A.C. No.- 17/10/2022

Item No: 6.5

Rayat Shikshan Sanstha's

KARMAVEER BHAURAO PATIL COLLEGE, VASHI. NAVI MUMBAI

Sector-15- A, Vashi, Navi Mumbai - 400 703

(**AUTONOMOUS COLLEGE**)

Program: M.Sc. Microbiology [Part II]

Syllabus for M.Sc. II Microbiology

(Choice Based Credit System
with effect from the academic year 2022-2023)

Rayat Shikshan Sanstha's

Karmaveer Bhaurao Patil College Vashi, Navi Mumbai

Autonomous College

[Affiliated to University of Mumbai]

Syllabus

Sr. No.	Heading	Particulars
1	**Title of Course**	M.Sc. II Microbiology (CBCS)
2	**Eligibility for Admission**	M.Sc. I (Microbiology), From a recognized university
3	**Passing Marks**	40%
4	**Ordinances/Regulations (if any)**	
5	**No. of Years/Semesters**	Two year/Four semester
6	**Level**	P.G.
7	**Pattern**	Semester
8	**Status**	New
9	**To be implemented from Academic year**	2022-2023

Preamble of the Syllabus:

Masters of Science (M.Sc.) in Microbiology is a post graduate programmed of Department of Microbiology, Karmaveer Bhaurao Patil College Vashi, Navi Mumbai [Autonomous College]

The Choice Based Credit System to be implemented through this curriculum, would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities. The students pursuing this course would have to develop understanding of various aspects of the Microbiology. The conceptual understanding, development of experimental skills, developing the aptitude for academic and professional skills, acquiring basic concepts and understanding of hyphenated techniques are among such important aspects.

The credit semester and grading system and continuous evaluation consisting of components of Internal Assessment and External Assessment followed by the esteemed University of Mumbai, have been maintained while the syllabus for Microbiology was revised for M.Sc. Semester -I & II to be implemented with effect from 2022-23. The proposed changes as per Choice-Based Credit System (CBCS) in the syllabus and introduction of new concepts for academic year 2022-23 passed several rounds of discussion before being presented to the members of Board of Studies for Microbiology, with Dr. Keshav Shinde as the Chairperson.

Suitably revised draft syllabus for M.Sc. II Semester III & IV in the subject of Microbiology, to be implemented from 2022-2023, has been approved by the concerned authorities of the BOS, Academic Council and Governing Body of Karmaveer Bhaurao Patil College, Vashi [Autonomous]
In order to assist students in developing research skills in general and in specific area of their interest/specialization in particular, research proposal & research project component has been retained in the revised syllabus. This component will provide students with an opportunity to conduct independent research in the subject of Microbiology.

Accordingly, a paper on “Virology”, “Immunology & Immunodiagnostics”, has been introduced in Semester III as a Core Course while “Medical & Clinical Microbiology”, “Environmental Microbiology” retained in the semester IV as a Core Course.
In order to enhance employability of students in various allied areas, Discipline Specific Elective Courses (DSEC) are introduced in the curriculum to focus on understanding of theoretical foundations and practical techniques required in R & D, quality control, regulatory function in pharmaceuticals, food industry, have been included in the proposed CBCS syllabus. With this aspect “Introduction to Omics” & “Soil & Agricultural Microbiology” papers are introduced in Semester-III while for Semester-IV selected paper as DSEC is “Waste Management System”. Along with the theoretical knowledge to develop skills among students Skill Enhancement Courses (SEC) are introduced for per semester. In semester-III “Biostatistics” & for Semester-IV “Bioinformatics” courses are introduced as

SEC. In both semester students have given choice for two MOOCs courses. “Biostatistics” & for Semester-IV “Bioinformatics” courses are introduced as SEC. In both semester students have given choice for two MOOCs courses.

Rayat Shikshan Sanstha's

KARMAVEER BHAURAO PATIL COLLEGE, VASHI, NAVI MUMBAI

(Autonomous)

Department of Microbiology

M. Sc. Microbiology

Program Outcomes (POs)

Learners are able to:

PO-1	**Disciplinary Knowledge and Skills**	Acquire the comprehensive and in-depth knowledge of various subjects in sciences such as Physics, Chemistry, Mathematics, Microbiology, Bio- analytical Science, Computer Science, Data Science, Information Technology and disciplinary skills and ability to apply these skills in the field of science, technology and its allied branches.
PO-2	**Communication and Presentation Skills**	Develop various communication skills including presentation to express ideas evidently to achieve common goals of the organization.
PO-3	**Creativity and Critical Judgement**	Facilitate solutions to current issues based on investigations, evaluation and justification using evidence-based approach.
PO-4	**Analytical Reasoning and Problem Solving**	Build critical and analytical attitude in handling the problems and situations.
PO-5	**Sense of Inquiry**	Curiously raise relevant questions based on highly developed ideas, scientific theories and its applications including research.
PO-6	**Use of Modern Tools**	Use various digital technologies to explore information/data for business, scientific research and related purposes.
PO-7	**Research Skills**	Construct, collect, investigates, evaluate and interpret information/data relevant to science and technology to adapt, evolve and shape the future.
PO-8	**Application of Knowledge**	Develop scientific outlook to create consciousness against the social myths and blind faith.
PO-9	**Moral and Ethical Reasoning**	Imbibe ethical, moral and social values to develop virtues such as justice, generosity and charity as beneficial to individuals and society at large.
PO-10	**Leadership and Teamwork**	Work cooperatively and lead proactively to achieve the goals of the organization by implementing the plans and projects in various field-based situations related to science, technology and society at large.

