-2/statistics-definition-characteristics-and-classes-biostatistics/47440.
3. http://sphweb.bumc.bu.edu/otlt/MPHModules/BS/BS704_BiostatisticsBasics/BS704BiostatisticsBasics_print.html

FIFTH SEMESTER

CORE V-THEORY: MEDICAL BACTERIOLOGY

CO No.	Course Outcome
CO-1.	To obtain knowledge on handling of clinical specimens of bacterial samples and learn the method of collection, transport and processing of clinical samples.
CO-2.	Students learn as diagnostic part of any specimen to identifying the antibiotic sensitive bacteria.
CO-3.	Learn the morphology, cultural characters, biochemical analysis, clinical finding and lab diagnosis of gram positive bacteria.
CO-4.	Know about medically important gram negative bacteria and diseases.
CO-5.	Learn the morphology, cultural characters, biochemical analysis, clinical finding and lab diagnosis, treatment of spirochetes, sexually transmitted microorganisms and miscellaneous microorganisms.

UNIT I

Classification and general properties of medically important bacteria. Human infections: primary Infection, opportunistic pathogens, microbial Invasion, infection

& diseases. Recommendation for collection, transport of specimens, isolation of bacteria from clinical specimens.

UNIT II

Primary media for isolation and their quality control - Antibiotic sensitivity testing procedures -Stokes & Kirby Bauer methods - Disc diffusion - Dilution -Agar dilution & broth dilution -MBC/MIC - Quality Control for antibiotics and standard strains.

UNIT III

Morphology, culture, biochemical, pathogenicity, laboratory diagnosis, treatment and prevention of bacterial diseases - *Staphylococcus aureus, Streptococcus pyogens, Corynebacterium diphtheria, Mycobacterium tuberculosis, Bacillus anthracis, Clostridium tetani, Enterococcus faecium, Neisseria gonorrhoeae and Neisseria meningitides.*

UNIT IV

Morphology, culture, biochemical, pathogenicity, laboratory diagnosis and prevention of bacterial diseases - *Escherichia coli, Klebsiella pneumoniae, Proteus vulgaris, Salmonella typhi, Shigella dysentriae, Vibrio cholerae, Pseudomonas aeruginosa, Haemophilus influenza*

UNIT V

Morphology, culture, biochemical, pathogenicity, laboratory diagnosis and prevention of bacterial diseases - *Bordetella pertusis., Brucella* sp., *Helicobacter pylori, Mycoplasma pneumoniae, Rickettsia rickettsii, Trepenema pallidum and Leptiospira sp.,*

Text Books:

1. Riedel S, Morse S, Mietzner T, Miller S (2019) Jawetz Melnick & Adelbergs Medical Microbiology 28th edition McGraw-Hill.

2. Kanungo R (2017) Ananthanarayan and Paniker's Textbook of Microbiology 10th edition. The Orient Blackswan.
3. Dubey RC and Maheswari DK (2013). A text book of Microbiology, 4th edition, S.Chand Publishers, New Delhi.
4. Joanne Willey and Linda Sherwood (2013) Prescott's Microbiology, McGraw-Hill Education; 9 edition (January 8, 2013). ISBN-10: 0073402400
5. Hawkey P, Lewis D Medical Bacteriology: A Practical Approach 2nd edition OUP Oxford.

Reference Books:

1. DelaMaza L.M, Peterson E.M, Pezzlo M.T, Shigei J.T. (2013) Color Atlas of Medical Bacteriology 2nd edition. Wiley-Blackwell.
2. Wilson M, McNab R, Henderson B (2002) Bacterial Disease Mechanisms: An Introduction to Cellular Microbiology. Cambridge University Press
3. Sleigh J.D. (1998) Notes on Medical Bacteriology, Churchill Livingstone.
4. Patrick R. Murray and Ken S. Rosenthal (2015) Medical Microbiology, Elsevier
5. Balows, A., Hauser Jr K.L., Isenberg, H.D., Shalomy, H.J. (1991). Manual of Clinical Microbiology, ASM, Washington D.C.

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

CORE VI- THEORY: MEDICAL MYCOLOGY AND PARASITOLOGY

CO No.	Course Outcome
CO-1.	The students learn about able the systematic of classification & essentials of fungal taxonomy.
CO-2.	To understand the medically important dermatophytic fungi, opportunistic fungi and subcutaneous fungi for its morphology, characteristic features and lab diagnosis, treatment.
CO-3.	The students will obtain knowledge on handling of clinical specimens of fungal samples. They acquire aseptic method of collection, transport, isolation and testing of medically important fungi.
CO-4.	The students learn about classification and importance of intestinal parasite and blood parasites.
CO-5.	To understand morphology, cultural characters, biochemical analysis, clinical finding, lab diagnosis and treatment of intestinally important cestodes, nematodes and helminthes.

UNIT I

Introduction to Medical Mycology. Fungal Morphology, Taxonomy-Binomial nomenclature, fungal repository, Classification of medically important fungi. General characteristics of Zygomycetes, Ascomycetes, Basidiomycetes and Duteromycetes.

UNIT II

Superficial mycoses – *Tinea piedra*, Cutaneous mycoses: Dermatophytoses – (Trichophyton, Epidermophyton and Microsporum). Subcutaneous mycoses - Sporotrichosis, Mycetoma, Opportunistic mycoses – Aspergillosis and Candidiasis. Systemic mycoses - Histoplasmosis, Cryptococcosis

UNIT III

Collection and transport of specimens, isolation of fungi from clinical specimens. Modern methods - Molecular diagnosis, serological tests for fungal infections. Mycotoxins, Antifungal agents – Classification, Mechanism of action, Drug resistance and sensitivity testing methods and quality control.

UNIT IV

Introduction to medical Parasitology – Classification, Intestinal protozoa – *Entameoba histolytica,* Intestinal and genital flagellates - *Giardia intestinalis, Trichomonas vaginalis,* Ciliates – *Balantidium coli*. Haemoflagallates - *Leishmania donovani – Trypanosoma cruzi*. Blood protozoan – *Plasmodium falciparum.*

UNIT V

Platyhelminthes: cestodes - *Taenia saginata, Taenia solium* . Trematodes – *Fasciola hepatica, Paragonimus westermani, Schistosoma haematobium.* Nematihelminthes: Intestinal nematodes - *Ascaris lumbricoids, Ancylostoma duodenale, Trichuris trichiura. Enterobius vermicularis*. Filarial nematodes - *Wuchereria bancrofti, Dracunculus medinensis* . Laboratory diagnosis - Examination of cyst and ova by Concentration methods. Blood smear examination for parasites. Cultivation of protozoan parasites.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Dube H.C (2012) An Introduction to Fungi: 4th Edition, Scientific Publishers.
2. Paniker C.J.K, Ghosh S (2018) Paniker's Textbook of Medical Parasitology 8th edition Jaypee Brothers Medical Publishers.
3. Sastry A.S, Bhat S. (2018) Essentials of Medical Parasitology, 2nd edition Jaypee Brothers Medical Publishers.
4. Chander J (2018) Textbook of Medical Mycology 4th edition Jaypee Brothers Medical Publishers.
5. Baveja V, Baveja C.P (2019) Medical Parasitology, 4th edition Arya Publishing Company.

Reference Books:

1. Procop G.W, Koneman E.W (2016) Koneman's Color Atlas and Textbook of Diagnostic Microbiology 7th edition, Lippincott Williams and Wilkins.
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.

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

CORE VII THEORY: MEDICAL VIROLOGY

CO No.	Course Outcome
CO-1.	To study the general properties, cultivation and Detection techniques.
CO-2.	Understand the morphology, pathogenecity, clinical feature, diagnosis and treatment, prophylaxis of arthropod and zoonotic viruses.
CO-3.	Information about the viruses like Pox, HIV, Flavi, Oncogenic viruses and recent viral outbreaks.
CO-4.	Bacteriophages- properties, life cycle and importance in microbiology.
CO-5.	Viral disease- prevention, diagnosis and treatment.

