Sarvodaya Kelavani Samaj Managed

Shree Manibhai Virani & Smt. Navalben Virani Science College, Rajkot

(Autonomous)

Affiliated to Saurashtra University, Rajkot

Reaccredited at the "A" Level (CGPA 3.28) by NAAC

"STAR" College Scheme & Status by MST-DBT

A College with Potential for Excellence – CPE (Phase - II) by UGC

Accredited at the G-AAA Highest Grade 'A-1' Level by KCG, Govt. of Gujarat

UGC-DDU KAUSHAL Kendra

GPCB-Government of Gujarat approved Environmental Audit Centre

DEPARTMENT OF MICROBIOLOGY

SYLLABUS OF

5 YEARS INTEGRATED B. Sc. - M. Sc. MICROBIOLOGY

For Students Admitted From A.Y. 2017-2018

Enclosure – IVA

Shree Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)
Affiliated to Saurashtra University, Rajkot

Department of Microbiology

5 YEARS INTEGRATED B.Sc. - M.Sc. MICROBIOLOGY

For Students Admitted From A.Y. 2017-2018

OBJECTIVES OF THE PROGRAMME

The Curriculum is designed to attain the following learning goals which students shall accomplish by the time of their graduation and post graduation

1. Understand the basic anatomy, physiology, diversity, and genetics of microorganisms including viruses, bacteria, protozoa, algae and fungi, and exploit their interactions with environment and human beings.
2. Plan production of economically important products including antibiotics, organic acids, vitamins, growth factors, hormones, enzymes.
3. Isolate, identify and maintain microbial cultures for disease diagnosis, application in agriculture, environment, genetic engineering, industry and other related fields of applied Microbiology.
4. Skill to operate basic and advanced instruments used for analysis of various biomolecules.
5. To impart in-depth knowledge, inculcate scientific thinking and develop practical skills to Microbiology students to pursue career in industry, academia or research.
6. To develop Microbiologists with ability to design, plan and implement research projects, scientific report writing skills and apply them to solve problems related to areas of Microbiology.
7. To work safely, independently and effectively in Microbiology laboratories along with understanding of microbes at molecular level.
8. To enable students to understand the applications of microbiology in healthcare, agriculture, food technology & environmental protection.

5 YEARS INTEGRATED B.Sc. - M.Sc. MICROBIOLOGY

SCHEME OF INSTRUCTION AND EXAMINATIONS
For Students Admitted From A.Y. 2017-2018 & Onwards

Semester –I							
Course Code	**Course**	**Hrs- of Instructions/wk**	**Exam Duration hrs**	**Marks allotted**			**Credits**
				CIE	**SEE**	**Total**	
Part – I							
17ILCEN01	Functional English-I	3	3	40	60	100	3
Part – II							
17IMBCC01	**Core 1**: Fundamentals of Microbiology	4	3	30	70	100	4
17IMBCC02	**Core 2**: Cell Biology	4	3	30	70	100	4
17IMBDA01	**DSE Allied-1**: Zoology	4	3	30	70	100	4
17IMBCC03	**Core Practical - 1-** Microbial Cell Biology	6	6*	40	60	100	2
17IMBDA02	**DSE Allied-1–Practical** Zoology	2	3	20	30	50	1
	TOTAL	**23**				**550**	**18**
Part –III							
	AECC-1: Environmental Science	1	--	-	-	-	-
17IVE01	**SEC-1**:Value Education –I	1	--	REMARKS			1
		25					

*3 hrs on day 1 and 3 hrs on second day

Semester –II							
Course Code	**Course**	**Hrs- of Instructions/wk**	**Exam Duration hrs**	**Marks allotted**			**Credits**
				CIE	**SEE**	**Total**	
Part –I							
17ILCEN02	Functional English-II	3	3	40	60	100	3
Part- II							
17IMBCC04	**Core 3**:Microbial Diversity	4	3	30	70	100	4
17IMBCC05	**Core 4:**Basic Biochemistry	4	3	30	70	100	4
17IMBCC06	**Core 5**:Bacteriology	4	3	30	70	100	4
17IMBDA03	**DSE Allied-2**: Botany	4	3	30	70	100	4
17IMBCC07	**Core Practical – 2** Microbial Diversity and Biochemistry	6	6*	40	60	100	2
17IMBDA04	**DSE Allied-2: Practical** - Botany	2	3	20	30	50	1
	TOTAL	**27**				**650**	**22**
Part – III							
17IAE01	**AECC-1**: Environmental Science	1	-	REMARKS			2
17IVE02	**SEC-2**:Value Education – II	1	-	REMARKS			1
		29					

*3 hrs on day 1 and 3 hrs on second day

Semester – III							
Course Code	**Course**	**Hrs- of Instructions/wk**	**Exam Duration hrs**	**Marks allotted**			**Credits**
				CIE	**SEE**	**Total**	
Part –I							
17ILCEN03	Advanced English Language – I	3	3	40	60	100	3
Part –II							
17IMBCC08	**Core 6:** Microbial Ecology	5	3	30	70	100	5
17IMBCC09	**Core 7**: Agricultural Microbiology	4	3	30	70	100	4
17IMBCC10	**Core 8**: Food and Environmental Microbiology	4	3	30	70	100	4
17IMBDA05	**DSE Allied -3**: Sustainable Management	4	3	30	70	100	4
17IMBCC11	**Core Practical – 3** Applied Microbiology	6	6*	40	60	100	3
17IMBDA06	**DSE Allied -3: Practical** - Sustainable Management	2	3	20	30	50	1
	TOTAL	**28**				**650**	**24**

*3 hrs on day 1 and 3 hrs on second day

Semester – IV							
Course Code	**Course**	**Hrs- of Instructions/wk**	**Exam Duration hrs**	**Marks allotted**			**Credits**
				CIE	**SEE**	**Total**	
Part - I							
17IENLC04	Advanced English Language – II	3	3	40	60	100	3
Part - II							
17IMBCC12	**Core 09:** Bacterial Metabolism	4	3	30	70	100	4
17IMBCC13	**Core 10**: Analytical Techniques	4	3	30	70	100	4
17IMBCC14	**Core 11**: Industrial Microbiology	4	3	30	70	100	4
17IMBDA07	**DSE Allied -4**: Biostatistics and Bioinformatics	4	3	30	70	100	4
17IMBCC15	**Core Practical – 4** Microbial Techniques and Instrumentation	6	6	40	60	100	3
17IMBDA08	**DSE Allied -4 Practical** Biostatistics and Bioinformatics	2	3	20	30	50	1
	TOTAL	**27**				**650**	**23**

*** Internship/ Training / Project in the vacation after Semester – IV for 2 months. The Internship / training report is to be submitted in the V Semester and the Viva-voce will be conducted in the beginning of V Semester**

Semester – V							
Course Code	**Course**	**Hrs- of Instructions/wk**	**Exam Duration hrs**	**Marks allotted**			**Credits**
				CIE	**SEE**	**Total**	
Part –II							
17IMBCC16	**Core 12**: Immunology	4	3	30	70	100	4
17IMBCC17	**Core 13:** Medical Microbiology	4	3	30	70	100	4
17IMBCC18	**Core 14** Phycology (Self Study)	1	3	30	70	100	4
17IMBCC19	**Core 15**: Computer Based Test (for Core Courses of Semesters I to V)	-	2	100	-	100	1
17IMBDC01/ 17IMBDC02/ 17IMBDC03	**DSE-Core 1** Pharmaceutical Microbiology/ Quality Assurance and Quality control/ Bioethics and IPR	4	3	30	70	100	4
17IMBCC20	**Core Practical- 5** Clinical Microbiology	9*	6	40	60	100	3
17IMBDC04/ 17IMBDC05/ 17IMBDC06	**DSE-Core 1 –Practical:** Pharmaceutical Microbiology/ Quality Assurance and Quality control/ Bioethics and IPR	3	3	20	30	50	1
17IMBCC21	**Research Project/ Training/Internship**	In the vacation after semester – IV		50	50	100	6
	Generic Elective-1 From Common UG Pool	2	-	100	-	100	2
	TOTAL	**27**				**850**	**29**

***3 hrs each Day for 3 days**

Semester – VI							
Course Code	**Course**	**Hrs- of Instructions/wk**	**Exam Duration hrs**	**Marks allotted**			**Credits**
				CIE	**SEE**	**Total**	
Part –II							
17IMBCC22	**Core 16:** Molecular Biology	4	3	30	70	100	4
17IMBCC23	**Core 17**: Genetic Engineering	4	3	30	70	100	4
17IMBDC07/ 17IMBDC08/ 17IMBDC09	**DSE-Core 2** Advances in Microbiology / Microbiology and Health Care / Fundamentals of Research Methodology	4	3	30	70	100	4
17IMBCC24	**Core Practical- 6** Molecular Biology	9*	6	40	60	100	3
17IMBDC10/ 17IMBDC11/ 17IMBDC12	**DSE-Core 2 Practical** Advances in Microbiology / Microbiology and Health Care / Fundamentals of Research Methodology	2	2	20	30	50	1
17IMBCC25	**Microbiology Outreach Activity**	2	-	REMARKS			2
	Generic Elective-2 From Common UG Pool	2	3	50	-	100	2
		27				**550**	**20**
Total Marks: 3900							
Total Credit: 136 + 8 = 144							

Semester – VII							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit Points**
				CIE	**SEE**	**Total**	
Part- I							
17IMBCC26	**Core 18:** Molecular Cell Biology	4	3	30	70	100	4
17IMBCC27	**Core 19:** Microbial Diversity and Evolution	4	3	30	70	100	4
17IMBCC28	**Core 20:** Mycology and virology	4	3	30	70	100	4
17IMBDA09/ 16IMBDA10	**DSE- Allied- 5 -** Research Methodology and Experimental Design/ Good Laboratory Practices	5	3	30	70	100	5
17IMBCC29	**Core Practical - 7** Molecular Cell Biology and Diversity	9	9* (3 days)	80	120	200	3
Part – II							
17IMBCE01	**Poster/ Seminar Presentation**	1	-	50	-	50	1
Total		**27**				**650**	**21**
17IMBCE02	**Professional Certification course**	2	-	REMARKS			**2**
Total		**29**				**650**	**23**