PO-11	**Environment and Sustainability**	Create social awareness about environment and develop sustainability for betterment of future.
PO-12	**Lifelong Learning**	Realize that pursuit of knowledge is a lifelong activity and in combination with determined efforts, positive attitude and other qualities to lead a successful life.

Program Specific Outcomes (PSO)	
PSO1	Explain different branches of Microbiology such as Bacteriology, Virology, Immunology, Medical.
PSO2	The student will be able to explain about various applications of Microbiology such as Environmental Microbiology, Industrial Microbiology and Quality assurance and Quality control, Biostatistics, Bioinformatics, Public health etc.
PSO3	Students will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics.
PSO4	Students will be able to execute Research Project incorporating techniques of Basic and Advanced Microbiology under supervision and Hands on training (Internship)
PSO5	The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired

Rayat Shikshan Sanstha's

KARMAVEER BHAURAO PATIL COLLEGE, VASHI

[AUTONOMOUS COLLEGE]

Department of Microbiology

M.Sc. Microbiology

Choice Based Credit System (CBCS)

<table>
<tr><th>Program</th><th>SEM</th><th>CORE Course
(4 credits per course)</th><th>DSE
(4 credits per course)</th><th>SEC
(4 credits per course)</th></tr>
<tr><td rowspan="8">MSC-I
Microbiology</td><td rowspan="5">I</td><td>Cell Biology</td><td rowspan="5">Fermentation Technology
Or
Food & Dairy Microbiology</td><td rowspan="5">Food Licensing and Certification
Or
2 MOOCs</td></tr>
<tr><td>Molecular Genetics I</td></tr>
<tr><td>Basic Biochemistry</td></tr>
<tr><td>Practical of Core Course 1 & 2</td></tr>
<tr><td>Practical of Core Course 1 & DSEC</td></tr>
<tr><td rowspan="5">II</td><td>Research Methodology</td><td rowspan="5">Advances in Biotechnology
Or
Pharmaceutical Microbiology</td><td rowspan="5">Quality Assurance and Quality Control in Pharmaceutical Industries
Or
2 MOOCs</td></tr>
<tr><td>Molecular Genetics II</td></tr>
<tr><td>Microbial Biochemistry</td></tr>
<tr><td>Review Writing (2 Credit)*</td></tr>
<tr><td>Laboratory Course (6 Credit)*</td></tr>
<tr><td colspan="5">Compulsory Course: Summer Internship for 6 credits (150 Marks)</td></tr>
</table>

<table>
<tr><td rowspan="6">MSC-II Microbiology</td><td rowspan="5">III</td><td>Virology</td><td rowspan="5">Introduction to Omics and Analytical Techniques
Or
Soil and Agricultural Microbiology</td><td rowspan="5">Biostatistics
Or
2 MOOCs</td></tr>
<tr><td>Immunology & Immunodiagnostics</td></tr>
<tr><td>Practical of Core Course 1 & 2</td></tr>
<tr><td>Practical of DSEC (2 Credit)*</td></tr>
<tr><td>On the Job Training (OJT) (6 Credit)*</td></tr>
<tr><td rowspan="5">IV</td><td>Medical & Clinical Microbiology</td><td rowspan="5">Waste Management</td><td rowspan="5">Bioinformatics
Or
2 MOOCs</td></tr>
<tr><td>Environmental Microbiology</td></tr>
<tr><td>Practical of Core Course 1 & 2</td></tr>
<tr><td>Practical of DSEC (2 Credit)*</td></tr>
<tr><td>Research Project (6 Credit)*</td></tr>
<tr><td colspan="5">CC: Core Course (these courses are compulsory to the students),
DSE: Discipline Specific Elective (Students can choose anyone)
SEC: Skill Enhanced Course (Compulsory Skill Based Course)
Compulsory: Summer Internship for 6 credits (150 Marks)
Credits: Part-I (28+28=56), Part-II (28+28=56), Total Credits: 112</td></tr>
</table>