UNIT I

General Properties of viruses – classification- Cultivation of Viruses. Detection of viruses and antigens in clinical specimens – Serological diagnosis of virus infections.

UNIT II

Arthropod borne- chikungunya ; rodent borne virus – Hanta virus; Picorna viruses – Polio virus and Rhinovirus; Hepatitis viruses; Zoonotic virus – Rabies virus ; neuro viruses - Nipah; Orthomyxoviruses – influenza virus and Paramyxoviruses – Parainfluenza, mumps, measles.

UNIT III

Pox virus – Variola, Vaccinia; Adeno virus; Herpes virus – Herpes simplex virus type I & type II; Reo viruses - Rota virus; HIV Viruses; Flavi viruses - Dengue virus and yellow fever virus; Oncogenic viruses – Human papilloma virus, study of recent outbreak human viral diseases (Ebola, swine flu); Zika virus.

UNIT IV

Viruses of importance to bacteria – Bacteriophages – Their Structure, life cycle, types – Application in Microbiology.

UNIT V

Applied virology – Viral diseases, epidemiology diagnosis, prevention and treatment. Antiviral agents – Interferons, Viral vaccines - types, their Preparation.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Dimmock N, Easton A, Leppard K. (2006) Introduction to Modern Virology, 6th edition John Wiley & Sons.
2. Burrell C, Howard C, Murphy F (2016) Fenner and White's Medical Virology 5th edition Academic Press.
3. Mishra B (2017) Textbook of Medical Virology, CBS Publishers.
4. Flint J.S, Racaniello V.R, Krug R (2015) 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.

Reference Books:

1. Dimmock N.J, Easton A.J, Leppard K.N. (2007) Introduction to Modern Virology, 6th edition, John Wiley and Sons Ltd.
2. Carter J, Saunders V (2013) Virology Principles and Applications 2nd edition. John Wiley & Sons.
3. Roger Hull (2002). Mathews' Plant Virology. (4thEdition). Academic press-A Harcourt Science and technology company, New York.
4. Flint S.J, Enquist L.W, Racaniello V.R, Skalka A.M. (2009) Principles of Virology 3rd edition, ASM press.
5. Acheson N.H. (2011) Fundamentals of Molecular Virology, 2nd edition Wiley.
6. Loeffelholz M, Hodinka R.L, Young S, Pinksy B (2016) Clinical Virology

Manual, 5th edition ASM Press.

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/

CORE V – PRACTICAL: BACTERIOLOGY, MYCOLOGY, PARASITOLOGY AND VIROLOGY

CO No.	Course Outcome
CO-1.	To develop skills for collection, transport and isolate the medically important bacteria from various clinical specimens
CO-2.	Learn about isolation and identification of clinically important bacteria.
CO-3.	To Understand methods for isolating viruses, bacteriophages.
CO-4.	Learn about both conventional and advanced techniques for isolation and identification of medically important fungi
CO-5.	To be familiar with various morphological features to identify the intestinal and blood protozoans.

UNIT I

General requirements of collections, transport of clinical Specimens – Methods of selective and enrichment culture techniques used to isolate organisms from clinical materials. Simple, differential and special staining of clinical materials viz: Throat swab, Pus, Urine, Sputum, Stool. Enumeration of Bacteria in Urine, Quantitative Urine Culture.

UNIT II

Isolation and identification of bacterial pathogens from clinical specimens (Throat, blood, swab, Pus, Urine, Sputum, Stool) and their biological reactions: using Morphological identification, cultural characterization, Biochemical identification, and antimicrobial Sensitivity testing by disc-diffusion technique using standard antibiotics and determination of MBC/MIC.

UNIT III

Identification of pathogenic viruses in Slides/ Smears / Spotters of viral inclusion and CPE. Isolation of bacteriophage from natural sources.

UNIT IV

KOH and Lactophenol preparations for skin/nail scrapings for dermatophytes. Microscopic identification medically important fungi/lab contaminants - Gomori / PAS and Methanamine staining, cultural characteristics. Cultivation and identification of *Trichophyton* sp., *Microsporum* sp., *Epidermophyton* sp., *Aspergillus* sp., *Penicillium* sp., *Mucor* sp., and *Rhizopus* sp., *candida albicans* - Germ tube test, carbohydrate assimilation and fermentation tests for yeasts.

UNIT V

Direct examination of faeces- wet mount and Lugol's iodine method- demonstration of protozoan cysts and helminthes eggs. Concentration techniques of stool specimen- floatation and sedimentation methods. Examination of blood for malarial parasites- thin and thick smear preparation. dentification of pathogenic parasites in slides/ specimens as spotters.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Collee, J.C., Duguid, J.P., Fraser, A.C. and Marimon, B.P. (1996), Mackie and McCartney Practical Medical Microbiology, 14thedn. Churchill Livingstone, London.
2. Medical Microbiology. (2008) MIMS. 5thednElsevier Ltd.
3. Ronald M. Atlas, Lawrence C. Pazis (1993) Hand book of Microbiological Media. Ed. LC. CRC Press, London.
4. Jawetz, E., Melnick, J.L. and Adelberg, E.A., (1991), Review of Medical Microbiology 19thedn. Lange Medical Publications, USA.
5. Burrell C, Howard C, Murphy F (2016) Fenner and White's Medical Virology 5th 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.

Reference Books:

1. Carter J, Saunders V (2013) Virology Principles and Applications 2nd edition. John Wiley & Sons.
2. Jeyaram Paniker, C.K. (2006) Text Book of Parasitology. Jay Pee Brothers,

New Delhi.
3. Schmidt, G.D. and Roberts, L.S. (1981) Foundations of Parasitology, 2nd Edn, Mosby, St. Louis.
4. Finegold, S.M. (2000) Diagnostic Microbiology, 10th Edn. C.V. Mosby Company, St. Louis
5. Jagadish Chander (1996) A Text Book of Medical Mycology. Interprint, New Delhi.
6. Arora, D.R. and Arora, B.(2002) Medical Parasitology, 1st Edn.
7. CBS Publishers & Distributors, New Delhi.
8. Levanthal R. and Cheadle R.S. (2012), Medical Parasitology, 6th edition, S.A.Davies Co., Philadelphia.

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 1 – THEORY: MICROBIAL GENETICS AND GENETIC ENGINEERING

CO No.	Course Outcome

CO-1. .	Gains basic knowledge on the concept of gene and gene transfer mechanism.
CO-2.	Learn about the mutation types and its detection.
CO-3.	Gives wide knowledge on various vectors for gene cloning.
CO-4.	Obtain ideas on the various enzymes used in genetic engineering.
CO-5.	Provides over view on the methods of gene cloning and gene transfer.

UNIT I

Molecular concept of gene. Gene transfer mechanisms- Transformation - Discovery, mechanism of natural competence - Conjugation - Discovery, F+ *v/s* F-, Hfr+ *v/s* F-. Transduction – Generalized and specialized transductions. Structures and types of bacterial transposons, Recombination and its types.

UNIT II

Mutations – spontaneous and induced, base pair changes, frame shifts, deletions, inversions, insertions. DNA repair mechanisms, Ames test, Role of mutation in evolution.

UNIT III

Vectors: Plasmid vectors: pSC101, pBR322, pUC series and Ti plasmids based vectors; Bacteriophage vectors: Lambda phage based vectors, phagemids, cosmids, and M13 based vectors; Viral vectors: Vaccinia, Retroviral, SV40 and Baculoviral system.

UNIT IV

Restriction endonucleases: Discovery, Type I, II and III and Mode of action, Taq DNA Polymerases, Methylases, Topoisomerases, Gyrases, and Reverse Transcriptases. Methods of Gene transfer in bacteria – Electroporation, microinjection and biolistics. Major steps of cloning techniques; Genomic DNA and cDNA library construction.