***3 hrs each Day for 3 days**

Semester – VIII							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit Points**
				CIE	**SEE**	**Total**	
Part –I							
17IMBCC30	**Core 21:** Bioprocess Technology	4	3	30	70	100	4
17IMBCC31	**Core 22**:Microbial Physiology and Energetics	4	3	30	70	100	4
17IMBCC32	**Core 23**: Basic Instrumentation and Biophysics	4	3	30	70	100	4
17IMBDA11/ 17IMBDA12/ 17IMBDA13	**DSE- Allied-- 6-** Soil and Agriculture Microbiology / Food and Dairy Microbiology / Cell Culture Technology	4	3	30	70	100	4
17IMBCC33	**Core Practical - 8** Fermentation Technology	9	9	80	120	200	3
17IMBDA14/ 17IMBDA15/ 17IMBDA16	**DSE- Allied-- 6 – Practical** Soil and Agriculture Microbiology / Food and Dairy Technology	2	3	20	30	50	1
	Generic Elective – 3	2	-	100	-	100	2
Part-II							
17IMBCE03	**Research Proposal Writing**	1	-	REMARKS			1
Total		**30**				**750**	**23**

Semester-IX							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit Points**
				CIE	**SEE**	**Total**	
Part-I							
17IMBCC34	**Core 24:** Advanced Molecular Technology	4	3	30	70	100	4
17IMBCC35	**Core 25**: Microbial Genetics	4	3	30	70	100	4
17IMBCC36	**Core 26: Computer Based Test**	-	-	100	-	100	1
17IMBDC13/ 17IMBDC14	**DSE- Core—3:** Genomics/ Bioethics	4	3	30	70	100	4
17IMBCC37	**Core Practical – 9** Advanced Molecular Technology	6	6	60	90	150	3
17IMBDC15/ 17IMBDC16	**DSE- Core—3 Practical** Genomics/ Bioethics	2	3	20	30	50	1
	Project / Training / Internship	10	-	-	-	-	-
		30				**600**	**17**

Semester – X							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit Points**
				CIE	**SEE**	**Total**	
Part – I							
17IMBCC38	**Core 27**: Environmental Biotechnology	4	3	30	70	100	4
17IMBCC39	**Core – 28:** Forensic Microbiology	4	3	30	70	100	4
17IMBCC40	**Core – 29:** Advanced Diagnostic Techniques	4	3	30	70	100	4
17IMBDC17 / 17IMBDC18	**DSE- Core-- 4**: Proteomics/ Bio-entrepreneurship	4	3	30	70	100	4
17IMBCC41	**Core Practical – 10** Diagnostic Techniques	6	6	60	90	150	3
17IMBDC19/ 17IMBDC20	**DSE- Core-- 4**: **Practical** Proteomics/ Bio-entrepreneurship	2	3	20	30	50	1
17IMBCC42	**Project / Internship/Training and Viva Voce**	6	-	80	120	200	12
		30				**800**	**32**
				TOTAL		**2800**	**95**

FOR SEMESTER: I - VI

Part III						
Course Code	**Semester**	**Particulars**	**Hrs of instruction/week**	**No. of Courses**	**Credit/Course**	**Total Credits**
Ability Enhancement Compulsory Course (AECC)						
As per common list	I & II	**AECC-I** Environment Science	1	1	2	2
	IV & V	**AECC-II** Communication Skill/Soft Skills	2	2	1	2
					Sub Total	**4**
Skill Enhancement Course (SEC)						
As per common list	I	**SEC-I** Value Education-I	1	1	1	1
	II	Value Education-II	1	1	1	1
	Any Semester between II – V	**SEC-II** *Co-Curricular Course	> 40 hours in total	1	1	1
	Any Semester between II - V	**SEC-III** **Value Added Courses	40 hours in total	1	1	1
					Sub Total	**4**
					Grand Total	**8**

*** Co- Curricular Courses –** Option to student to choose one from a list of courses offered by the college, such as Add-on courses, Gandhian Studies Certificate Course, Women Studies Course, etc.
**** Value Added Courses -** Option to student to choose at least one from a list of courses offered by UG Departments
Microbiology Outreach Course offered in semester VI and will be assessed in the same semester.
Project/Survey/Review writing / Internship: Between 4th and 5th semester (Vacation period)
Total Credit to earn Degree = 144 credits
Part I and II = 136 credits AND Part III = 8 credits

- **TOTAL MARKS & CREDIT DISTRIBUTION**

S.NO	PART	Total Marks	Total Credits
1.	PART I: Language Course	400	12
2.	PART II : Core, DSE Allied, DSE Core, GE	3500	124
3.	PART III: AECC- I & II SEC – I,II &III	Remarks	08
	TOTAL	**3900**	**144**

- **PART – I : LANGUAGE COURSE**

The following are compulsory courses offered in first to fourth semesters.

S.No	Semester	Course code	Course
1	I	17ILCEN01	Functional English –I
2	II	17ILCEN02	Functional English –II
3	III	17ILCEN03	Advanced English Language – I
4	IV	17ILCEN04	Advanced English Language – II

- **PART – II : CORE, DSE ALLIED, DSE CORE, GE**

CORE COURSES [Theory]

S. No	Semester	Course code	Course
1	I	17IMBCC01	Core 1: Fundamentals of Microbiology
2		17IMBCC02	Core 2: Cell Biology
3	II	17IMBCC04	Core 3:Microbial Diversity
4		17IMBCC05	Core 4: Basic Biochemistry
5		17IMBCC06	Core 5:Bacteriology
6	III	17IMBCC08	Core 6:Microbial Ecology
7		17IMBCC09	Core 7: Agricultural Microbiology
8		17IMBCC10	Core 8: Food and Environmental Microbiology
9	IV	17IMBCC12	Core 9: Bacterial Metabolism
10		17IMBCC13	Core 10: Analytical Techniques
11		17IMBCC14	Core 11: Industrial Microbiology
12	V	17IMBCC16	Core 12 Immunology
13		17IMBCC17	Core 13: Medical Microbiology
14		17IMBCC18	Core 14: Phycology (Self Study)
15		17IMBCC19	Core 15: Computer Based Test
16	VI	17IMBCC22	Core 16: Molecular Biology
17		17IMBCC23	Core 17: Genetic Engineering

CORE COURSE [Practical]

S. No	Semester	Course code	Course
1	I	17IMBCC03	**Core Practical - 1-** Microbial Cell Biology
2	II	17IMBCC07	**Core Practical – 2-** Microbial Diversity and Biochemistry
3	III	17IMBCC11	**Core Practical – 3-** Applied Microbiology
4	IV	17IMBCC15	**Core Practical – 4 –** Microbial Technology and Instrumentation
5	V	17IMBCC20	**Core Practical- 5 -** Clinical Microbiology
6	VI	17IMBCC24	**Core Practical- 6 -** Molecular Biology

OTHER CORE COURSES

S. No.	Semester	Course Code	Course
1	IV & V	17IMBCC21	Research Project/ Training/Internship
2	VI	17IMBCC25	Microbiology Outreach Activity

DSE ALLIED COURSE

S.No	Semester	Course code	Course
1	I	17IMBDA01	Zoology
2	II	17IMBDA03	Botany
3	III	17IMBDA05	Sustainable Management
4	IV	17IMBDA07	Biostatistics and Bioinformatics

DSE ALLIED COURSE [Practical]

S.No	Semester	Course code	Course
1	I	17IMBDA02	Zoology
2	II	17IMBDA04	Botany
3	III	17IMBDA06	Sustainable Management
4	IV	17IMBDA08	Biostatistics and Bioinformatics

DSE CORE COURSES [Theory & Practical]

Students are required to opt for any one of the courses offered in 5^{th} & 6^{th} semesters respectively.

S. No	Semester	Theory		Practical	
		Course code	Course	Course code	Course
1.	V	17IMBDC01/	Pharmaceutical Microbiology	17IMBDC04/	Pharmaceutical Microbiology
		17IMBDC02 /	Quality Assurance and Quality Control	17IMBDC05/	Quality Assurance and Quality Control
		17IMBDC03	Bioethics and IPR	17IMBDC06	Bioethics and IPR
2.	VI	17IMBDC07/	Advances in Microbiology	17IMBDC10/	Advances in Microbiology
		17IMBDC08/	Microbiology and health care	17IMBDC11/	Microbiology and health care
		17IMBDC09	Fundamentals of Research Methodology	17IMBDC12	Fundamentals of Research Methodology

GENERIC ELECTIVE

S. No	Semester	Course
1.	V	Any one course from list of courses offered across UG Departments
2.	VI	

- **PART –III : AECC , SEC**

Course Code	Semester	Particulars	Hrs of instruction/week	No. of Courses	Credit/Course	Total Credits
Ability Enhancement Compulsory Course (AECC)						
As per common list	I & II	**AECC-I** Environment Science	1	1	2	2
	IV & V	**AECC-II** Communication Skill/Soft Skills	2	2	1	2
					Sub Total	**4**
Skill Enhancement Course (SEC)						
As per common list	I	**SEC-I** Value Education-I	1	1	1	1
	II	Value Education-II	1	1	1	1
	Any Semester between II - V	**SEC-II** *Co-Curricular Course	> 40 hours in total	1	1	1
	Any Semester between II - V	**SEC-III** **Value Added Courses	40 hours in total	1	1	1
					Sub Total	**4**
					Grand Total	**8**

- **Courses offered by the Department to UG students of other Departments**

GENERIC ELECTIVE COURSE

S. No.	Semester	Course Code	Course	Name of Program
1	V	17IMBGE01	Microbes in Human welfare	For all other UG Programs
2	VI	17IMBGE02	IPR and Patenting	For all other UG Programs