Teaching - Evaluation Scheme

Semester-III

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	CIE	Sem End-Exam	Term	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
PGMB301-CC	Virology	04	-	-	40	60	-	-	-	100	04	-	-	04
PGMB302-CC	Immunology & Immunodiagnostic	04	-	-	40	60	-	-	-	100	04	-	-	04
PGMB301 (DSEC1) **Or** PGMB301-DSEC-2	Introduction to Omics and advanced **Or** Soil and Agricultural Microbiology	04	-	-	40	60	-	-	-	100	04	-	-	04
PGMBSEC 301	Biostatistics	04	-	-	40	60	-	-	-	100	04	-	-	04
PGMBP301	Practicum of Core Course 1 & 2		08					100		100		04		04
PGMBP302	Practicum of DSEC		04					50		50		02		02
	Internship	-	12	-	-	-	-	150	-	150		06		06
Total		**16**	**12**	**-**	**160**	**240**	**-**	**300**	**-**	**700**	**16**	**12**	**-**	**28**
Total Credit											**16**	**12**	**-**	**28**

Semester-IV														
Course Code	**Course Name**	**Teaching Scheme (Hours/Week)**			**Examination Scheme and Marks**						**Credit Scheme**			
		Lecture	**Practical**	**Tutorial**	**CIE**	**Sem End-Exam**	**Term**	**Practical**	**Oral**	**Total**	**Lecture**	**Practical**	**Tutorial**	**Total**
PGMB401	Medical & Clinical Microbiology	04	-	-	40	60	-	-	-	100	04	-	-	04
PGMB402	Environmental Microbiology	04	-	-	40	60	-	-	-	100	04	-	-	04
PGMB404 (DSEC1)	Waste Management	04	-	-	40	60	-	-	-	100	04	-	-	04
PGMB401-SEC	Bioinformatics	04	-	-	40	60	-	-	-	100	04	-	-	04
PGMBP401	Practicum of Core Course 1, 2 & DSEC	-	12	-	-	-	-	150	-	150	-	06	-	06
PGMB403	Research Project	-	12	-	-	-	-	150	-	150	-	06	-	06
Total		**16**	**12**	**150**	**160**	**240**	**-**	**150**	**-**	**700**	**16**	**12**	**-**	**28**
Total Credit											**16**	**12**	**-**	**28**

COURSE STUCTURE FOR M.Sc. II MICROBIOLOGY
SEMESTER III

	Course	Unit	Topic	Credit	L/W
CORE COURSE	**Virology**				
	PGMB301	I	Microbial Phages	4	4
		II	Animal Viruses		
		III	Plant Viruses and Viroids		
		IV	Virus cell interaction and Viral vaccines		
CORE COURSE	**Immunology and Immunodiagnostics**				
	PGMB302	I	Immunobiology	4	4
		II	Immune system and health		
		III	Cancer Immunology		
		IV	Experimental Immunology		
CORE COURSE	**Biostatistics**				
	PGMBSEC 301	I	Introduction to Statistics & Central Tendency	4	4
		II	Testing		
		III	Tests of significance		
		IV	Correlation & Regression Tests		
DISCIPLINE SPECIFIC ELECTIVE (DSE-A)	**Introduction to Omics and Analytical Techniques**				
	PGMB301 (DSEC1)	I	Introduction To Omics	4	4
		II	Hyphenated techniques- Principle, Instrumentation, Applications		
		III	Molecular Biology Techniques (Principle, Instrumentation, Applications)		
		IV	Advance Microscopy and Spectroscopy Techniques		
DISCIPLINE SPECIFIC ELECTIVE (DSE-B)	**Soil and Agricultural Microbiology**				
	PGMB104 (DSEC2)	I	Soil and Agricultural Microbiology	4	4
		II	Estimation of microbial activities in soil environment		
		III	Agriculture Microbiology for plants		
		IV	Plant Pathology		
Laboratory Session	PGMBP301	I	Practicum of Core Course 1 & 2	4	8
	PGMBP302	II	Practicum of DSEC	4	8
INTERNSHIP			Internship	6	24

SEMESTER IV

	Course	Unit	Topic	Credit	L/W
CORE COURSE	**Medical & Clinical Microbiology**				
	PGMB401-CC	I	Emerging Diseases	4	4
		II	Parasitology & Mycology		
		III	Immunopathology		
		IV	Clinical Research & Modern Diagnostics		
CORE COURSE	**Environmental Microbiology**				
	PGMB402-CC	I	Concept of Ecology	4	4
		II	Biodegradation		
		III	Bioremediation		
		IV	Advanced Environmental Microbiology		
CORE COURSE	**Waste Management**				
	PGMB401 DSEC-1-CC	I	Waste Water Management Systems	4	4
		II	Industrial Waste Management		
		III	Biomedical Waste Management		
		IV	Environmental Management		
DISCIPLINE SPECIFIC ELECTIVE (DSE-A)	**Bioinformatics**				
	PGMB401-SEC	I	Introduction to Bioinformatics	4	4
		II	Gene Prediction & Transcriptomics		
		III	Protein Computational Biology & Tools		
		IV	Genomics Proteomics & Phylogenetic analysis		
Laboratory Session	PGMBP401	I	Practicum of Core Course 1 & 2	4	8
	PGMBP402	II	Practicum of DSEC	4	8
Research Project			**Research Project**	6	

Teaching Pattern for Semester III and IV:

1. Four lectures per week per course. Each lecture is of 60 minutes duration.
2. For SEC four lectures per week per course and practical sessions for 16Hrs. Each lecture is of 60 minutes duration.
3. In addition, there shall be tutorials, seminars as necessary for each of the five courses.