UNIT V

Selection and Screening of recombinants- Direct Method: Selection by Complementation, Marker inactivation methods – Indirect methods: Immunological and Genetic methods. Polymerase chain reaction; Blotting techniques- Southern, Northern, Western.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Primrose SB (2001) Molecular Biotechnology, 2nd edition, Panima Publishing Corporation.
2. Chen B.Y, Janes H.W. (2002) PCR Cloning Protocols 2nd edition, Humana press.
3. Brown T.A. (2016) Gene Cloning and DNA Analysis: An Introduction 7th Edition. Wiley-Blackwell.
4. Watson J.D, Tania A.B, Stephen P.B, Alexander G, Michael L, Richard L.(2017) Molecular Biology of the Gene, 7th edition, Pearson Education

Reference Books:

1. Cibelli J, Wilmut I, Jaenisch R, Gurdon J, Lanza R, West M, Campbell K. (2013). Principles of Cloning 2nd Edition, Academic Press.
2. Glick B.J, Pasternak J.J, Patten C.L. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA, ASM Press.

3. Primrose S.B, Twyman R. (2013) Principles of Gene Manipulation and Genomics, 7 edition, Wiley-Blackwell.
4. Glazer A.N, Nikaido H. (2007). Microbial Biotechnology: Fundamentals of Applied Microbiology Cambridge University Press; 2 edition
5. Lewin, B. (2000). Lewin's Genes XII. Oxford University Press, Oxford.

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

SIXTH SEMESTER

CORE VIII- THEORY: ENVIRONMENTAL MICROBIOLOGY

CO No.	Course Outcome
CO-1.	To know about organisation of biosphere and components of ecosystem.
CO-2.	To learn about microbes in extreme environments.
CO-3.	To learn in detail about microbes in aquatic environment, water pollution, water borne disease, Microbiological analysis of water, Home treatment system.
CO-4.	To know about Composition of air, air borne microorganism, air borne

	diseases, quality assessment methods and air sanitation.
CO-5.	To learn about solid and liquid waste management.

UNIT I

Introduction: Organization of the biosphere and components of ecosystem, Natural habitats of microorganisms. Microorganisms as components of ecosystem - as producers and decomposers.

UNIT II

Microbial life in extreme environments: Effect of temperature, pH, Pressure, salt and heavy metals such as Cr, As, Hg and Pb. Microbial life in conditions of high irradiation, Radiosensitivity; mechanism of damage and recovery.

UNIT III

Microbes in aquatic environments: Distribution of Microorganisms in the Aquatic Environment: Fresh (ponds, lake, River) and marine water. Sources and types of water pollution, Water-borne diseases, Microbiological analysis of water purity, Indicator organisms, ground water quality and home treatment system.

UNIT IV

Microbes in air: Composition of Air; Number and kinds of organisms in air; Droplet and droplet nuclei; Assessment of air quality; Air sanitation; Airborne diseases.

UNIT V

Environmental application: Waste –types; Treatment of solid wastes –composting, Vermiform composting, silage, Pyrolysis and scarification; Treatment of liquid wastes, Treatment of textile dye effluent.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Vijaya Ramesh K (2019). Environmental Microbiology. MJP Publishers.
2. Sharma PD (2016). Environmental Microbiology. (1st Edition). Rastogi Publications.
3. Subbha Rao N.S. (2017) Biofertilizers in Agriculture and Forestry. (4th Edition). Medtech Publishers.
4. Subba Rao, N.S. (2020) Soil Microorganisms and Plant Growth. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
5. Paul, E.A. and Clark, F.E. (1989) Soil Microbiology and Biochemistry. Academic Press, London.
6. Buckley RG (2005). Environmental Microbiology. CBS Publishers.

Reference Books:

1. Ian L. Pepper and Charles P. Gerba (2014) Environmental Microbiology. (3rd Third Edition). Academic Press.
2. Atlas Ronald, M., Bartha, and Richard (1987). Microbial Ecology: Fundamentals and Applications. (4th Edition). Pearson Education India.
3. Dirk, J. Elasas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil

Microbiology. (3rd Edition). CRC Press.

4. Grant W.D. and Long, P.L. (1981). Environmental Microbiology. Blackie Glasgow and London.
5. Mitchel, R. (1992). Environmental Microbiology. Wiley – John Wiley and Sons. Inc. Publications, New York.
6. Lynch, J.M. and Poole, N.J. (1979) Microbial Ecology: A. Conceptual Approach. Blackwell Scientific Publications, London.
7. Atlas, R.M. and Bartha, R. (1992) Microbial Ecology: Fundamentals and Applications, 2nd Edn. The Benjamin / Cummings Publishing Co.,Redwood City,CA.
7. Rheinheimer, G. (1980) Aquatic Microbiology, 2nd Edn. John Wiley & Sons, New York.
8. Clesceri L.S, Greenberg A.E, Eaton AD. (1998) Standard methods for examination of water & waste water American Public Health Association.

Journals:

1. **Soil Microbiology:** https://www.nature.com/subjects/soil-microbiology
2. **Applied and Environmental Microbiology:** https://aem.asm.org/
3. **Journal of Environmental Microbiology:** https://www.pulsus.com/journal-environmental-microbiology.html

Web Resources:

1. https://microbe.net/resources/microbiology-web-resources/
2. https://www.microbes.info/resources/3/environmental-microbiology
3. https://www.edx.org/learn/microbiology

CORE IX- THEORY: FOOD AND DAIRY MICROBIOLOGY:

CO No.	Course Outcome
CO-1.	To study the role of microorganism in food. Importance of microorganism in food.
CO-2.	Understand the principles of food Preservation by physical method.

CO-3.	To study the contamination of different types of food.
CO-4.	Pathogenesis and clinical feature of food borne pathogens. Food analyse and by laboratory testing and food sanitation.
CO-5.	Fermentation food –cheese bread, and beverages.

UNIT I

Food as a substrate for microorganisms–Microorganisms important in food microbiology; Molds, yeasts and bacteria–General Characteristics–Classification and importance.

UNIT II

Principles of food preservation – Asepsis – Removal of micro organisms, anerobic conditions – High temperature – Low temperature- Drying –Food additives.

UNIT III

Contamination and spoilage- Cereals, sugar products, vegetables and fruits, meat and meat products, milk and milk products – Fish and sea foods – poultry, spoilage of canned foods.

UNIT IV

Food borne infections and intoxications – bacterial, non-bacterial – Food borne disease outbreaks – Laboratory testing – preventing measures – Food sanitation – plant sanitation – Employees' heals standards – waste treatment and disposal – quality control.

UNIT V

Food fermentation: Bread cheese, vinegar, fermented vegetables, fermented dairy products. Spoilage and defects of fermented dairy products – oriental fermented foods. Introduction to Food laws.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Frazier WC and Westhoff DC. (2013). Food Microbiology. (5th Edition). McGraw Hill Publishing Company Ltd. New Delhi.
2. Hobbs BC and Roberts D. (1993) Food poisoning and food hygiene, Edward Arnold (A division of Hodder and Stoughton), London.
3. Jay JM. (2005). Modern Food Microbiology. (4th Edition). CBS Publishers and distributors, New Delhi.
4. Stanbury, P.F., Whitaker, A. and Hall, S.J. (1995) Principles of Fermentation Technology, 2nd Edn. Pergamon Press, Oxford.
5. Foster WM (2015). Food Microbiology. CBS Publishers and Distributers Ltd.

Reference Books:

1. Montville TJ and Matthews KR (2012). Food Microbiology: An Introduction. (3rd Edition). ASM Press.
2. Adams MR, Moss MO and McClure P (1995). Food Microbiology (4th Edition). The Royal Society of Chemistry.
3. Andrews AT, Varley J. (1994) Biochemistry of milk products. Royal Society of

Chemistry.

4. Banwart GJ. (2004), Basic Food Microbiology (2nd Edition). CBS Publishers.
5. Robinson RK. (2002). Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products. (3rd Edition). John Wiley and Sons. Inc.

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

CORE VI- PRACTICAL: ENVIRONMENTAL, FOOD AND DAIRY MICROBIOLOGY

CO No.	Course Outcome
CO-1.	To learn about Detection of number of Bacteria in milk by various method.
CO-2.	Gains knowledge to determine the quality of milk
CO-3.	Learn to isolate the yeast and molds from spoiled food.
CO-4.	Assessment of water quality by selected Biological and chemical methods.
CO-5.	Learn to Quantify the microorganisms in air and detection of aflatoxin.