FOR SEMESTER VII - X

- **TOTAL MARKS & CREDIT DISTRIBUTION**

S.NO	PART	Total Marks	Total Credits
1.	PART I: Core, DSE Allied, (Theory & Practical)	2800	91
2.	PART II : SEC, CC	Remarks	02
4	Professional Certification course	-	02
	TOTAL	**2800**	**95**

- **PART – I : CORE, DSE**

CORE COURSES [Theory]

S. No	Semester	Course code	Course
1	VII	17IMBCC26	Core 18: Molecular Cell Biology
2		17IMBCC27	Core 19: Microbial Diversity and Evolution
3		17IMBCC28	Core 20: Mycology and Virology
4	VIII	17IMBCC30	Core 21: Bioprocess Technology
5		17IMBCC31	Core 22:Microbial Physiology and Energetics
6		17IMBCC32	Core 23: Basic Instrumentation and Biophysics
7	IX	17IMBCC34	Core 24: Advanced Molecular Technology
8		17IMBCC35	Core 25: Microbial Genetics
9		17IMBCC36	Core 26: Computer Based Test
10	X	17IMBCC38	Core 27: Environmental Biotechnology
11		17IMBCC39	Core 28: Forensic Microbiology
12		17IMBCC40	Core 29: Advanced Diagnostic Technology

CORE COURSES [Practical]

S. No	Semester	Course code	Course
1	VII	17IMBCC29	**Core Practical – 7 –** Molecular Cell Biology and Diversity
2	VIII	17IMBCC33	**Core Practical – 8-** Fermentation Technology
3	IX	17IMBCC37	**Core Practical – 9 –** Advanced Molecular Technology
4	X	17IMBCC41	**Core Practical – 10** Diagnostic Techniques

OTHER CORE COURSES

S. No.	Semester	Course Code	Course
1	IX - X	17IMBCC42	Internship / Training / Project and Viva Voce

DSE CORE COURSES - [Theory & Practical]

S. No	Semester	Theory		Practical	
		Course code	Course	Course code	Course
1.	IX	17IMBDC13	Genomics	17IMBDC15	Genomics
		17IMBDC14	Bioethics	17IMBDC16	Bioethics
2.	X	17IMBDC17	Proteomics	17IMBDC19	Proteomics
		17IMBDC18	Bioentrepreneurship	17IMBDC20	Bioentrepreneurship

DSE ALLIED COURSES - [Theory & Practical]

S. No	Semester	Theory		Practical	
		Course code	Course	Course code	Course
1.	VII	17IMBDA09/ 17IMBDA10	Research Methodology and Experimental Design / Good Laboratory Practice	-	-
2.	VIII	17IMBDA11/ 17IMBDA12/ 17IMBDA13	Soil and Agriculture Microbiology / Food and Dairy Technology / Cell Culture Technology	17IMBDA14/ 17IMBDA15/ 17IMBDA16	Soil and Agriculture Microbiology / Food and Dairy Technology / Cell Culture Technology

GENERIC ELECTIVE:

Offered by Microbiology Department to the students of other Integrated M. Sc. Programmes

S. No	Semester	Course
1.	VIII	Bioinformatics and Biostatistics

- **PART – II : COMPETENCY ENHANCEMENT COURSES**

S. No	Semester	Course code	Course
1	VII	17IMBCE01	Poster/ Seminar Presentation
2	VII	17IMBCE02	Professional Certification course
3	VIII	17IMBCE03	Research Proposal writing

- **PART – III : SKILL ENHANCEMENT COURSES**

S. No.	Semester	Course Code	Course
1	I	-	Value Added Courses offered by the Institution

Enclosure – I C (I)

5 Years Integrated B.Sc - M.Sc Microbiology
SEMESTER - I

17IMBCC01	Core I: Fundamentals of Microbiology	4hrs/wk	4 Credits

Course Objectives:

After successfully completing this course the student should be able to:

1. Identify major contributions of the early scientists and the historical milestones that laid the groundwork for modern microbiology
2. Understand the characteristics of major groups of microorganisms
3. Explain the fundamentals of microscopy and staining technique
4. Understand the characteristics of prokaryotic cells and eukaryotic cells
5. Identify, discuss and illustrate morphological features of bacterial cell and its organelles.

Unit 1: Scope and History of Microbiology (10hrs)

- Microbiology as a field of Biology
- History and Development of Microbiology
- The Place of Microorganisms in the living world; Distribution of Microorganisms in Nature
- Spontaneous generation versus Biogenesis; Germ Theory of disease
- Applied areas of Microbiology

Unit 2: Microscopy (09hrs)

- Microscopy: Introduction and Types
- Principle, Construction and working of: Bright field Microscopy, Dark field Microscopy, Fluorescent Microscopy, Phase Contrast Microscopy
- Introduction to Advanced Microscopic techniques: Confocal microscopy
- Electron Microscopy – Types, working and Limitations
- Preparation of sample for Electron Microscopy

Unit 3: Staining (09hrs)

- Stains and staining solutions
- Types of Stains: Natural, Acidic & Basic Stains
- Chromophore & Auxochrome groups, Leuco compounds
- Theories and types of Staining

Unit 4: Major Groups of Microorganisms (10hrs)

- Difference between Eukaryotes, Prokaryotes and Archaea
- Major groups of Microorganisms
- Bacteria: General characteristics
- Eukaryotic Microorganisms: Fungi, Algae, Protozoa
- Viruses: Plant, Animal Viruses, Bacteriophages

Unit 5: Morphology of Microorganisms (10hrs)

- Size, Shape and Arrangement of Bacteria
- The cell wall of Bacteria – Structure and chemical composition of Gram negative and Gram positive Bacteria
- Bacterial Structures – Internal to Cell Wall – Cell Membrane, Protoplast, Spheroplast, Membranous intrusions and intracellular membrane system, Cytoplasm, Cytoplasmic inclusions and Vacuoles, Nuclear Material
- Bacterial Structures – External to Cell Wall – Capsule, Flagella, Pilli, Prostheca, Shealth & Stalk
- Bacterial Spores & Cyst – Types of Spore, Structure and formation of Endospores (Sporogenesis) , Occurrence & Functions of Akinetes & Heterocyst

Text Books:

- Pelczar, M.J., Chan, E.C.S., Kreig, N.R. (1993). Microbiology, 5th Edition. New Delhi: Tata Mc Graw Hill Publishing Company Ltd.
- Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology, 5th Edition, New York: WCB Mc GrawHill publication.

Reference Books:

- Pommerville, J.C. (2013). Alcamo's Fundamentals of Microbiology, 10th Edition: Jones and Barlett learning LLC.
- Black, J.G. (2005). Microbiology: Principles and Explorations. New York: Wiley publication
- Tortora, G.J., Funke, B.R., Case, C.L. (2004). Microbiology: An Introduction. Singapore: Pearson Education.
- Singh, R.P. (2007). General Microbiology. New Delhi: Kalyani Publishers.

17IMBCC02	Core 2: Cell Biology	4hrs/wk	4 Credits

Course Objectives:

By the end of the semester, a student should be able to:

1. Appreciate and understand the dynamic nature of the cell, including how it receives and responds to information from its environment.
2. Explain and compare different mechanisms for receptor activation and regulation.
3. Understand and explain how membrane chemistry and regulation are essential in cell communication.
4. Understand intracellular signalling cascades and their impact on cellular activities, including cytoskeleton rearrangements, motility and changes in gene expression.
5. Understand mechanisms of cell cycle regulation.
6. Appreciate the cellular organization of intracellular and extracellular organelles

Unit 1: Cell concept and Cytology (09hrs)

- Cell concept, principal levels of cellular organization
- Historical aspects of Cytology
- Basic differences in structural organization in Prokaryotes and Eukaryotes
- Structure of Animal and Plant cell
- Endosymbiosis Theory

Unit 2: Membrane organization, function and Cell cycle (10hrs)

- Models of cell membrane
- Structural organization of plasma membrane – Fluid Mosaic Model
- Transport of Small Molecules across cell membrane-Active and Passive Transport
- Transport of Macromolecules across cell membrane -Phenomenon of exocytosis and endocytosis
- Cell Cycle and Cell Division – Mitosis and Meiosis

Unit 3: Cell wall, intercellular and intracellular transport (09hrs)

- Plant cell wall: its ultra structure and function
- Intracelluar junction, tight junction, intermediate junction, spot desmosome, gap junctions, plasmodesmata
- Endoplasmic reticulum: structure, chemical nature and function
- Golgi apparatus: structure, chemical nature and function
- GERL system and its role in intra-cellular secretion

Unit 4: Cellular Organelles (10hrs)

- Chloroplast: ultrastructure and function
- Mitochondria: structure, morphogenesis, chemical nature and functions
- Lysosomes: structure, chemical nature, concept of suicidal bag
- Peroxisomes and Glyoxisomes: structure & functions
- Centrosomes, Centrioles, and Cytoskeletal elements
- Motility: Cilia, Flagella

Unit 5: Nucleus **(10hrs)**

- Light and electron microscopic structure of chromosome and types
- Polytene chromosome, lampbrush chromosomes and their importance
- Nucleus and nucleolus : Ultra structure, chemical nature, nucleolar Chromosome
- Nuclear envelop: ultra structure, transport of material

Text Books:

- De Robertis, EDP, De Robertis EMF. (2006). Cell and Molecular Biology, 8th edition. Philadelphia: Lipincott Williams and Wilkins.
- Verma, P.S., Agrawal, V.K. (2005). Ecology, Cell Biology, Molecular Biology, Genetics. New Delhi: S. Chand and Company Limited.
- Powar, C.B., Daginawala, J.F. (1982). General Microbiology Vol-I. Mumbai: Himalaya Publishing House.