Objective:

1. To introduce the application-based research in Microbiology
2. To inculcate sense of scientific responsibilities and social and environment awareness
3. To enrich students' knowledge and train them in the applied microbial sciences
4. To help student's build-up a progressive and successful career

SEMESTER III

Core Course
PGMB301-CC: Virology

By the end of this course, the students will be able to

CO1: Characterize various strategies of replication deployed by different animal viruses. [3]*
CO2: Illustrate the life cycle of various microbial viruses. [4]*
CO3: Compare and contrast between viroid and plant virus infection. [4]*
CO4: Appraise interactions between animal viruses and cells [5*]
CO5: Categorize different viral vaccine with its efficiency [6*]
CO6: Perform enrichment, isolation of viruses and further visualize using SEM [3]*

*Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating

CO-PO Matrix Mapping												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	3	-	2	2	2	1	-	3	-	-	-	-
CO2	2	-	1	1	2	-	-	1	-	-	-	-
CO3	2	-	1	1	2	-	-	1	-	-	-	-
CO4	2	-	2	2	2	-	-	1	-	-	-	-
CO5	3	-	2	2	2	1	-	1	-	-	-	-
CO6	3	-	3	3	2	2	3	3	-	1	-	-

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Core Course Code-	Title	4 Credits (60 Lectures)
PGMB301 (CC)	**Virology**	**4**
Unit I	**Microbial Phages:-**	
	1.1 Bacteriophages: General properties of phages, Attachment of bacteriophages to the bacterial cell, Entry of the genomes of bacteriophages into bacterial cells, properties of phage-infected bacterial cultures, specificity of phage infection 1.2 Organization of the genes, Multiplication cycle, Regulation of transcription of following phages: 1.2.1 *Escherichia coli* Phage T7 1.2.2 *Escherichia. coli* Phage (phi) X174 1.2.3 Mu Phage 1.2.4 Filamentous DNA phages – M13 virus 1.2.5 Single stranded RNA phages - phage MS2 1.3 Lysogenic cycle – bacteriophage P22 1.4 Overview of mycoviruses, algal viruses, protozoal viruses	**15 L**
Unit II	**Animal Viruses: -**	
	2.1 The process of infection: 2.1.1 Attachment of viruses and the entry of their genomes into the target cell 2.1.2 Infection of animal cells – attachment to the cell 2.1.3 Infection of animal cells – entry into the cell 2.1.4 Prevention of the early stages of infection **2.2 The process of infection: IIA. The replication of viral DNA** 2.2.1 The universal mechanism of DNA synthesis 2.2.2 Replication of circular double-stranded DNA genomes 2.2.3 Replication of linear double-stranded DNA genomes that can form circles 2.2.4 Replication of linear double-stranded DNA genomes that do not circularize 2.2.5 Replication of circular single-stranded DNA genomes 2.2.6 Replication of linear single-stranded DNA genomes 2.2.7 Dependency versus autonomy among DNA viruses **2.3 The process of infection: IIB. Genome replication in RNA viruses** 2.3.1 Nature and diversity of RNA virus genomes 2.3.2 Regulatory elements for RNA virus genome synthesis 2.3.3 Synthesis of the RNA genome of Baltimore class 3 viruses 2.3.4 Synthesis of the RNA genome of Baltimore class 4 viruses	**15 L**