UNIT I

Detection of number of Bacteria in milk by breed count. Detection of number of bacteria in milk by standard plant count.

UNIT II

Determination of quality of milk sample by methylene blue reductase test and Resorzurin method.

UNIT III

Isolation of yeast and molds from spoiled nuts, fruits, and vegetables. Bacteriological examination of specific food a) Curd b) Raw meat c) Fish d) Ice cream.

UNIT IV

Determination of BOD and COD of wastewater. Water analysis

a) MPN method b) Membrane filter method.

UNIT V

Quantification of microorganisms in air by settle plate and air sampler methods. Detection of aflatoxin B_1 from moldy grains using thin layer chromatography.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (1994). Methods for General and Molecular Bacteriology, ASM Publications, Washington D.C.
2. Patricia Cunning (1995). Official Methods of Analysis, Vol. I and II, 16th

Edition, Arlington, Virginia, U.S.A., AOAL
3. Richard G. Burus and Howard Slater (1982). Experimental Microbial Ecology, Blackwell
4. Tuffery (1996). Laboratory Animal, an Introduction, II Edition, John Wiley and Sons, New York.
5. Rogers JE and Writman WB (1991) Microbial production and consumption and green house gases: Methane: Nitrogen oxides and Halomethanes. American Society for Microbiology, Washington DC
6. Cambell, R. (1983) Microbial Ecology, 2nd Edn. Blackwell Scientific Publications

Reference Books:

1. Atlas Ronald, M., Bartha, and Richard (1987). Microbial Ecology 2nd Edition. Benjamin/Cummings Publishing Company, California.
2. Dirk, J. Elasas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology, Marcel Dekker INC, New York, Hong Kong.
3. EcEldowney S, Hardman D.J., Waite D.J., Waite S. (1993). Pollution: Ecology and Biotreatment– Longman Scientific Technical.
4. Grant W.D. and Long, P.L. (1981). Environmental Microbiology. Blackie Glasgow and London
5. Mitchel, R. (1992). Environmental Microbiology. Wiley – John Wiley and Sons. Inc. Publications, New York
6. Clescri, L.S., Greenberg, A.E. and Eaton, A.D. (1998). Standard Methods for Examination of Water and Waste Water, 20th Edition, American Public Health Association

Journals:

1. Journal of Chemical and Pharmaceutical Research: http://www.jocpr.com/articles/screening-of-bacteria-responsible-for-the-spoilage-of-milk.pdf
2. Journal of food science: https://www.sciencedirect.com/topics/food-science/milk-quality

3. International journal of dental and health science: https://www.researchgate.net/publication/320172191_isolation_of_bacteria_associated_with_spoiled_vegetables..

Web recourses:

1. https://www.healthline.com/health/airborne-diseases#prevention.
2. https://www.researchgate.net/publication/322759519_Microbes_as_Indicators_of_Water_Quality_and_Bioremediation_of_Polluted_WatersA_Novel_Approach.
3. http://www.fao.org/3/t0551e/t0551e05.htm
4. https://unctad.org/en/Docs/ditcted200710_en.pdf
5. http://www.biologydiscussion.com/environmental-microbiology/biodeterioration-of-various-materials-microbiology/66809.

ELECTIVE 2 – THEORY: INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY:

CO No.	Course Outcome
CO-1.	Learn about of fermentation process and industrially important microorganisms.
CO-2.	Learn about types of fermentations and fermentor.
CO-3.	Provides knowledge on the production of commercial microbial products.
CO-4.	Gain knowledge on separation, extraction, purification and packaging of products.
CO-5.	Acquire knowledge on the ecology of Pharmaceutical industries, Good manufacturing practices, and sterile pharmaceutical preparations.

UNIT I

General introduction to fermentation process. Large scale cultivation of industrially important microbes (Streptomyces, Saccharomyces, Spirulina and Penicillium)

Fermentation media-desired qualities- carbon, nitrogen, vitamin, mineral sources, role of buffers, precursors, inhibitors, inducers and antifoams.

UNIT II

Types of fermentation-fermentors-basic functions, design and components, asepsis and containment requirement. Specifications of fermentors- sterilization of fermentors- aseptic inoculation methods.

UNIT III

Microbial products of commercial use-penicillin, ethanol, vinegar, vitamin B12, protease, citric acid and glutamic acid.

UNIT IV

Downstream processing - objective and criteria, foam separation, precipitation methods, filtration, industrial scale centrifugation and cell disruption methods. Liquid-liquid extraction, chromatography, two phase aqueous extraction, super – critical fluid extraction, ultra filtration, drying device, crystallization and whole broth processing.

UNIT V

Ecology of microorganisms affecting pharmaceutical industries- atmosphere-water-raw materials- packaging- equipment. Control of contamination during manufacture - good pharmaceutical manufacturing process. Quality control of pharmaceutical products.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Sandle T (2015) Pharmaceutical Microbiology Woodhead Publishing.
2. Mehra P.S (2013) A Textbook of Pharmaceutical Microbiology, I K International Publishing House Pvt. Ltd.
3. Denyer S.P, Hodges N, Gorman S.P, Gilmore B.F. (2013) Hugo and Russell's Pharmaceutical Microbiology 8th Edition Wiley India Pvt Ltd.
4. Wittmann C, Liao J.C. (2016). Industrial Biotechnology: Products and Processes, Wiley-VCH.
5. KL Benson (2016) Industrial Microbiology, CBS

Reference Books:

1. El-Mansi E. M. T., Nielsen J, Mousdale D, Carlson R.P (2019) Fermentation Microbiology and Biotechnology, Fourth Edition, CRC Press.
2. Stanbury, P.F., Whitaker, A. and Hall, S.J. (2016) Principles of Fermentation Technology 3rd edition, Butterworth-Heinemann.
3. Baltz R.H, Demain A.L, Davies J.E (2010) Manual of Industrial Microbiology and Biotechnology 3rd edition ASM press.
4. Kokate, C.K. (2008) Pharmacognosy 54th edition - Nirali.
5. Ali M. (2019) A text book of Pharmacognosy, 2nd edition, CBS.

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

ELECTIVE 3 – THEORY: BIOTECHNOLOGY

CO No.	Course Outcome
CO-1.	To acquire knowledge on history of biotechnology and known the Microbial production of industrial enzymes and its application. To understand the kinetics of soluble and immobilized enzymes.
CO-2. .	Understand the principles and application of genetic recombinant technology, Biofertilizer, Biopesticides and gene-therapy methods
CO-3.	To acquire knowledge in plant tissue culture techniques and methods of gene transfer.
CO-4.	To know the methods of plant micro propagation, crop improvement and development of transgenic plants.
CO-5.	Be familiar with animal cell metabolism, cell cycle and regulation. Know the animal cell culture techniques and transgenic animals.

UNIT I

Biotechnolgy– definition & history; Microbial production of industrial enzymes; methods for immobilization of enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

UNIT II

Principles and application of genetic recombinant technology and strain improvement (Mutation, rDNA technologies). Production of biotechnological products: Food – SCP (algae, yeast, mushroom). Fuel – Bioethanol, Pharmaceuticals – antigens, interferons, plant based and edible vaccines, insulin. Bioremediation.

UNIT III

Plant tissue culture techniques; methods of gene transfer into plant cells; production of secondary metabolites using suspension/immobilized cell culture.

UNIT IV

Methods for plant micropropagation; crop improvement and development of transgenic plants.