Reference Books:

- Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology, 5th Edition. New York: WCB Mc GrawHill publication.
- Stanier, R.Y. (1987). General Microbiology, 5th Edition: Macmillan publication.
- Tortora, G.J., Funke, B.R., Case, C.L. (2008). Microbiology, 8th Edition: McGraw Hill Company.

17IMBCC03	Core Practical – 1- Microbial Cell Biology	6hrs/wk	2 Credits

Objectives:

The course will impart

1. Operational skills for basic instruments used in Microbiology Laboratory
2. Understanding about the staining process and reagent preparation
3. Knowledge about the morphological properties of Microbial cell structure
4. To develop skills, through lab experiments, in some of the specific methodologies used in the study of modern cell biology

List of Practicals

1) Good microbiological Laboratory Practices
2) Principles of Laboratory Sanitation
3) Principles, working and uses of the following laboratory instruments :
   a) Microscope
   b) Incubator
   c) pH meter
   d) Refrigerator
   e) Colorimeter
   f) Colony counter
4) Principles, working and uses of the following sterilizers:
   a) Autoclave
   b) Hot air oven
   c) Inspissator
   d) Bacteriological filters.
5) Preparation of glassware for sterilization and disposal of laboratory media & cultures.
6) Preparation of Stains and Staining Reagents.
7) Study of Permanent Slides: Bacteria, Fungi, Algae, Protozoa, Flagella, Chromosome and its abberations
8) Study of bacterial motility by hanging drop method.
9) Monochrome Staining:
   a) Negative Staining
   b) Positive Staining
10) Gram's Staining
11) Special staining of bacteria:
   a) Capsule staining – Hiss's method
   b) Cell wall staining – Webb's method
   c) Spore staining – Schaeffer's method
   d) Metachromatic granule staining – Albert's method
   e) Spirochete staining – Harrie's method
12) Measurement of size of microorganisms by Micrometry (Demonstration)
13) Calibrations of microscopic measurements (Ocular & stage micrometers)
14) Demonstration and study of various phases of mitosis and meiosis
15) Microscopic observation of plant cells from onion
16) Microscopic observation of Barr bodies and Drum stick
17) Mitochondrial staining

Reference Books:

- Patel. R.J., Patel. K.R. (2009). Experimental Microbiology, Vol-I, Ahmedabad: Aditya Publications.
- Patel. R.J., Patel. K.R. (2009). Experimental Microbiology, Vol-II, Ahmedabad: Aditya Publications.
- Dubey, R.C., Maheshwari, D.K. (2005). Practical Microbiology. New Delhi: S. Chand & Company Limited.
- Sharma, K. (2005). Manual of Microbiology – Tools and Techniques. New Delhi: Ane books.
- Benson, H.J. (2002). Microbiological Applications – Laboratory Manual in General Microbiology – 8th edition: MacGrow Hill Company.

5 years Integrated B. Sc. – M.Sc. Microbiology

SEMESTER – II

17IMBCC04	Core 3: Microbial Diversity	4hrs/wk	4 Credits

Course Objectives:

After completing the course, the student will become competent enough to:

1. Understand the need and the types of microbial classification
2. Identify diverse varieties of microorganisms from their natural surroundings
3. Acknowledge the economical role of microorganisms

Unit 1: Introduction to Microbial Diversity (09hrs)

- Introduction to Biodiversity- Microbial evolution and diversity, Types of diversity
- Microbial Taxonomy: Introduction and overview
- Taxonomic ranks of microorganisms , Classification systems
- Major characteristics used in taxonomy
- Assessing Microbial Phylogeny
- The Major Divisions of Life

Unit 2: Prokaryotic Diversity (10hrs)

- Introduction to Archaea and Eubacteria
- Gram negative bacteria – General features of:
    - Aerobic/Microaerophilic motile, helical vibroid
    - Non-motile curved bacteria
    - Aerobic/Microaerophilic rods and cocci
    - Facultative anaerobes – rods, curved and helical bacteria
    - Dissimilatory Sulfate reducers
    - Anaerobic cocci
    - Phototrophic bacteria
- Gram positive bacteria – General features of:
    - Endospore forming rods and cocci
    - Asporogenous rods
    - Mycobacteria and Actinomycetes

Unit 3: Diversity of some unusual Prokaryotes (09hrs)

- General Features of Bacteria with unusual morphology:
    - Rickettsia and Chlamydia
    - Budding and appendaged bacteria
    - Sheathed Bacteria
    - Bacteria with gliding motility
    - Mycoplasma
- General Features of Bacteria of extreme environments:
    - Thermophiles
    - Halophiles
    - Acidophiles
    - Barophiles

- Methanogens
- Psychrophiles

Unit 4: Eukaryotic Diversity (10hrs)

A: FUNGI:

- General characteristics – Definition, Occurrence and Ultra- Structure
- Introduction to major divisions of Fungi
- Economic importance of Fungi

B: ALGAE:

- General Characteristics – Definition, Occurrence and Ultra- Structure,
- Economic importance of Algae

C: PROTOZOA:

- General Characteristics – Definition, Occurrence and Ultra- Structure
- Economic importance of Protozoa

Unit 5: Akaryotic Diversity - Viruses (10hrs)

- Introduction and General Characteristics: Definition, Structure and Major groups
- Cultivation and Enumeration of Viruses
- Bacterial Viruses: Classification, Lytic life cycle (T4 phage), lysogenic life cycle (Lambda and Mu phage), RNA Phage (MS13)
- Plant and animal viruses : Structure and importance with reference to TMV and HIV

Text Books:

- Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology, 5th Edition. New York: WCB Mc GrawHill publication.
- Atlas, R.M., Bertha, R. (1997). Microbial Ecology, 4th Edition: Benjamin Cummings publication
- Pelczar, M.J., Chan, E.C.S. and N.R. Kreig (1993). Microbiology, 5th Edition. New Delhi: Tata Mc Graw Hill Publishing co. Ltd.

Reference Books:

- Dubey, R.C., Maheshwari, D.K. (2005). Practical Microbiology. New Delhi: S. Chand & Company Limited.
- Tortora, G.J., Funke, B.R., Case, C.L. (2008). Microbiology, 8th Edition: McGraw Hill Company.
- Powar, C.B., Daginawala, J.F. (1982). General Microbiology Vol-I. Mumbai: Himalaya Publishing House.

17IMBCC05	Core 4: Basic Biochemistry	4hrs/wk	4 Credits

Course Objectives:

Upon completion of the course, the student should achieve an understanding of the following:

1. Basic cellular structure and the special properties of water
2. The structures of amino acids, their chemical properties and their organization into polypeptides and proteins.
3. Structure of fundamental monosaccharides and polysaccharides
4. Structure and basic function of nucleotides
5. Structure of different classes of lipids and their roles in biological systems

Unit 1: Basic Biochemistry (09hrs)

- Introduction to Atoms, Elements & Molecules
- Major Chemical bonds found in biological system: Ionic Bonds, Covalent Bonds, Hydrogen Bonds, Van der Waals interactions, Hydrophobic interactions
- Introduction to pH
- Major Chemical reactions: Acid Base, Redox, Condensation-Hydrolysis Reactions
- Water and its important properties
- Major elements of life and their significance

Unit 2: Basics of Bioenergetics (09hrs)

- Laws of Thermodynamics
- Definitions of Gibb's Free Energy, Entropy and Enthalpy
- Standard free energy change and equilibrium constant
- Energy rich compounds: Phosphoenolpyruvate, Thioesters, ATP

Unit 3: Carbohydrates and Lipids (10hrs)

- Definition, Functions and Classification of Carbohydrates
- Structure and properties of Monosaccharides
- Disaccharides & Polysaccharides
- Definition, Functions and Classification of Lipids
- Fatty acids: Structure and types
- Introduction to phospholipids: Examples and Significance
- Introduction and Significance of Steroids

Unit 4: Proteins and Nucleic acids (10hrs)

- Definition, Functions and Classification of Proteins
- Amino acids: Classification, Physical & Chemical Properties
- Structure of Proteins: Primary, Secondary, Tertiary & Quaternary Levels
- Introduction to Nitrogen Base, Nucleosides & Nucleotides
- Structure of Deoxyribonucleic acid: A-DNA, B-DNA, Z-DNA
- Introduction to RNA & its types

Unit 5: Enzymes (10hrs)

- Definition and Classification of Enzymes
- Definition of Apoenzyme, Core Enzyme, Holo enzyme, Coenzyme, Cofactors, Prosthetic Groups
- Mechanism of enzyme action – Active Sites, Activation Energy, Lock & Key Model, Induced Fit model
- Factors affecting enzyme activity
- Definition of terms: Enzyme Unit, Specific Activity and turn over number
- Phenotypic and genotypic regulation of Enzymes

Text Book:

- Atlas, R.M., Bartha, R. (1997). Microbial Ecology, 4th Edition: Benjamin Cummings publication
- Satyanarayan, U. (2008). Biotechnology. Kolkata, West Bengal: Books and allied (P) Ltd
- Pelczar, M.J., Chan, E.C.S., Kreig, N.R. (1993). Microbiology, 5th Edition. New Delhi: Tata Mc Graw Hill Publishing co. Ltd.
- Powar, C.B., Daginawala, J.F. (1982). General Microbiology Vol-I. Mumbai: Himalaya Publishing House.

Reference Book:

- Conn E.E., Stumpf P.K. (1989). Outlines of Biochemistry. Wiley publication.
- Stanier, R.Y. (1987). General Microbiology, 5th Edition: Macmillan publication.
- Nelson, D.L., Cox, M.M. (2013). Lehninger Principles of Biochemistry. W.H. Freeman publication.