	2.3.5 Synthesis of the RNA genome of Baltimore class 5 viruses 2.3.6 Synthesis of the RNA genome of viroids and hepatitis delta virus **2.4 The process of infection: IIC. The replication of RNA viruses with a DNA intermediate and vice versa** 2.4.1 The retrovirus replication cycle 2.4.2 Discovery of reverse transcription 2.4.3 Retroviral reverse transcriptase 2.4.4 Mechanism of retroviral reverse transcription 2.4.5 Integration of retroviral DNA into cell DNA 2.4.6 Production of retrovirus progeny genomes 2.4.7 Spumaviruses: retrovirus with unusual features 2.4.8 The hepadnavirus replication cycle 2.4.9 Mechanism of hepadnavirus reverse transcription 2.4.10 Comparing reverse transcribing viruses	
Unit III	**Plant Viruses: -**	
	3.1 Plant viruses: 3.1.1 Morphology 3.1.2 Transmission of Plant Viruses 3.1.3 Symptoms of Plant Diseases caused by Viruses. 3.2 Plant Virus Life Cycles, 3.3 Plant Satellite Viruses and Satellite Nucleic Acids 3.4 Detailed Structure, Transmission, Symptoms and control of 3.4.1 Banana Bunchy Top Virus 3.4.2 Citrus Tristeza Virus (CTV) 3.4.3 Papaya mosaic virus 3.5 Diagnosis of Viral Infections in Plants 3.6 Infectivity Assays of Plant Viruses 3.7 Viroid	**15 L**
Unit IV:	**Virus cell interaction and Viral vaccines**	
	4.1 Interactions between animal viruses and cells:- 4.1.1 Acutely cytopathogenic infections 4.1.2 Persistent infections 4.1.3 Latent infections 4.1.4 Transforming infections 4.1.5 Abortive infections 4.1.6 Null infections 4.1.7 How do animal viruses kill cells? **4.2 Mechanisms in virus latency** 4.2.1 The latent interaction of virus and host 4.2.2 Gene expression in the lytic cycle of bacteriophage λ 4.2.3 Immunity to superinfection 4.2.4 The benefits of lysogeny	**15 L**

	4.2.5 Herpes simplex virus latency 4.2.6 Epstein–Barr virus latency 4.2.7 Latency in other herpesviruses 4.2.8 HIV-1 latency **4.3 Prion diseases** 4.3.1 The spectrum of prion diseases 4.3.2 The prion hypothesis 4.3.3 The etiology of prion diseases 4.3.4 Prion disease pathogenesis 4.3.5 Bovine spongiform encephalopathy (BSE) 4.3.6 BSE and the emergence of variant CJD 4.4 **Viral Vaccines** 4.4.1 Conventional Vaccines -Killed and Attenuated 4.4.2 Modern Vaccines—Recombinant Proteins, Subunit Vaccine, RNA vaccine and DNA Vaccines, Peptides 4.4.3 Immunomodulators (Cytokines) 4.4.4 Vaccine Delivery and Adjuvants 4.4.5 Large Scale Manufacturing-QA/QC Issues 4.4.6 Animal Models and Vaccine Potency Testing 4.4.7 Vaccine Induced Immune Response and Immune Markers of Protection 4.4.8 Interferons, Designing and Screening for Antivirals, Mechanisms of Action, Antiviral Libraries, Antiretrovirals- mechanism of Action & Drug Resistance 4.4.9 Antisense RNA, siRNA, miRNA, Ribozymes, In-silico Approaches for Drug Designing	

Reference Book:

1. Dr Brian W J Mahy And Dr Marc H V Van Regenmortel (2008), Encyclopedia of Virology, Academic Press (Elsevier), Third Edition, pp. 3057
2. John B. Carter and Venetia A. Saunders, (2007), Virology Principles And Applications, John Wiley & Sons Ltd, first edition, pp 383
3. David M. Knipe and Peter M. Howley (2013), Fields Virology Sixth Edition, Lippincott Williams & Wilkins, A Wolters Kluwer Business, Volume 1, pp. 2582
4. N. J. Dimmock, A. J. Easton and K. N. Leppard (2007), Introduction to Modern Virology, Blackwell Publishing Ltd, Sixth Edition, pp. 531
5. Edward K. Wagner, Martinez J. Hewlett, David C. Bloom, David Camerini, (2009) Basic Virology, Wiley-Blackwell, 3rd Edition, pp. 580, ISBN: 978-1-444-30889-1
6. Jane Flint, Vincent R. Racaniello, Glenn F. Rall, Theodora Hatziioannou, Anna Marie Skalka, (2020) Principles of Virology, ASM Press, 5th Edition, pp. 1136, ISBN: 978-1-68367358-

Core Course

PGMB302-CC: Immunology and Immunodiagnostics

By the end of this course, the student will be able to -

CO1. Justify the diversity in antibodies based on the multigene rearrangement [5]*

CO2. Annotate the immunological and molecular mechanism of graft rejection [2]*

CO3. Demonstrate the role of Tcells, MHC and TCR in autoimmunity [3]*

CO4. Distinguish between chemotherapy, stem cell therapy and immunotherapy mechanisms [4]*

CO5. Evaluate in vitro systems to design the immunology experiments [5]*

CO 6: Determine the concentration of antigen in patient's blood by single radial immunodiffusion [5]*