UNIT V

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; transgenic animals. Testing methods of quality in cell culture.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Dubey, R.C. 2018. Text book of Biotechnology. S.Chand& company Ltd., New Delhi.
2. Whitton, B. A. and potts, M. (2000). The ecology of cyanobacteria: their diversity in time and space. Kluwer Academic publisher, Dordrecht.
3. Gerard J. Tortora, Berdell R. Funke, Christine L. Case (2015) Microbiology: An Introduction (12th Edition).PEARSON, London, United Kingdom
4. Joanne Willey, Linda Sherwood and Christopher J. Woolverton (2013) Prescott's Microbiology, McGraw-Hill Education; 10th Edition (2017). ISBN-10: 0073402400
5. Balasubramanian, D., Bryce, C., Dharmalingam, K., Green, J. and Jayaraman, K. (1999). Concepts in Biotechnology, University Press, India. M.Sc. Applied Microbiology: Syllabus (CBCS) 58
6. Trivedi P.C. 2001. Algal biotechnology.
7. Colin Ratledge and Bjorn Kristiansen (2001). Basic Biotechnology, Cambridge University Press, U.K.
8. Joshi, V.K.and Ashok Pandey. (1999). Biotechnology, Food fermentation (Microbiology, Biochemistry and Technology) Vol. I & II Basic, Educational Publishers and Distributors, Ernakulam.
9. Venkataraman, L.V. (1983). A monograph on Spirulina platensis, CFTRI, Mysore. M.Sc. Applied Microbiology: Syllabus (CBCS) 61
10. Murray Moo (1992) Plant Biotechnology. Young, Pergamon Press.
11. Radledge, C. and Kristiansen, B. (2001). Basic Biotechnology, II Edition, Cambridge University Press.
12. Watson, JD., Gilman, M, Witkowski, J. Zoller M. (1992) Recombinant DNA. Scientific American Books.
13. Borowitzka MA, Borowitzka LJ (1989) Microalgal Biotechnology, Cambridge University Press.
14. Glazer AN, Nikaido H. (1994) Microbial Biotechnology - Fundamentals of Applied Microbiology WH Freeman and Company, New York
15. Chirikjian JG Eds (1995). Biotechnolgy - Theory and Techniques, Vol. 1, Jones

and Burtlett Publishers

Reference Books:

1. Vedpal's S. Malik, Padma Sridhar, Sharma, M.C. and Polasa, H. (1992). Industrial Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi
2. Khattar, J.I.S., Singh, D.P., Kaur, (2009) Algal Biology Biotechnology, - Microalgae: A source of natural colours, Edition: 1, I. K. International Publishing House Pvt. Ltd. New Delhi,
3. Antonia Herrero and Enrique Flores(2008) The Cyanobacteria: Molecular biology, genomics and Evolution, Caister Academic Press, Spain.
4. Leela, S.S and Jyothi Kumar,2010. Algal BioProcessTechology, 1st Edition, New age International Publishing house, New Delhi.
5. Demain, A.L. and Davies, J.E. (1999). Manual of Industrial Microbiology and Biotechnology. ASM Press.
6. Glick, B.R. and Pasternak, J.J. (1998). Molecular Biotechnology, II Edition, ASM Press, New York.
7. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.

Journals:

1. Journal of chemistry: https://www.hindawi.com/journals/jchem/2013/946248/
2. Journal cell: https://www.cell.com/cell-metabolism/newarticles
3. Journal of agriculture and biological science: https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/micropropagation.
4. PMC: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6463069/
5. Frontiers: https://www.frontiersin.org/articles/10.3389/fnut.2019.00007/full

Web recourse:

1. http://bbruner.org/107net99.htm
2. https://www.sciencedaily.com/
3. https://www.biozone.co.nz/

4. https://www.web-books.com/MoBio/
5. http://www.cellbiol.com/
6. https://www.biozone.co.nz/biolinks/cell-biology/
7. https://www.agrifarming.in/growing-spirulina
8. https://www.wincloveprobiotics.com/quality/production-process

ELECTIVE 4 – THEORY: HERBAL TECHNOLOGY (OPTIONAL)

CO No.	Course Outcome
CO-1.	To acquire knowledge on history of Indian medicine systems.
CO-2. .	To learn about the Classification and cultivation of various Medicinal Plants.
CO-3.	To describe benefits of various type of medicinal plants.
CO-4.	To get knowledge about herbal medicine against several disorders.
CO-5.	To learn conservation methods for medicinal plants and to identify the adulteration and Contamination of herbal food.

UNIT - I

Pharmacognosy - Definition and history, Indian systems of medicine - Siddha, ayurvedha, and Unani systems. Classification of Crude drugs - Chemistry of Drugs - Future of pharmacognosy.

UNIT - II

Classification of medicinal plants, cultivation, collection, and processing for market and commerce in crude drugs. Morphological and histological studies, chemical constituents - Therapeutic and other pharmaceutical uses.

UNIT - III

Underground stem – ginger; Roots – Rauolfia; Bark – Cinchona; Leaves – Eucalyptus; Flower - Clove fruits seeds; fixed oil - castor oil.

UNIT - IV

Herbal medicines for Human ailments - Drugs acting on cardiac diseases, cerebral diseases, Nasal, diseases - Blood pressure Drugs acting on Nervous system - Depressants. - stimulants - Respiration and Drugs - Urogenital system and drugs - Psychoactive plants.

UNIT - V

Propagation of medicinal plants - Micro and macro propagation conservation of rare medicinal plants Role of biotechnology in medicinal plants banks - cultivation of medicinal and aromatic plants - Drug adulteration - methods of Drug evaluation, Herbal food - Food processing - packaging - Herbal sale and Export of medicinal plants - marketing - Intellectual property rights - Export laws.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

Text Books:

1. Kumar N.C. (1993) An Introduction to Medical Botany and Pharmacognosy.
2. Nadkarni (1981) Indian Materia Medica.
3. Shah, S.C. and Qudary (1990) A text book of Pharmacognosy.
4. Wallis, T.E, Text book of pharmacognosy by 5th edition. CBS publishers and distributors, New Delhi.

Reference Books:

1. George Edward Trease and W.C. Evans - Pharmacognosy 12th edition, English Language Books Society, Baelliere Tindall.
2. Handa, S.S. and Kapoor, V.K. Pharamcognosy by 2nd Edition, Vallabh Prakashan Publishers, New Delhi.
3. Jain, S.K (1980) Indian Medicinal plants.
4. Kokate, C.K., Durohit, A.P. and Gokhale, S.R., Pharmacognosy by 12th edition - Nirali Prakasham Publishers, Pune.

Journals:

1. **JOURNAL OF HERBAL MEDICINE**: https://www.journals.elsevier.com/journal-of-herbal-medicine.
2. **INTERNATIONAL JOURNAL OF ADVANCED HERBAL SCIENCE AND TECHNOLOGY:** http://www.cloud-journals.com/journal-of-herbal-science-and-technology.html**.**
3. **JOURNAL OF HERBAL PHARMACOTHERAPY:** https://www.tandfonline.com/loi/iher20.
4. **JOURNAL OF HERBS, SPICES & MEDICINAL PLANTS:** https://www.tandfonline.com/loi/whsm20.

Web recourse:

IMPORTANCE OF MEDICINAL PLANTS: https://www.nhp.gov.in/introduction-and-importance-of-medicinal-plants-and-herbs_mtl

MEDICINAL PLANTS: https://www.healthline.com/health/most-powerful-medicinal-plants.

List of Medicinal Plants: https://www.odishafdc.com/products_medicinal_plants.php.

ELECTIVE 5 – THEORY: CLINICAL BIOCHEMISTRY (OPTIONAL)

CO No.	Course Outcome
CO-1.	Provide knowledge on blood glucose homeostasis. Maintenance of blood glucose by hormone
CO-2. .	Discuss the Liver function
CO-3.	Study the function of amino acid and Kidney function tests - Inulin, urea and creatinine clearance tests
CO-4.	Learn lipid mechanisms and abnormal levels of these lipids in diseases.
CO-5.	Learn about hormonal disorders - Acromegaly, Cushing's syndrome, Addison's disease, Goitre, Grave's disease.

UNIT-I

Scope of clinical biochemistry.Blood glucose homeostasis.Maintenance of blood glucose by hormone with special reference to insulin and glucagon.Abnormalities in glucose metabolism. Diabetes mellitus-types, causes, biochemical manifestations, diagnosis and treatment, Inborn errors of carbohydrate metabolism. Galactosemia, fructosuria and Glycogen storage diseases.