17IMBCC06	Core 5: Bacteriology	4hrs/wk	4 Credits

Objectives:

At the end of the course, the student shall be able to

1. Understand the nutritional requirements of microbes
2. Understand the principle and the techniques of microbial cultivation
3. Know the techniques of pure culture
4. Understand the methods of microbial control

Unit 1: Bacterial Systematics (10hrs)

- Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain
- Conventional, Molecular and Recent approaches to polyphasic bacterial taxonomy,
- Evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences.
- Differences between Eubacteria and Archaebacteria

Unit 2: Microbial Growth and Nutrition (09hrs)

- Introduction and Definition of Growth, Modes of Cell division in procaryotes
- Septum Formation
- Bacterial Growth Curve
- Synchronous culture & Continuous Growth of Bacteria
- Measurement of Bacterial Growth

Unit 3: Cultivation of Bacteria and Pure Culture Techniques (09hrs)

- Nutritional requirements of Bacteria
- Nutritional types of Bacteria
- Chemical requirement of Growth – Bacteriological Media & their Types
- Physical Conditions required for growth – Air, pH & Temperature
- Cultivation of Anaerobes
- Natural Microbial Population (Mixed Cultures)
- Selective methods to obtain Pure Cultures
- Isolation and Preservation of pure cultures
- Cultural Characteristics

Unit 4: Control of Microbes by Physical methods (10hrs)

- Definitions: Sterilization, Disinfection, Sanitization, Antisepsis, Microbiocidal & Microbiostasis, Thermal Death Time, Thermal Death Point, D-Value, z-Value & F-value
- Control by High Temperature
- Moist Heat – Autoclave, Fractional Sterilization, Boiling, Use of Inspissator, Pasteurization
- Dry Heat – Hot Air Oven, Incineration
- Control by Low Temperature
- Control by Desiccation
- Control by Radiation – UV radiation, x-rays, Gamma rays and Cathode rays
- Control by Surface tension & Interfacial tension

- Control by Filtration

Unit 4: Control of Microbes by Chemical methods (10hrs)

- Characteristics of an Ideal Antimicrobial agent
- Phenol & Phenolic compounds
- Alcohols
- Halogens – Iodine & Chlorine
- Heavy Metals & Dyes
- Detergents & Quaternary Ammonium Compounds
- Aldehydes & Gaseous agents
- Phenol coefficient method

Unit 5: Control of Microbes by Antibiotics

- Chemotherapeutic agents and Chemotherapy
- Characteristics of ideal chemotherapeutic agent
- Antibiotics and their mode of action : Inhibition of cell wall synthesis, Damage to cytoplasmic membrane, Inhibition of nucleic acid and protein synthesis, Inhibition of specific enzyme system
- Antifungal, antiviral and antitumor chemotherapeutic agents
- Microbiological assay of antibiotics
- Nonmedical uses of antibiotics

Text Books:

- Pelczar, M.J., Chan, E.C.S., Kreig, N.R. (1993). Microbiology, 5th Edition. New Delhi: Tata Mc Graw Hill Publishing co. Ltd.
- Powar, C.B., Daginawala, J.F. (1982). General Microbiology Vol-I. Mumbai: Himalaya Publishing House.

Reference Book:

- Stanier, R.Y. (1987). General Microbiology, 5th Edition: Macmillan publication.

17IMBCC07	Core Practical – 2 - Microbial Diversity and Biochemistry	6hrs/wk	3 Credits

Objective: The course is designed to impart practical skills and the fundamental understanding about

1. Qualitative and quantitative analysis of Biomolecules
2. Determination of enzymatic activity
3. Techniques of Microbial Isolation
4. Enumeration of microbial cells
5. Effect of Chemicals on microbial growth

List of Practicals:

1) Isolation of Gram negative bacteria from the given sample.
2) Identification of Gram negative bacteria from the given pure culture using biochemical media (*E.coli, Entrobacter aerogens, Proteus, Salmonella*)
3) Isolation of Gram positive bacteria from the given sample.
4) Identification of Gram positive bacteria from the given pure culture using biochemical media (*Bacillus megaterium, Bacillus subtilis, Staphylococcus aureus*)
5) Identification of Fungi on the basis of Morphological Characteristics.
6) Cultivation of yeast from different natural samples and its morphological characterization using microscopic observation.
7) Microscopic observation of different algae from the given samples.
8) Microscopic observation of different protozoa from the given sample.
9) Isolation and cultivation of bacteriophage of *E.coli* from the given sewage sample.
10) Estimation of Protein by Foiln-Lowry's Method.
11) Estimation of Sugar by Cole's Method.
12) Estimation of DNA by DPA Method.
13) Qualitative Analysis of Carbohydrates.
14) Qualitative Analysis of Proteins & Amino acids.
15) Determination of alpha amylase activity by iodometric method.
16) Study of Turbidometric growth curve of *E.coli* and derivation of Growth rate & Generation time.
17) Enumeration of bacteria by viable count technique.
18) Enumeration of bacteria by Total Count Technique.
19) Effect of various chemicals on microbial growth
20) Effect of antibiotics on microbial growth

Reference Books:

- Jayaraman, J. (1981). Laboratory Manual in Biochemistry: Wiley publication.
- Sawhney S.K., Singh, R. (2005). Introductory Practical Biochemistry: Alpha Science International.
- Cappuccino, J.G., Sherman, N. (2004). International student edition: Microbiology- A laboratory Manual 4th edition: Benjamin Cummings publications

EVALUATION NORMS for 5 Years Integrated B.Sc.- M. Sc. Programmes

Assessment and evaluation of learning experiences of the students in various courses or components of the curriculum is an important part of measuring learning outcomes, besides others. The courses or components could be evaluated through continuous Internal Evaluation (CIE) or Semester End Examination (SEE) or both.

The following are the evaluation norms for some of the courses, especially that of the first two semesters of the UG programmes introduced from 2016-2017 and onwards.

1. **Theory**
   i. Generally CIE - 30 marks
   SEE - 70 marks
   Total - 100 marks
   Unless otherwise mentioned.

   ii. **Components of CIE**

Sr. No	**Component**	**Content**	**Duration, if any**	**Marks**	**Sub Total**
a)	Test-I Test-II	1st two Units All 5 Units	2 hrs 3 hrs	5 (set for 50) 10 (set for 70)	15
b)	Assignment-I Assignment-II Assignment-III	- - -	- - -	5 (Mark on 20) 5 (Mark on 20) 5 (Mark on 20)	15
				Grand Total	**30 Marks**

2. **Practical**
   i. CIE - 40 marks
   SEE - 60 marks
   Total - 100 marks

   ii. Components of CIE

S. No.	**Component**	**Content**	**Duration, if any**	**Marks**	**Sub Total**
a)	Test-I Test-II	50% of experiments All experiments	2 hrs/3hrs As per duration of SEE	10 (set for 30 marks) 20 (set for 60 marks)	30
b)	Observation book & record	-	-	10	10
				Grand Total	**40 Marks**

Guidelines for CIE of Theory & Practical

1. There is no passing minimum for CIE of theory and Practical Courses.
2. There is no provision for re-appearance or improvement of marks in CIE.
3. The candidate is permitted to appear for the SEE of the practical course only if he/she has completed at least **75% of the experiments** in the syllabus.
4. In the event of non conformity of S. No. 3 above, the candidate may make up for the deficit percentage of experiments, only in the ensuing semester, when being conducted.
5. A total of only 2 such attempts to make up the deficit is permitted.

The Evaluation norms & Guidelines framed for the following courses unique to Department

S.No	Programme	Semester	Course
1.	B.Sc. Microbiology	VI	Microbiology Outreach Activity

Evaluation norms & Guidelines for B.Sc Microbiology course:

Course title: Microbiology Outreach Activity
Offered in: Semester VI
Mode of evaluation: 100% CIE
Components of CIE:

S.No	Component	Marks	Evaluated in
1	Participation	50	Semester VI
2	Initiative and Leadership	30	
3	MCQ	20	
	Total	**100**	
Remark will be given on the basis of marks obtained in the semester			
100-90 – Out standing 89-80 – Excellent 79-60 – Very Good 59-50 – Good 49-40 – Fair Below 40 – Not Satisfactory			

S.No	Programme	Semester	Course
1..	M.Sc. (Integrated) Microbiology	VII	Poster/ Seminars/ Presentations
		VIII	Research Proposal Writing

Evaluation norms & Guidelines for M.Sc Microbiology course:

A. Course title: **Poster/ Seminars/ Presentations**
Offered in: Semester VII
Mode of evaluation: 100% CIE
Components of CIE:

S.No	Components	Marks
1	Presentation	10
2	Content	10
3	Understanding of the Topic	10
4	Confidence	10
5	Participation (in discussion of other students presentation)	10
	TOTAL	**50**

B. Course title: **Research Proposal Writing**
Offered in: Semester VIII
Mode of evaluation: 100% CIE
Components of CIE: Peer reviews and remarks

Enclosure – IB

5 years Integrated B. Sc. Microbiology
Semester III

17IMBCC08	Core 6: Microbial Ecology	5hrs/wk	5 Credits

Course objectives:

• To introduce the field of microbial ecology and environmental microbiology

• To explore the functional ubiquity and diversity of microorganisms

Unit 1: Introduction to Microbial Ecology **10hrs**

- History, Significance, Developments in the field of Microbial Ecology, Major Contributions
- Origin of life : Theories
- Types, structure and functions of Ecosystems

Unit 2: Microorganisms and their Habitat **10hrs**

- Ecological Niche
- Terrestrial Environment: Brief account of Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat of microbes, Soil microflora
- Aquatic Environment: Stratification & Microflora of Freshwater & Marine habitats
- Atmosphere: Stratification of the Atmosphere, Aeromicroflora, Dispersal of Microbes
- Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.