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Mapping Matrix												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	2	-	-	-	1	-	-	2	-	-	-	1
CO2	3	-	2	-	2	1	-	1	-	-	-	1
CO3	1	-	1	-	2	1	-	2	-	-	-	1
CO4	2	-	2	-	2	2	-	1	-	-	-	1
CO5	3	-	3	2	2	3	2	2	-	2	-	1
CO6	1	-	2	3	3	3	2	3	-	-	-	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Core Course Code	Title	Credits (60 lectures)
PGMB302	**Immunology & Immunodiagnostic**	4
Unit I	**Control of Gene Expression in Eukaryotes & Chromosomal rearrangement.**	
	1.1 Functional Anatomy & development of Immune System-Biology Immune response 1.2 Immunoregulation 1.3 Immunogens & Antigen binding molecules & their detection 1.4 Antigen Antibody interactions- Epitope and Paratope 1.5 Molecular basis of diversity of immunoglobulin molecules 1.6 Multigene organization of Ig genes 1.7 Variable-Region Gene Rearrangements 1.8 Mechanism of Variable-Region DNA Rearrangements 1.9 Generation of antibody diversity 1.10 Manipulations of the immune response	1 credit
Unit II	**Immune system and health**	**15NH**
	2.1 Transplantation ● Immunologic Basis of Graft Rejection ● Clinical Manifestations of Graft Rejection ● General Immunosuppressive Therapy ● Specific Immunosuppressive Therapy ● Immune Tolerance to Allografts ● Clinical Transplantation **2.2 Autoimmunity** ● Maintenance of tolerance ● Organ specific Autoimmune disease ● Systemic autoimmune disease ● Animal models for Autoimmune disease ● Role of T cell, MHC and TCR in autoimmunity ● Therapeutic approaches to Autoimmune diseases **1 Transplantation** ● Immunologic Basis of Graft Rejection ● Clinical Manifestations of Graft Rejection ● General Immunosuppressive Therapy ● Specific Immunosuppressive Therapy ● Immune Tolerance to Allografts ● Clinical Transplantation	

	2.2 Autoimmunity ● Maintenance of tolerance ● Organ specific Autoimmune disease ● Systemic autoimmune disease ● Animal models for Autoimmune disease ● Role of T cell, MHC and TCR in autoimmunity ● Therapeutic approaches to Autoimmune diseases	
Unit III	**Unit III Cancer Immunology**	**15NH**
	3.1 Nomenclature & Classification of tumors 1. Characteristics of tumor **3.2 Mechanism & Biology of invasion & Metastasis** 2. Epidemiology & predisposition to cancer **3.3 Carcinogenesis:** 3. Etiology & Pathogenesis of Cancer 4. Genetic mechanism of Cancer a) Oncogenes and cancer induction b) Tumour Suppresser gene 5. Chemical Carcinogenesis 6. Tests for chemical carcinogenesis **3.4 Pathologic diagnosis of Cancer** **3.5 Modern tools in diagnosis of Cancer** **3.6 Cancer Immunotherapy**	1 Credit
Unit IV:	**Experimental Immunology**	
	4.1 Experimental Animal Models ● Cell Culture Systems **4.2 *In vitro* systems** ● Kinetics of antigen antibody reactions ● Haemolytic plaque assay ● ELISPOT assay ● Functional assays for phagocytosis **4.3 *In vivo* systems – Experimental animals in immunology research** ● Inbred animal strains a. Transgenic animals	1 Credit

Reference Books:

1. Immunology- Kuby 5th edition W. H. Freeman and company- New York.
2. Essential Immunology by Ivan Roitt and Peter Delves, 10th Edition, Blackwell Science.
3. Medical Microbiology-Jawetz

4. The elements of Immunology-Fahim Halim Khan-Pearson Education

Core Course

PGMB301-CC: Introduction to Omics and Analytical Techniques

By the end of this course, the student will be able to -

CO1: Differentiate various branches of Omics [4*]
CO2: Predict the expected structure of Proteins based on newer methods [5*]
CO3: Apply modern tools for protein structure identification and correlate use of different advanced molecular techniques with its applications [3*]
CO4: Explain use of different sequencing methods [2*]
CO5: Correlate use of Hyphenated techniques with their applications [4*]
CO6: Design primers for PCR [6*]

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Mapping Matrix												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	3	1	1	2	1	2	2	2	-	-	-	-
CO2	3	1	1	2	1	2	2	2	-	-	-	-
CO3	3	1	1	2	1	2	3	2	-	-	-	-
CO4	3	1	1	2	1	2	2	3	-	-	-	-
CO5	3	1	1	3	2	2	2	3	-	-	-	-
CO6	3	1	1	3	2	-	3	3	-	-	-	-

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Core Course Code	Title	Credits (60 lectures)
PGMB301	**INTRODUCTION TO OMICS AND ANALYTICAL TECHNIQUES**	4
Unit I	**Amino acids & Proteins**	15 NH
	Introduction To Omics (15L) **1.1 Proteomics** 1.1.1 Genetics of Proteins 1.1.2 Protein misfolding and Human diseases 1.1.3 Determination of primary Structure of protein: Edman Degradation 1.1.4 Overview of Multidimensional approach for separation of proteins 1.1.5 Overview of Determination of 3D structure of Proteins **1.2 Transcriptomic**s 1.2.1 Study and Importance of transcriptomics 1.2.2 Serial analysis of gene expression (SAGE) 1.2.3 Platform used for transcriptomics sequence **1.3 Metabolomics** 1.3.1 Introduction to Metabolomics 1.3.2 Metabolic profiling **1.4 Pharmacogenomics** 1.4.1 Principle and Introduction to personalized medicine 1.4.2 Pharmacogenomics and Cancer chemotherapy **1.5 Genomics** 1.5.1 Next Generation Sequencing- Illumina NGS 1.5.2 Pyro-sequencing 1.5.3 Whole genome shotgun sequencing	1
Unit II	**Hyphenated techniques- Principle, Instrumentation, Applications**	**15NH**