UNIT –II

Liver function test, Tests based on bile pigment metabolism. Carbohydrate metabolism, plasma proteins and lipids. Detoxification and excretory functions of liver, Jaundice classification, biochemical changes and differential diagnosis for jaundice.

UNIT-III

Inborn errors of amino acid metabolism-Phenyl ketonuria, Alkaptonuria, Tyrosinemia, cystinuria.Normal and abnormal constituents in urine. Kidney function tests - Inulin, urea and creatinine clearance tests.

UNIT-IV

Disorders of lipid metabolism-normal levels of cholesterol, triglycerides, phospholipids, free fatty acids and lipoprotein in blood. Abnormal levels of these

lipids in diseases. Lipidosis, Atherosclerosis, hyper and hypo lipoproteinemias, sphingolipidoses, – causes and pathology.

UNIT-V

Hormonal disorders - Acromegaly, Cushing's syndrome, Addison's disease, Goitre, Grave's disease, Hyperparathyroidism - clinical features.Clinical enzymology - enzymes of diagnostic importance - LDH, creatine kinase, transaminases, phosphatases, pancreatic lipase, amylase and choline esterase.Isoenzymes of lactate dehydrogenase.

MAPPING OF CO WITH PSO

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

S- Strong; M-Medium; L-Low; N-Not Relevant

References Books

1. Thomas M.Devlin (2014). Textbook of Biochemistry with Clinical Correlations (7^{th}ed), John Wiley and Sons.

2. Montgomery R, Conway TW, Spector AA (1996). Biochemistry: A Case-Oriented Approach (6th ed), Mosby Publishers, USA.

3. Tietz (2014). Fundamentals of Clinical Chemistry and Molecular Diagnostics (7th ed), Saunders.

4. Dinesh Puri, (2002). Text book of Biochemistry: A clinically oriented approach Churchill Livingstone Inc., India.

5. M.N.Chatterjee and RanaShinde (2007). Textbook of Medical Biochemistry (7 thed)

Web Recourses:

1. https://www.healthline.com/health/hormonal-imbalance
2. https://medlineplus.gov/lipidmetabolismdisorders.html
3. https://liverfoundation.org/for-patients/about-the-liver/the-progression-of-liver-disease/diagnosing-liver-disease/#1503683841810-eca3af80-46f5

SYLLABUS FOR ALLIED MICROBIOLOGY SUBJECTS FOR B.SC., BIOCHEMISTRY AND B.SC., BIOTECHNOLOGY

ALLIED MICROBIOLOGY-I FOR B.SC., BIOCHEMISTRY

Title of the paper	**Allied Microbiology I**		
Category : **Part III - Allied Theory**	Year & Semester Second Year/third Semester	Credits 4	Teaching hours 6 hours/week

CO No.	Course Outcome
CO-1.	To learn about history, taxonomy of microorganism, also microbiological techniques of pure culture.
CO-2	Understand different microscope, sterilization techniques.
CO-3	Study about the bacterial, algal and protozoan characteristics.
CO-4	Acquire knowledge on microbial growth, bio-geo cycle and biofertilizers.
CO-5	Aware about microbiology of water and sewage.

UNIT -I

Evolution of Microbiology, Taxonomy, Classification of micro-organisms. Basic microbiological techniques. Microbial culture methods – Types of culture media - Streak plate, spread plate, pours plate enrichment culture, single spore isolation.

UNIT – II

Microscopy – Bright field, Dark field, phase contrast, Electron Microscopy – TEM & SEM. Cleaning of glassware, Sterilization of glassware and media. Sterilization – Physical method – Dry heat, moist heat, pasteurization, Tyndallisation. chemical method – alcohol, phenol, halogens, formaldehyde. Radiation – UV and gamma radiation. Pure culture technique - serial dilution, standard plate count. Lyophilization. Staining techniques - simple and differential.

UNIT- III

General characteristics of Bacteria, cyanobacteria, Actinomycetes, Mycoplasma and viruses. Structural characteristics of micro algae (Oscillatoria, Volvox and Chlorella), fungi (molds and yeasts) and Protozoa (Entemoeba, Plasmodium and Euglena).

UNIT -IV

Measurement of microbial growth (turbidity, biomass, cell count, area, pigments). Microbiology of Soil. Microbes in soil, rhizospheres and rhizoplane.Nitrogen-fixing, nitrifying and denitrifying bacteria. Sulphur bacteria. Biofertilizers (bacteria - Rhizobium, cyanobacetria -Nostoc).

UNIT -V

Microbiology of water. Potable water. Municipal water purification. Sewage disposal and treatment-Physical and biological. Assessment of water quality -MPN.

Text Books:

1. Webster and R.W.S. Weber (2007). Introduction to Fungi. (3rd edition).Cambridge University press, Cambridge.

2. Schaechter M and Leaderberg J (2004). The Desk encyclopedia of Microbiology. Elseiver Academic press, California.
3. Prescott's Microbiology, McGraw-Hill Education; 10th Edition (2017). ISBN-10: 0073402400
4. David White, James Drummond, and Clay Fuqua (2011). The physiology and biochemistry of Prokaryotes, Oxford University Press, Oxford, New York.
5. Ketchum, P.A. (1984) Microbiology: Concepts and Applications. John Wiley and Sons, New York.

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)
3. Prescott's Microbiology, McGraw-Hill Education; 10th Edition (2017). ISBN-10: 0073402400
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.

Journals:

1. PLOS ONE: https://journals.plos.org/plosone/browse/microbial_taxonomy
2. BMC Microbiology: https://bmcmicrobiol.biomedcentral.com/
3. Applied and Environmental Microbiology: https://aem.asm.org/
4. Frontiers and Microbiology: https://www.frontiersin.org/journals/microbiology.
5. ASM: https://jb.asm.org/content/7/6/537
6. Journal of Water Process Engineeering: https://www.journals.elsevier.com/journal-of-water-process-engineering

Web Resources:

1. https://www.life.umd.edu/classroom/bsci424/BSCI223WebSiteFiles/LectureList.htm
2. https://www.microbiologyonline.org.uk
3. http://sciencenetlinks.com/tools/microbeworld/
4. https://courses.lumenlearning.com/microbiology/chapter/staining-microscopic specimens
5. https://www.cdc.gov/infectioncontrol/guidelines/disinfection/sterilization/index.html
6. https://www.britannica.com/science/bacteria/Growth-of-bacterial-populations
7. https://www.sas.upenn.edu/LabManuals/biol275/Table_of_Contents_files/5-PureCulture.pdf

ALLIED MICROBIOLOGY- PRACTICAL -I FOR B.SC., BIOCHEMISTRY

Title of the paper	**Allied Microbiology I**		
Category : **Part III - Allied Practical**	Year & Semester Second Year/third Semester	Credits 3	Teaching hours 3 hours/week

CO No.	**Course Outcome**
CO-1	To learn about Good laboratory practice and sterilization methods
CO-2	To practice the media preparation and microbial quality assessment.
CO-3	Learn the culture techniques and microbial characterization.
CO-4	Applying microscopy for microbial techniques.
CO-5	Learn basic concepts in different staining techniques

UNIT- I

Laboratory rules and Precautions.Cleaning of glass wares, sterilization principle and methods- moist heat, dry heat and filtration methods.

UNIT- II

Culture Media preparation: liquid media and solid media - Agar slants, Agar plates, Basal medium, Enriched, Selective media preparation. Quality control of media growth supporting properties - sterility check of media.

UNIT- III

Pure culture techniques: streak plate, pour plate, decimal dilution. Culture characteristics of microorganisms: colony morphology on different media, growth characteristics. Demonstration of pigment production.

UNIT -IV

Microscopy: light microscopy, bright field microscopy, dark field microscopy. Motility demonstration: hanging drop, wet mount preparation, dark field microscopy, semi solid agar, Craigie's tube method.

UNIT -V

Staining techniques: Smear preparation, simple staining, Gram's staining, Acid fast staining, Metachromatic granule staining and spore staining.