Unit 3: Successions and Interactions **10hrs**

- Succession of microbial commUnities in the decomposition of plant organic matter
- Biological Interactions
  - ❖ Microbe–Microbe Interactions
    - Mutualism, Synergism, Commensalism, Competition, Amensalism, Parasitism,
    - Predation, Biocontrol agents
  - ❖ Microbe–Plant Interactions
    - Roots, Aerial Plant surfaces, Biological Nitrogen fixation- (symbiotic / nonsymbiotic - biofertilizers)
  - ❖ Microbe–Animal Interactions (2 periods)
    - Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as symbiont

Unit 4: Biogeochemical Cycles **10hrs**

- Carbon cycle
- Nitrogen cycle: Ammonification, nitrification, denitrification & nitrate reduction.
- Phosphorous cycle: Phosphate immobilization and phosphate solubilization
- Sulphur Cycle: Microbes involved in sulphur cycle

Unit 5: Applications of Microbial processes **10hrs**

- Bioleaching
- Biomagnification
- Bioremediation
- Microbial deterioration of metals (corrosion), textile and paper

Text Books:

- Atlas, R.M., Bertha, R. (1997). Microbial Ecology, 4th Edition: Benjamin Cummings publication
- Madigan, M.T., Martinko, J.M., Stahl, D.A., Clark, D.P. (2011). Brock Biology of Microorganisms, 13th ed.: Benjamin-Cummings publication
- Barton, L.L., Northup, D.E. (2011). Microbial Ecology: Wiley-Blackwell publication

Reference Book:

- Begon, M., Townsend, C.R., Harper, J.L. (2006). Ecology – From Individuals to Ecosystems, 4th ed.: Wiley-Blackwell publication.
- Kirchman, D.L. (2008). Microbial Ecology of the Oceans: Wiley-Blackwell publication.
- Madsen, E.L. (2008). Environmental Microbiology - From Genomes to Biogeochemistry: Wiley-Blackwell publication.
- Rochelle, P.A. (2001). Environmental Molecular Microbiology: Protocols and Applications: Horizon Scientific Press

17IMBCC09	Core 7: Agricultural Microbiology	4hrs/wk	4 Credits

Course objectives:

After successfully completing this course the student should be able to:

1) Identify the role of soil in the sustenance of microbial life
2) Understand the characteristics of major groups of microorganisms in soil
3) Explain the fundamentals of various geochemical cycles in the soil and the role of microbes in each
4) Understand the beneficial as well as harmful role of microbes in Agriculture.

Unit 1: Soil as a culture media **9hrs**

- Introduction to soil
- Formation of soil- weathering of rocks, pedogenesis
- Soil profile and microbial diversity of soil
- Rhizosphere and Rhizoplane
- Edaphic factors-Physical and chemical properties of soil

Unit 2: Biofertilizers and Biopesticides **12hrs**

- Overview of organic farming
- Biofertilizers
- Biopesticides
- Plant Growth Promoting Rhizobacteria
- Introduction to Mycorrhizae
- Integrated Pest Management

Unit 3: Beneficial role of microbes in Agriculture **10hrs**

- GMO – Definition, history and Current status
- Microbial Techniques in Crop improvement
- Phytoremediation
- Beneficial Sea weeds

Unit 4: Harmful effects of microbes in Agriculture **10hrs**

- General Mechanism, Propagation and control of:
  - Plant diseases by Bacteria-Xanthomonas citrii
  - Plant diseases by viruses - TMV
  - Plant diseases by fungi – Types and one example of each
  - Plant pathogenic Nematods

Unit 5: Veterinary Microbiology **9 hrs**

- Introduction to veterinary microbiology
- Microbial diseases of farm Animals: Anthrax, CJD, FMD, Mastitis
- Zoonotic diseases and its management
- Vaccines for farm animals: vaccination schedule, modes of administration and side effects

Text Books:

- Alexander, M. (1991). Introduction to Soil Microbiology: Krieger Publication.
- Motsara, M.R. Bhattacharyya, P., Srivastava, B. (1995). Biofertilizer- Technology, Marketing and Usage. New Delhi: Fertilizer Development & Consultant Organization. Rangaswami, G., Bagyaraj, D.J. (1992). Agricultural Microbiology. New Delhi: Asia Publishing House.
- Subba Rao, N.S. (1999). Biofertilizers in Agriculture and Agro forestry. New Delhi: Oxford & IBH.
- Subba Rao, N.S. (1995). Soil Microorganisms and Plant Growth. New Delhi: Oxford & IBH.
- Waiter, M.J., Morgan, N.L., Rocky, J.S., Higton, G. (1999). Industrial Microbiology: An Introduction: Wiley-Blackwell publication.
- Sharma S.N. Adlakha S.C (1996) Textbook of Veterinary Microbiology. Vikas Publications.

Reference Books:

- Dirk, J., Elas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology. New York: Marcel Dekker INC.
- Ramanathan, N., Muthukaruppan, S.M. (2005). Environmental Microbiology. Annamalai Nagar: Om Sakthi Pathipagam.

17IMBCC10	Core 8: Food and Environmental Microbiology	4hrs/wk	4 Credits

Course objectives:

This course is designed to provide Instruction about

1. General principles of food, dairy and water Microbiology.
2. Food spoilage, food preservation and food commodities;
3. Processing in dairy for milk and milk product;
4. Fundamentals of drinking water and waste water treatment;
5. Overview of air microbiology
6. Role of microbes in environmental processes

Unit –1 Food Microbiology **10hrs**

- Microbial flora of fresh food
- Microbial spoilage of foods: Fresh foods & Canned foods
- Food Borne infection & intoxication: Role of *S.aureus,, C.botulinum & Salmonella* Spp.in food poisoning
- Preservation of foods: General principles & methods of food preservation
- Microbiological examination of food; Introduction to AGMark
- Brief introduction about fermented foods: Pickles, Sauerkraut, Silage, Sausages & Bread
- Microorganisms as food: Single Cell Protein, Mushrooms and Functional foods

Unit –2 Dairy Microbiology **10hrs**

- Milk as a medium, normal flora of milk
- Types of microorganisms in milk: Biochemical types, Pathogenic types, Temperature types
- Spoilage of milk & milk products
- Microbial analysis of milk: SPC, Direct count, MBRT, Resazurin test
- Grading of milk
- Fermented milk Beverages & Manufactured Dairy Products: Starter Culture, Cheese, Yogurt, Buttermilk, Acidophilus milk, Kefir
- Preservation of milk: Principles & methods of preservation

Unit – 3 Air Microbiology **10hrs**

- Air flora - Concept of transient air flora, droplet, droplet nuclei, and aerosols
- Monitoring and control of air flora of
  - Hospitals
  - Aseptic filling areas
  - Research laboratories
  - Industries – Food and Pharmaceutical
- Air pollution: Chemical pollutants and their sources in air 1
- Methods of Air sampling

- Air sanitation 1
- Air borne infections

Unit-4 –Water Microbiology 10hrs

A Microbiology of drinking water

- Sanitary survey, Bacteriological evidence of pollution, Bacteriological analysis & Sampling techniques of water
- Microorganisms other than Coliforms as nuisance organisms

B Water purification

- Sedimentation, Filtration use of Sand filters, Disinfection

C Waste water

- Chemical and Microbial Characteristics of waste water, B.O.D., C.O.D. as indicator of quality of waste water
- Waste water treatment & Disposal - Single Dwelling Process & Municipal Treatment - Primary Treatment, Secondary Treatment, Advanced & final treatment
- Solid waste processing: Anaerobic Sludge digestion & Composting

Unit –5 Environmental Microbiology 10hrs

- Types of Pollutants, Sources & Effect on ecology
- Pollution by pesticides, Biomagnifications of pesticide & their Biological control
- Brief account on Water pollution (by Oil, Detergent, Heavy metal & industrial effluent) & their Biological control
- Role of microorganisms in Biodeterioration of Paper, Textiles, paints, woods & metals and their control
- Air Pollution & Air Sanitation
- Bioleaching, Microbial enhanced oil recovery
- Biofuels
- Bioplastics

Text Books:

- Frobisher, M. (1974). Fundamentals of Microbiology. 9th Edition. Philadelphia, PA: W. B. Saunders Company.
- Frazier, W.C., Westhoff, D.C. (1978). Food Microbiology. Tata McGraw-Hill Publishing Company.
- Swaminathan, M. (1990). Food Science, Chemistry and Experimental Foods. Mysore: Bappco Book Publishing Company.
- Jay, J.J., Loessener, M.J., Golden, D.A. (2005). Modern Food Microbiology: Springer publication.
- Prajapati, J.B. (1995). Fundamentals of Dairy Microbiology: Ekta Publication.
- Microbiology by Pelczar M.J. & Chain E.C.S. : 5th edition

- Industrial Microbiology by Prescott S.C. : 3rd edition
- Modern food microbiology by J James

Reference Book:

- Manay, S., Shadaksharaswami, M. (2008). Foods: Facts and Principles. New Delhi: New Age Publishers.
- Srilakshmi, B. (2002). Food Science. New Delhi: New Age Publishers.
- Meyer, L.H. (2004). Food Chemistry. New Delhi: New Age Publishers.
- Kenneth, F.K., Kriemhild, K.O. (2000). The Cambridge World History of Food. Cambridge: Cambridge University Press.

16IMBDA05	DSE Allied - 3: Sustainable Management	4hrs/wk	4 Credits

Course objectives:

This course is designed to provide awareness and importance about

1. Environment, its condition and its impact globally and locally
2. Need for sustainable management
3. Agricultural biodiversity in sustainable growth
4. Role of society, corporate and government in sustainable management

Unit 1: Introduction to Sustainable Management **10hrs**

- What is Sustainable Management?
- Sustainable development and Green Climate Fund
- Introduction to Corporate Social Responsibility and ISO 14001
- Brief account on SDGs (Sustainable Development Goals), Agenda 21, MDGs (Millennium Development Goals), UNDP

Unit 2: Basic concepts of Biodiversity **10hrs**

- Biodiversity – Definition, Types and Importance of Biodiversity, Keystone Species,
- Global Distribution of Biodiversity and Biodiversity Hotspots
- Biodiversity in India – Wetlands, Marine Environment, Endemism

Unit 3 : Agro biodiversity and Food Security **10hrs**

- Scope and importance of agricultural biodiversity and food Security
- Genetic vulnerability, Human dependency
- The decline of biodiversity
- Agro ecosystems v/s natural ecosystems, Issues in sustainable agriculture
  Food Security and sustainability in India

Unit 4: Threats to Biodiversity and impact of Biodiversity loss on sustainability **10hrs**

- Extent of Biodiversity Loss
- Biodiversity Threats
- The Indian Scenario
- Protected Areas and Countering Biodiversity Loss

Unit 5: Sustainable use of Biodiversity **10hrs**

- Sustainable use of Biodiversity
- International and National Instruments Relating to Biodiversity Management
- Gender and Biodiversity in India
- Conservation Measures of Biodiversity

Reference Book:

- IGNOU Study Materials
- Verma, P.S., Agrawal, V.K. (2005). Ecology, Cell Biology, Molecular Biology, Genetics. New Delhi: S. Chand and Company Limited.