Text Books:

1. Alcomo, I.E. Fundamentals of Microbiology. VI Edition, Jones and Bartlet Publishers. Sudbury. Massachusetts, (2001).
2. Black J.G.Microbiology-Principles and Explorations. JohnWiley&SonsInc. NewYork, (2002).
3. Cappuccino and Sherman. Microbiology – A Laboratory Manual. 7th Edition, Dorling Kindersley (India) Pvt. Ltd., New Delhi. 2012.
4. Gunasekaran P. Laboratory Manual in Microbiology, New Age International (P)

Ltd. Publishers, New Delhi. 2008.

5. Harry W. Seeley JR, Paul J. Van Demark and John J Lee. Microbes in Action – A Laboratory Manual of Microbiology.W.H.Freeman and Company, New York. 1997.
6. Kanika Sharma. Manual of Microbiology – Tools and Techniques.2nd edition, Ane Books Pvt. Ltd., New Delhi. 2009.

Reference Books:

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

Journals:

1. American Society of Microbiology: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC378746/
2. American Society of Microbiology: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC290607/
3. Journal of chemistry: https://pubs.acs.org/doi/abs/10.1021/ed4006248

Web Resources:

1. https://www.sas.upenn.edu/LabManuals/biol275/Table_of_Contents_files/5-PureCulture.pdf
2. https://www.cdc.gov/infectioncontrol/guidelines/disinfection/sterilization/index.html
3. http://www.preservearticles.com/biology/what-are-the-methods-of-measuring-microbial-growth/28473

4. https://www.microbes.info/
5. https://www.britannica.com/science/bacteria/Growth-of-bacterial-populations
6. https://www.asmscience.org/VisualLibrary

ALLIED MICROBIOLOGY-II FOR B.SC., BIOCHEMISTRY

Title of the paper	**Allied Microbiology II**		
Category : **Part III - Allied Theory**	Year & Semester Second Year/fourth Semester	Credits 4	Teaching hours 6 hours/week

CO No.	**Course Outcome**
CO-1	Students to acquire knowledge on aeromicrobiology
CO-2	To learn about role of food microorganisms.
CO-3	Understanding the milk microorganism and microbes of industrial importance
CO-4	Acquire knowledge on microbial diseases, immunity and hygiene practices.
CO-5	Importance of microorganism in genetic engineering and biotechnology.

UNIT-I

Aerobiology – Microorganisms in air: Types and number of microbes in air, Sources of airborne microbes – Droplets, droplet nuclei. Airborne diseases, Air purification methods, Air sanitation

.

UNIT-II

Food Microbiology – Microbes importance in food microbiology. Microbial spoilage of foods – Food Preservation techniques with special emphasis on preservation of home foods by turmeric, salts, spices, oil and sugar. Food borne diseases.

UNIT-III

Microbiology of milk – Source of Microbes in milk and spoilage – Pasteurization - phosphatase–and reductase tests – Types of microbial Dairy products. Industrial microbiology – Microbes in the production of organic acids (Vinegar), antibiotics (Penicillin), alcoholic beverages (Ethanol)

UNIT-IV

Microbes and diseases: pathogenesis – Treatment - Laboratory diagnosis of bacteria - Antibiotic sensitivity testing. Immune system – Active and passive immunity – AIDS. Personal hygiene and sanitation.

UNIT-V

A brief account of genetic engineering and biotechnology: Restriction enzymes types, Plasmid Vector types, Basic steps in Cloning method, Insulin production, Hepatitis B vaccine production.

Text Books:

1. Gerard J. Tortora, Berdell R. Funke, Christine L. Case (2015) Microbiology: An Introduction (12th Edition).PEARSON, London, United Kingdom .

2. Alcamo IE. Fundamentals of Microbiology, sixth edition, Addison wesley Longman, Inc. California. 2001
3. Joanne Willey, Linda Sherwood and Christopher J. Woolverton (2013) Prescott's Microbiology, McGraw-Hill Education; 10th Edition (2017). ISBN-10: 0073402400
4.Ingraham, J.L. and Ingraham, C.A. (2000) Introduction to Microbiology, 2nd Edn. Books / Cole Thomson Learning, UK.
5. Schelegel, H.G. (1993) General Microbiology,7th Edn. Cambridge University Press, Cambridge.

Reference Books:

1. Prescott L.M. Harley J.P. and Klein D.A. (2003). Microbiology (5th edition) McGraw Hill, New York.
2. J. Webster and R.W.S. Weber (2007). Introduction to Fungi. (3rd edition).Cambridge University press, Cambridge.
3. Schaechter M and Leaderberg J (2004). The Desk encyclopedia of Microbiology. Elseiver Academic press, California.
4. Chan E.C.S., Michael J. Pelczar, Jr.,Noel R. Krieg (2010). Microbiology. (5th edition). Mc. Graw Hill. Inc, New York.
5. Salle, A.J. (1996). Fundamental principles of Bacteriology.(7th edition).Tata McGraw - Hill publishing company Ltd, New Delhi.

Journals:

ASM: https://mmbr.asm.org/content/64/2/412

Agriculture and biological science: https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/restriction-enzyme

BMC Microbiology: https://bmcmicrobiol.biomedcentral.com/

Applied and Environmental Microbiology: https://aem.asm.org/

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

Neuroscience: https://www.sciencedirect.com/topics/neuroscience/metabolic-pathway

Web Resources:

https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology

https://courses.lumenlearning.com/microbiology/

https://www.microbes.info/

https://www.asmscience.org/VisualLibrary

http://sciencenetlinks.com/tools/microbeworld/

https://www.britannica.com/science/bacteria/Growth-of-bacterial-populations

http://www.preservearticles.com/biology/what-are-the-methods-of-measuring-microbial-growth/28473

ALLIED MICROBIOLOGY-PRACTICAL -II for B.SC., BIOCHEMISTRY

Title of the paper	**Allied Microbiology II**		
Category : **Part III – Practical**	Year & Semester Second Year/fourth Semester	Credits 3	Teaching hours 3 hours/week

CO No.	**Course Outcome**
CO-1	To learn of forms bacteria, fungi, yeast and antimicrobial assay.
CO-2	Understand the bacterial biochemical characterization and pure culture techniques.
CO-3	To practice the assessment of water micro flora.
CO-4	To learn about food spoilage microorganism
CO-5	Acquire knowledge on assessment air microorganism and microbial photomicrographs.

UNIT-I

Morphology of microorganisms: morphological variations in algae (unicellular, filamentous and spiral forms). Morphology of fungi- LPCB wet mount, slide culture technique. Antibiotic sensitivity testing: Disc diffusion test - quality control with standard strains. Micrometry: Demonstration of size of yeast and fungal filaments.

UNIT-II

Bacterial biochemical characteristics: IMVIC test, TSI, Oxidase, catalase, urease test. Carbohydrate fermentation test. Maintenance of pure culture – Refrigeration, paraffin method, stab culture , glycerol stock method. Maintenance of mold culture.

UNIT-III

Observation of pond water for the presence of microorganism – Volvox, Chlorella, Oscillatoria, Entamoeba, Paramoceium, Euglena, Diatoms and chlamydomonas.

UNIT-IV

Identification of organisms that spoil the following: Citrus fruits, Grapes, Emblica fruits, Coconut Kernel, Milk products, bread and jam. Methylene blue reductase test, Phosphatase and reductase tests.

UNIT-V:

Air quality assessment by open plate method, Reuter's air sampler method. Kirby bauer antibiotic sensitivity test – Disk diffusion method. Study of photomicrographs of different types of bacteria, fungi and viruses.

Text Books:

1. Aneja KR (2018). Laboratory Manual of Microbiology and Biotechnology. (1st

Edition). Bio-Green Publisher.
2. Mukesh Kumar (2018). Practical Manual for Undergraduates Microbiology. (3rd Edition). Jain Brothers.
3. Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India.
4. Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS

Reference Books:

1. Cappuccino J G and Welsh CT (2017). Microbiology: A Laboratory Manual (11th Edition). Pearson Education, Noida
2. Mahon C and Lehman DC (2019). Textbook of Diagnostic Microbiology. (6th Edition). Elsevier Publisher.
3. Banu N and Pavithra (2015). Laboratory Manual on Cell Biology and Microbiology. Sara Book Publication.
4. Tortora, G.J., Funke, B.R. and Case, C.L. Microbiology: An Introduction. Pearson Education, Singapore, (2004).
5. Alcomo, I.E. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers. Sudbury. Massachusetts, (2001).
6. Black J.G.Microbiology-Principles and Explorations. JohnWiley&SonsInc. NewYork, (2002).

Journals:

1. ASM: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3867773/

Indian Journal of Pathology and Microbiology:

3. http://www.ijpmonline.org/article.asp?issn=03774929;year=2011;volume=54;issue=3;spage=556;epage=560;aulast=Joseph.
4. Journal of antimicrobial chemistry: https://academic.oup.com/jac/article-pdf/48/suppl_1/1/19569287/0480001.pdf.
5. Journal of dairy science: https://www.journalofdairyscience.org/article/S0022-0302(45)95152-6/abstract.

Web Resources:

1. http://sciencenetlinks.com/tools/microbeworld/
2. https://www.microbes.info/
3. https://www.asmscience.org/VisualLibrary
4. https://courses.lumenlearning.com/microbiology/chapter/staining-microscopic specimens/
5. https://www.cdc.gov/infectioncontrol/guidelines/disinfection/sterilization/index.html
6. https://www.britannica.com/science/bacteria/Growth-of-bacterial-populations

PART –III: ALLIED MICROBIOLOGY THEORY for B.SC., BIOTECHNOLOGY

Title of the paper	**Allied Microbiology**		
Category : **Part III - Allied Theory**	Year & Semester first Year/first Semester	Credits 4	Teaching hours 6 hours/week

CO No.	**Course Outcome**
CO-1	To understand the microbiology history, scope and prokaryotic and eukaryotes anatomy.
CO-2	Learn the microbial classification, taxonomy, nucleic acid and microscopy.
CO-3	To focus on role of microorganism in environment and industrial microbial applications.
CO-4	Explain about importance of medical microbiology and pharmaceutical applications
CO-5	To acquire knowledge on microbial fermentation and biodegradation.

UNIT- I

History and Scope of Microbiology- Anatomy of Prokaryotes and Eukaryotes- Bacteria, Fungi, Algae, Protozoa and Viruses- structure and functions of the cellular components- Growth and nutrition- media and culture.

UNIT- II

Classification of microbes- DNA analysis, Ribosomal RNA analysis- Numerical taxonomy- Molecular taxonomy- methods of microbial identification. Basic in Microscopy – bright field, dark field, phase contrast and electron microscopy.

UNIT- III

Environmental Microbiology- role of microorganisms in the productivity of ecosystems- Role of microorganisms in food production- spoilage microorganisms and diseases; dairy and non-dairy products- fermented foods and alcoholic beverages- production of food (single cell protein), Fuel (ethanol). Food sanitation: food control agencies and regulations.

UNIT- IV

Medical Microbiology- Pathogenic microbes- Bacterial, Viral, Fungal and Protozoan diseases. Cure, control and prevention- Pharmaceuticals (antibiotics – penicillin prodution, vaccines- recombinant Hepatitis B vaccine.), Biofertilizers (BGA), Biopesticides, biopolymers, biosurfactants.

UNIT- V

Industrial use of microbes- fermentation products- bioconversions- products of industrial microbiology- Streptomyces, yeasts (Saccharomyces, Hansenula), Spirulina and Penicillium. Biodegradation of environmental contaminants

Text Books:

1. Chan E.C.S., Michael J. Pelczar, Jr.,Noel R. Krieg (2010). Microbiology. (5th edition). Mc. Graw Hill. Inc, New York.
2. Jayaram Paniker C. K. and Ananthanarayan R. (2017). Textbook of

Microbiology. (10th Edition). Universities Press (India) Pvt. Ltd.
3. Michael T. Madigan, John M. Martinko, Jack Parker (2009) Biology of Microorganisms.(12th edition).Prentice Hall International Inc, London.
4. David White, James Drummond, and Clay Fuqua (2011). The physiology and biochemistry of Prokaryotes, Oxford University Press, Oxford, New York.
5. Dubey RC (2000). Textbook of Microbiology. S. Chand, Limited.
6. Ingraham, J.L., and Ingraham, C.A. 2000. Introduction to microbiology, 2nd edition. Brooks/Cole, Thomson Learning, USA.
7. Lakshmanan, M.etal. 1971.Laboratory Experiments in Microbiology and Molecular Biology. Higginbothams (private) Ltd.
8. Stainer R.Y, Ingharam, Wheelis M.L. Painter (2010). General Microbiology, 5thedn Edition,MacMillanPress Ltd.
9. Wheelis M, (2010). Principles of Modern Microbiology, 1st edn. Jones and Bartlett Publication.

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.
6. Atlas.R (1997). Principles of Microbiology, 2ndedn, Wm.C.Brown publishers

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.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology

PART –III: ALLIED MICROBIOLOGY PRACTICAL for B.SC., BIOTECHNOLOGY

Title of the paper	**Allied Microbiology**		
Category : **Part III – Practical**	Year & Semester first Year/first Semester	Credits 3	Teaching hours 3 hours/week

CO No.	**Course Outcome**
CO-1	To learn about sterilization methods, media preparation and pure culture isolation.
CO-2	To gain knowledge on Culture characteristics of microorganisms
CO-3	Learn about microscopy methods and different staining techniques.
CO-4	Study the morphology of microorganisms and antibiotic sensitivity assay.
CO-5	To learn microbial characterization and pure culture technique

UNIT I

Cleaning of glass wares, Sterilization principle and methods- moist heat- dry heat and filtration methods. Media preparation: liquid media, solid media, agar slants,

agar plates, basal, enriched, selective media preparation- quality control of media: sterility check of media. Pure culture techniques: streak plate, pour plate, decimal dilution.

UNIT-II

Culture characteristics of microorganisms: growth on different media, growth characteristics and description. Demonstration of pigment production (*Pseudomonas* sp and algal pigment).

UNIT-III

Microscopy: light microscopy, bright field microscopy, dark field microscopy. Motility demonstration: hanging drop, wet mount preparation, dark field microscopy, semi solid agar, Craigie's tube method. Staining techniques: smear preparation, simple staining, Gram's staining, acid fast staining, staining of Metachromatic granules, spore staining method.

UNIT-IV

Morphology of microorganisms: morphological variations in algae, morphology of fungi- using LPCB, slide culture technique. Antibiotic sensitivity testing: Disc diffusion test- quality control with standard strains. Micrometry: Demonstration of size of yeast and fungal filaments.

UNIT-V

Physiology characteristics: IMViC test, H2S, TSI, Oxidase, catalase, urease test. Carbohydrate fermentation test, maintenance of pure culture, paraffin method, stab culture, maintenance of mold culture.

Text 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. Mukesh Kumar (2018). Practical Manual for Undergraduates Microbiology. (3rd Edition). Jain Brothers.
4. Banu N and Pavithra (2015). Laboratory Manual on Cell Biology and Microbiology. Sara Book Publication.
5. Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS

Reference Books:

1.Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India.

2.Mahon C and Lehman DC (2019). Textbook of Diagnostic Microbiology. (6th Edition). Elsevier Publisher.

3.Prescot, M.J., Harley, J.P. and Klein, D.A. Microbiology. 5th Edition WCB Mc Graw Hill, New York, (2002).

4.Mandelstam, J., McQuillen, K. and Dawes, L. (1992) Biochemistry of Bacterial Growth, 3rd Edn. Blackwell Scientific Publications, Oxford.

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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)

CONTENT **PAGE NO**

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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

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2. Joanne Willey, Linda Sherwood and Christopher J. Woolverton (2013) Prescott's Microbiology, McGraw-Hill Education; 10th Edition (2017). ISBN-10: 0073402400
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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.
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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/