17IMBCC11	Core Practical – 3 Applied Microbiology	6hrs/wk	3 Credits

Course objectives:

The course will impart

1. Technical skill for enumeration of soil, food and milk microbes
2. Understanding about the role of microbes in agriculture and food
3. Knowledge about the properties of microbes which make them important in nature .
4. To develop skills, through lab experiments, in some of the specific methodologies used in the study of modern food and dairy microbiology

List of Practicals

1. Enumeration of different kinds of microorganisms in soil – qualitative and quantitative methods
2. Study of degradation of organic matter.
3. Isolation of rhizosphere microorganisms – Isolation of nitrogen fixing microorganisms. *Rhizobium*, *Azospirillum* and *Azotobacter*
4. Isolation of Phosphate solubilizing bacteria from soil
5. Observation of mycorrhiza roots.
6. Isolation and identification of microorganisms involved in food spoilage
7. Isolation of microorganisms from milk and milk products and their identification
8. Production of fermented milk by Lactobacillus acidophilus - Yogurt
9. Standard qualitative analysis of milk
10. Methylene Blue Reduction Time test for milk
11. Isolation of probiotics
12. Estimation of Dissolved oxygen
13. Isolation and identification of coli forms from Water by Presumptive, Confirmed & Completed test
14. Determination of air flora and air density from indoor & outdoor sources

Reference Books:

- Adams M.R., Moss, M.O. (2008). Food Microbiology. 2nd Edition: Royal Society of Chemistry.
- Banwart, G.J. (1989). Basic Food Microbiology: Springer publications.
- Doyle, M.P., Buchanan, R.L. (1997). Food Microbiology: Fundamentals and Frontiers: ASM publication.
- Joshi, V.K., Pandey, A. (1999). Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2. Emakulam: Educational Publishers & Distributors.
- Prajapati, J.B. (1995). Fundamentals of Dairy Microbiology: Ekta Publication.
- Garbult, J. (1997). Essentials of Food Microbiology: Hodder Arnold publication.
- Wood, B.J. (2012). Microbiology of Fermented Foods. Volume I and II: Elsiever Applied Science Publication.
- Robinson, R.K. (2002). Dairy Microbiology Handbook: Wiley-Blackwell publication.

17IMBDA06	DSE Allied – 3 Practical : Sustainable Management	2 hrs/wk	1

The students will have better understanding of the basic concepts like:

1. Isolation and Microscopic Study of water / soil from different sources to compare microbial and other biodiversity
2. Study of Agro diversity in the form of pictures, samples and slides
3. Case Study
4. Group Discussion
5. Field visit
6. Permanent slide preparation
7. Herbarium preparation for agro diversity
8. Animal and insect diversity from the permanent slides, preserved samples and field visit

5 Years Integrated B. Sc. – M.Sc. Microbiology
SEMESTER - IV

17IMBCC12	Core 9: Bacterial Metabolism	4hrs/wk	4 Credits

Course objectives:
After successfully completing this course the student should be able to:

1) Understand the central metabolic reactions in a cell and an organism
2) Understand the mechanism of energy generation and its utilization during cellular activities
3) Explain the fundamentals of catabolism of different biomolecules, its mechanism and its importance
4) Identify the metabolic differences among various categories of bacteria.
5) Understand the process and mechanism of transport of molecules across the membrane for metabolic reactions

Unit 1: Introduction to Metabolism, Bioenergetics and Enzyme Kinetics 10hrs

- General Overview of Metabolism, primary and Secondary Metabolism and their significance
- Thermodynamics –First law of thermodynamics, second law of thermodynamics
- Bioenergetics: The concept of free energy, Determination of ΔG & Energy rich compounds
- Energy metabolism: Introduction to metabolism, Role of ATP in metabolism, Role of reducing power in metabolism, Role of precursor metabolites in metabolism
- Kinetics of a single-substrate enzyme catalysed reaction, Michaelis-Menten Equation, K_m, V_{max}, L.B. Plot, Turnover number, K_{cat}; Kinetics of Enzyme Inhibition; Kinetics Allosteric enzymes

Unit 2: Catabolism of Carbohydrates 10hrs

- General overview of various metabolic pathways, regulations and their significance
- Glycolysis and its regulation
- Pentose phosphate pathway
- Entner-Doudrroff pathway
- Citric acid cycle and its regulation
- Glyoxylate cycle

Unit 3: Metabolism of amino acids, Nucleic acids and Lipids 10hrs

- Biodegradation of amino acids – deamination, transamination, decarboxylation; Stickland Reactions
- Urea cycle including its regulation
- Biosynthesis of amino acids

- Biologically active amines Recycling of Purine and Pyrimidine nucleotides by salvage pathways
- Oxidation of Fatty Acids, Beta-Oxidation of Fatty Acids

Unit 4: Bioenergetics and Membrane Transport 10hrs

Bioenergetics:

- Different modes of ATP generation and comparative study of ATP (energy budget)
- Electron transport chain: Introduction, Components of ETC and energy yield
- Anaerobic Respiration
- Methods of studying biosynthesis: Strategy of Biosynthesis, Use of Biochemical Mutants, Use of Isotopic Labelling
- Bacterial photosynthesis; Biosynthesis of peptidoglycan

Membrane Transport:

- Transport of small molecules across membrane: Active and Passive transport
- Specific Transport Systems: Mechanosensitive channels, ATP-binding cassette Transport family, Chemiosmotic-driven transport, Establishing Ion gradients, Iron transport
- The phosphotransferase system
- Quorum sensing

Unit 5: Some selected aspects of metabolism in specific microbial systems 10hrs

- Chemo-autotrophs: Nitrifying Bacteria, Sulfur Oxidizers, The Iron bacteria, The Hydrogen bacteria
- The lactic acid bacteria: Patterns of carbohydrate fermentation in lactic acid bacteria
- The Enteric group and related Eubacteria: Fermentative patterns of Gram negative Eubacteria
- Archaebacteria: Energy metabolism and Carbon - Assimilation in Methanogens, photophosphorylation in *Halobacterium*

Text Books:

- White, D. (2000). The physiology and Biochemistry of Prokaryotes, 2nd edition: Oxford University Press.
- Conn E.E., Stumpt P.K. (1989). Outlines of Biochemistry. Wiley publication.
- Stanier, R.Y. (1987). General Microbiology, 5th Edition: Macmillan publication.
- Nelson, D.L., Cox, M.M. (2013). Lehninger Principles of Biochemistry. W.H. Freeman publication.
- Moat, A.G., Foster. J.W., Spector, M.P. (2009). Microbial Physiology, 4th Ed: Wiley India Pvt Ltd.

Reference Books:

- Dirk, J., Elas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology. New York: Marcel Dekker INC.

17IMBCC13	Core 10: Analytical Techniques	4hrs/wk	4 Credits

Course objectives:

After successfully completing this course the student should be able to:

1. Understand the working principle and application of various analytical techniques in the field of Bioscience
2. To comprehend theories and principles of various Chromatographic techniques
3. Understand General principles and applications of electrophoresis and Centrifugation techniques
4. Identify the role and the application of various molecular biology techniques in the field of Microbiology

Unit 1 Basic Analytical Technique in Biosciences 10hrs

- Colorimetry and Spectrophotomerty
- Introduction to Flame Photometry and its applications
- Applications of Radioisotopes in biosciences
- Atomic spectroscopy: Principles and application of Atomic Absorption/Emission Spectrometer
- Microtomy – sectioning.

Unit 2 Chromatography 10hrs

- Chromatography : Theories and Principles
- Paper and Thin layer Chromatography
- Affinity and Ion Exchange Chromatography
- Partition and Size Exclusion Chromatography
- Gas Chromatography and High Performance Liquid Chromatography, HPTLC

Unit 3 Electrophoresis 10hrs

- Electrophoresis : General principles, Horizontal & Vertical Gel electrophoresis, Isoelectric focusing
- Paper Electrophoresis
- Gel Electrophoresis : PAGE and AGE and PFGE, Capillary Electrophoresis
- Immunoelectrophoresis. Immunoblotting.

Unit 4 Centrifugation 10hrs

- Centrifugation techniques- Basic principles,
- Different types of centrifuges, Analytical and Preparative
- Ultracentrifugation methods.
- Density gradient centrifugation.

Unit 5 Molecular Biology Techniques 10hrs

- DNA sequencing: Principles and Methods, Automated DNA sequence Analyzer
- Blotting techniques and FISH
- RFLP, RAPD, VNTR, STR and SNP analysis, ARDRA
- Chemical synthesis of DNA
- PCR Technology: Principle, Methods and Applications
- Introduction to Biosensor Technology

Text Books:

- Purohit, S.S. (2007). Microbiology-Fundamentals and Applications, 6th Edition. New Delhi: Agrobios Publications.
- Wilson, K., Walker, J. (2010). Practical Biochemistry – Principle and Technique, 7th Edition. Cambridge: Cambridge University Press.
- Attwood, T.K., Parry. D.J. (1999). Introduction to Bioinformatics: Longman publication

Reference Books:

- Westhead D.R., Parish J.H., Twyman, R.A. (2002). Instant notes in Bioinformatics. Taylor and Francis publications.
- Andreas, D. B., Ouellette, B.F.F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition: Wiley publication.
- Chatwal R.G., Anand, S.K. (2012). Instrumental Methods of Chemical Analysis. Mumbai: Himalaya publication.
- Freifelder, D. (1982). Physical Biochemistry: Application to Biochemistry and Molecular biology, 2nd edition. San Francisco: W.H. Freeman and company.
- Sadashivam, S., Manickam, A. (2004). Biochemical methods, 2nd edition. New Delhi: New Age International (P) Limited.
- Upadhyay, A., Upadhyay, K., Nath, N. (2009). Biophysical Chemistry: Principles and techniques. Mumbai: Himalaya publication.
- Oser, B.L. (2006). Hawk's physiological chemistry. 14th Ed. New York, NY: McGraw-Hill Book Company.
- Boyer, R.F. (2002). Modern Experimental Biochemistry. San Francisco: Benjamin Cummings Publ. Company.
- Williams, B.D., Wilson, K. (1981). A Biologist’s Guide to Principles and Techniques of Practical Biochemistry. London: Edward Arnold publications.

17IMBCC14	Core 11: Industrial Microbiology	4hrs/wk	4 Credits

Course objectives:

The course is designed to provide to the students:

1. Knowledge of basic principle of fermentation process,
2. Insight in helping students to design, develop and operate industrial level fermentation process.
3. This fundamental knowledge is essential for the students to make their career in industry based on bioprocess.

Unit 1: Fermentation Technology & Industrially Important Microorganisms

10hrs

- Basic concept: Industrial Microbiology
- Range of Fermentation Processes; Component parts a fermentation process
- Fermentation Economics; GLP and GMP
- Screening of industrially important microorganisms: Use of enrichment techniques in isolation methods; Primary & Secondary Screening; Culture Collection Centres in India and abroad
- Improvement of industrially important microbes: Application of Mutation, protoplast fusion and recombinant DNA technology

Unit 2: Formulation of Fermentation Media **10hrs**

- Introduction, Types of Media and Medium formulation
- Raw materials: Crude Carbon and Nitrogen sources
- Minerals, Precursors, Growth Regulators, Buffers, Antifoam agents
- Media Optimization
- Inoculum Medium

Unit 3: Design and aseptic operation **10hrs**

- Introduction and basic functions of fermenter
- Types of bioreactors: Continuous stirred tank bioreactor, air lift fermenter, tower fermenter, immobilized enzyme bioreactors
- Aeration and Agitation
- Fermentation process: Batch Fermentation, Continuous fermentation and their comparative advantages and disadvantages
- Sterilization process in fermentation industries: Fermentor sterilization; Medium sterilization; Sterilization of air and feed
- Aseptic operation and Containment

Unit 4: Overview of Downstream Processes 10hrs

- Methods of Cell separation: Broth conditioning, Precipitation, Sedimentation,
- Centrifugation, Filtration
- Techniques of Cell Disruption: Mechanical and Non mechanical methods
- Product Recovery: Liquid-Liquid extraction, Solvent recovery, Two Phase aqueous extraction, Super critical fluid extraction; Chromatography, Drying and crystallization
- Physical, Chemical and Biological assay of fermentation products

Unit 5: Studies of selective fermentation processes 10hrs

- Production of organic solvents: Ethyl alcohol
- Production of enzymes: Amylases and Proteases
- Production of antibiotics: Penicillin
- Production of amino acids: Lysine
- Production of organic acids: Citric acid
- Production of vitamins: Riboflavin
- Introduction to methods to immobilize whole cell and/ or enzymes; Applications

Text books:

- Stanbury, P.F., Whittaker, A. (1984). Principles of Fermentation Technology, 2nd Edition. Pergamon Press.
- Casida, L.E. (1968). Industrial Microbiology. New Delhi: New Age International Pub. (P) Limited.

Reference Books:

- Crueger, W., Crueger, A. (1990). A text book of Industrial Microbiology, 2nd edition: Sunderland, Mass.: Sinauer Associates.
- Patel, A.H. (2011). Industrial Microbiology, 2nd Edition: Laxmi publication.
- Joshi, V.K., Pandey, A. (1999). Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2. Emakulam: Educational Publishers & Distributors.
- Prescott, S.C., Dunn, C.G., Reed, G. (1982). Prescott & Dunn's Industrial Microbiology. Westport: AVI Publication.

17IMBDA07	DSE – Allied – 4 – Biostatistics and Bioinformatics	4hrs/wk	4 Credits

Course objectives:

The goal for the Biostatistics and Bioinformatics for Basic Scientists course is to

1. Provide an introduction to statistics and informatics methods for the analysis of data generated in biomedical research.
2. Teach through Practical examples covering both small-scale lab experiments and highthroughput assays.
3. Emphasis on the basic concepts of biostatistics and bioinformatics

Unit 1 Introduction to Biostatistics **10hrs**

- Data Collection and presentation
- Origin of the word, Applications of biostatistics
- Sampling methods, Random and non random sampling
- Graphical presentation of data

Unit 2 Measures of Biostatistics, Probability Distributions **10hrs**

- Measures of central tendency Mean, median and mode
- Measures of dispersion- Range, mean deviation, standard deviation, variance
- Laws of probability
- Normal distribution, Binomial distribution, Poisson distribution

Unit 3 Hypothesis Testing, Correlation and Regression Analysis **10hrs**

- Types of hypothesis
- Tests of significance-student's t test, F test
- Chi-square test, ANOVA test
- Types of correlation
- Methods to study correlation analysis
- Methods of regression analysis

Unit 4 Computer Science : Components and Applications **10hrs**

- Structure of computer: Components, peripherals, uses and types
- The window screen and parts of window, the control panel
- MS Office: MS Word, MS Powerpoint, MS Excel
- Internet: History, Basic Concepts, Connection Types, Applications, Search Engines and E mail
- Basics of HTML, Page creation and design using HTML
- Multimedia Usage in biological studies

Unit 5 Bioinformatics **10hrs**

- Introduction and importance of Bioinformatics
- Database: Introduction, Types, File formats,
- Primary and Secondary Biological databases, Structure databases, Miscellaneous databases.
- Information retrieval from Biological database : ENTREZ, SRS and DBGET

- Sequence Alignment : FASTA, BLAST and Gap penalties
- Introduction to Drug discovery and Chemi informatics

Reference Books:

- Banerjee P.K. (2007) Introduction to Biostatistics: S Chand Publication
- Andreas, D. B., Ouellette, B.F.F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition: Wiley publication.
- Misener, S. (2000). Bioinformatics – Methods and Protocols: Humana Press.
- Attwood, T.K., Parry. D.J. (1999). Introduction to Bioinformatics: Longman publication
- Westhead D.R., Parish J.H., Twyman, R.A. (2002). Instant notes in Bioinformatics. Taylor and Francis publications.
- Satyanarayan, U. (2008). Biotechnology. Kolkata, West Bengal: Books and allied (P) Ltd.

17IMBCC15	Core Practical - 4: Microbial Techniques and Instrumentation	6hrs/wk	3 Credits

Course objectives:

The course will impart

1. Technical skill to the students perform various analytical methods for estimations
2. Hands on training on many sophisticated instruments
3. Understanding of upstream and downstream process in the fermentation process

List of Practical

1. Estimation of Protein by Bradford method
2. Circular paper Chromatography of Amino acids
3. Ascending paper chromatography of sugars
4. Thin Layer Chromatography of Amino acids
5. Agarose Gel Electrophoresis of DNA
6. SDS PAGE of Protein
7. Centrifugation techniques
8. Microtome usage, sectioning and staining
9. Primary screening of industrially important microorganisms capable of producing: Antibiotics, Organic acids, amylases
10. Bioassay of penicillin using *B. subtilis*
11. Laboratory fermentation of Ethyl Alcohol by *Saccharomyces cerevisiae* & its estimation
12. Laboratory fermentation of amylase by *B. subtilis* & itsestimation
13. Sterility testing of fermentation products (Demo) – Use of Sterile products for testing Microbial contamination
14. Immobilization of yeast cells by Ca-alginate entrapment method & determination of viability of immobilized cells by invertase activity / Gluconic acid formation. (Demo)

Reference Books:

- Jayaraman, J. (1981). Laboratory Manual in Biochemistry: Wiley publication.
- Sawhney S.K., Singh, R. (2005). Introductory Practical Biochemistry: Alpha Science International.
- Chappuccino, J.G., Sherman, N. (2004). International student edition: Microbiology- A laboratory Manual 4th edition: Benjamin Cummings publications.
- Baker, F.J., Breach, M.R. (1967). Handbook of Bacteriological Technique: Butterworth & Co Publishers Ltd.

17IMBDA08	DSE - Allied Practical - 4: Biostatistics and Bioinformatics	2hrs/wk	1 Credits

Course Objectives:

The course is designed to

1. Understand mathematic/physical principles of information retrieving and analyzing
2. build up the experience of utilizing website-based softwares and database
3. awareness about the accuracy, limitation and boundary of theoretical methods
4. develop the ability to perform basic computer programming

List of Practical

1. Review of NCBI Portal
2. Review of Biological Data Bases
3. Demonstration on BLAST analysis
4. Comparison of Entrez, SRS, and DBGET retrieval
5. Basic use of Computer – Use of Excel, Power point and Internet
6. Mean, Median, Mode
7. Standard deviation
8. Student t-Test
9. Chi – square Test
10. ANOVA

Reference Books:

- Andreas, D. B., Ouellette, B.F.F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition: Wiley publication.
- Misener, S. (2000). Bioinformatics – Methods and Protocols: Humana Press.
- Rao, C.R. (1973). Linear Statistical Inference and its Applications. New York: Wiley publication.