	1. Gas chromatography- Mass spectroscopy (GC-MS) 2. Gas chromatography - Fourier-transform infrared spectroscopy (GC-FTIR) 3. Liquid chromatography- Mass spectroscopy (LC-MS) 4. Liquid chromatography-Infrared spectroscopy (LC-IR) 5. Liquid chromatography-Nuclear Magnetic Resonance (LC-NMR) 2. Capillary zone electrophoresis - Mass spectroscopy (CE-MS)	1
Unit III	**Molecular Biology Techniques (Principle, Instrumentation, Applications)**	**15NH**
	3.1 Modifications of PCR 3.1.1 Hot- Start PCR 3.1.2 Multiplex PCR 3.1.3 Nested PCR 3.1.4 RT-PCR 3.1.5 Broad Range PCR 3.1.6 Arbitrarily primed PCR 3.1.7 Quantitative PCR 3.1.8 Real time PCR **3.2 Hybridization array technology** 3.2.1 Applications of microarrays in Microbiology 3.2.2 Microarray platform technologies (oligonucleotide microarrays, cDNA microarrays) **3.3 Other techniques** 3.3.1 Immunofluorescence 3.3.2 FISH 3.3.3 Confocal laser scanning microscopy 3.3.4 Micro autoradiography 3.3.5 Flow cytometry Micro sensors	1
Unit IV	**Advance Microscopy and Spectroscopy Techniques (15L)**	15 NH

	4.1	**Microscopy**	1
	4.1.1.	Scanning tunnelling microscope (STM)	
	4.1.2.	Atomic force microscope (AFM)	
	4.1.3.	Magnetic force microscope (MFM)	
	4.1.4.	Scanning near field microscope (SNOM)	
	4.1.5.	Scanning Electron Microscope	
	4.1.6.	Transmission Electron Microscope	
	4.2.	**Photoluminescence Spectroscopy**	
	4.2.1.	X-ray and UV photoelectron spectroscopies (XPS)	
	4.2.2.	Auger electron spectroscopy	
	4.3.	**Diffraction Techniques: X-ray diffraction (XRD)**	

Reference Books

1. Patel, K. N., Patel, J. K., Patel, M. P., Rajput, G. C., & Patel, H. A. (2010). Introduction to hyphenated techniques and their applications in pharmacy. *Pharmaceutical methods*, *1*(1), 2–13. https://doi.org/10.4103/2229-4708.72222
2. S. Nagajyothi, Y. Swetha, J. Neeharika, P. V Suresh, N. Ramarao (2017). Hyphenated Techniques- A Comprehensive Review, *International Journal of Advance Research, Ideas and Innovations in Technology*, 2(4) www.IJARnD.com**.**
3. Genomic and Personalized Medicine Volume 1, Second Edition, Edited by Geoffrey S. Ginsburg and Huntington F. Willard, 2013, Elsevier Inc.
4. Lämmerhofer, M. & Weckwerth, Wolfram. (2013). Metabolomics in Practice: Successful Strategies to Generate and Analyze Metabolic Data. 10.1002/9783527655861.
5. Introduction to Proteomics, Principles and Applications
   Packwood, K. (2011), Introduction to Proteomics, Principles and Applications Navin C. Mishra Foreword by Guenter Blobel John Wiley and Sons, 2010, pp. 200 Print ISBN: 978-0471754022 Online ISBN: 978-0470603871. Proteomics, 11: 2936-2936. https://doi.org/10.1002/pmic.201190066
6. Loralie J. Langman & Amitava Dasgupta (2012), Pharmacogenomics in clinical therapeutics, Wiley-Blackwell, pp. 400, ISBN: 978-1-119-95958-8
7. Mike Starkey & Ramnath Elaswarapu (2010), Genomics: Essential methods, , Wiley-Blackwell, pp. 350, ISBN: 978-0-470-71162-0
8. J-L Sebedio, L Brennan (2014), Metabolomics as a tool in nutrition Research, Woodhead Publishing (Elsevier), pp. 268, eBook ISBN: 9781782420927

PGMBSEC301: Biostatistics

Course Learning Outcome: By the end of this course, the student will be able to:

CO1: Understand the fundamental concepts of Statistics [2]*
CO2: Enlist different methods of data collection and testing [1]*
CO3: Understand characteristics of a Testing design and implement for his/her research [6]*
CO4: Compare the role of different Testing [4]*
CO5: Understand the method of Null Hypothesis & other tests [3]*
CO6: Describe features of ANOVA [2]*

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Mapping Matrix												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	3	-	1	2	1	1	2	2	-	-	-	-
CO2	3	-	1	2	1	1	2	2	-	-	-	-
CO3	3	-	1	2	1	2	3	3	-	-	-	-
CO4	3	-	2	2	2	2	2	3	-	-	-	-
CO5	3	-	1	2	1	2	2	3	-	-	-	-

CO6	3	-	1	2	1	2	3	3	-	-	-	-

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Course Code	**Title**	**Credits**
PGMBSEC301	Biostatistics	4Credits (60 Lectures)
Unit I	**Introduction to Statistics & Central Tendency** Statistical population Sample from population Random sample Central Tendency: Mean, Median and Mode Standard Deviation	(15L)
Unit II	**Testing** Gaussian Distribution and testing for normality, Non-parametric tests (Sign test, Wilcoxon test, Mann-Whitney Test, Kruskal–Wallis test), Transforming data to create Gaussian Distribution	(15L)
Unit III	**Tests of significance** Test of Significance. Hypothesis testing:- Theory of errors- Type I and Type II errors Null hypothesis P values-one v/s two tail P values, t test(paired & unpaired), z-test, Chi square test Contingency table	(15L)
Unit IV	**Correlation & Regression Tests** Comparing three or more groups-Introduction to	(15L)

	ANOVA, One way ANOVA, Two way ANOVA , (Repeated measures ANOVA), Friedman Test. Correlation and Regression: Linear and multiple Correlation and Regression.	

DISCIPLINE SPECIFIC ELECTIVE (DSEC-A)

PGMB301 (DSEC1): Soil and Agricultural Microbiology

By the end of this course, the student will be able to:

CO1.Understand basic concepts of Soil microbiology
CO2. . Develop methods of bioremediation of soil
CO3. Students will able to do evaluation of activities in soil
CO4. Student will learn and apply sustainable practices in agriculture.
CO5. Students will able to learn and classify diseases affecting crop plants.
CO6.Students will able to solve problems related to plant diseases and its effect on crop yield

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Mapping Matrix												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	2	1	-	-	3	-
CO3	-	-	-	2	-	-	-	1	-	-	3	-

CO4	1	-	-	-	-	-	-	2	-	-	3	-
CO5	-	-	-	-	-	-	-	1	-	-	2	-
CO6	1	-	-	3	-	-	-	2	-	-	-	-

Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Core Course Code	Title	Credits (60 lectures)
PGMB SEC301	**Soil and Agricultural Microbiology**	**4**
Unit -I	**Soil microbiology**	**15NH**

	1.1 Overview on soil structure 1.2 Factors influencing soil microbial population 1.3 Microbial communities, *Mycorrhizal* interactions - Ecto, endo, AM and VAM 1.4 Microbiology of rhizosphere ● Associative and antagonistic activities in the rhizosphere ● Role of root exudates in fungistasis 1.5 Microbially mediated transformations in soil ● Phosphorus, Sulfur, Nitrate, Ferrous and Manganese(Mineralization and Solubilization) ● Microbial methylation 1.6 Bioremediation of soil ● Diversity and Magnitude of Soil Contaminants ● Criteria and strategies for Bioremediation ● Microbial decontamination of soil(on site and off site) ● Decontamination in bioreactors ● In situ bioremediation of saturated soil Evaluation of bioremediation success	1
Unit-II	**Estimation of microbial activities in soil environment**	**15NH**
	2.1 Estimation of ATP in soils- The TCA extraction method, sample The Sulphuric acid- Phosphate extraction method 2.2 Estimation of the adenylate energy charge in soils- HPLC method 2.3Estimation of soil respiration in closed jars, closed bottles, Sapromat 2.4 Study of Dimethyl Sulfoxide reduction in sulphur cycle of soil sample 2.5 Estimation of Nitrogen mineralization in soil sample 2.6 Estimation of Nitrogenase activity of free-living bacteria in Soil	1
Unit-III	**Agriculture Microbiology for plant**	**15NH**
	3.1 Overview on new green revolution in agriculture 3.2 Microbial flora of rhizoplane, phyllosphere and phylloplane. 3.3 Abiotic stress and role of microorganisms in combating abiotic stress in plants	

	3.4 Microbes and sustainable agriculture ● Plant growth promoting rhizobacteria (PGPR) and its application ● Yield response to rhizobium inoculants in India ● Tests for ability of rhizobium isolates to nodulate 3.5 Frankia induced root nodulation 3.6 Biological dinitrogen Fixation ● Significance ● The Nitrogenase Enzyme Complex, nif genes 3.7 Recent development in the field of biological nitrogen fixation using ● Root nodulation in cereals ● Transfer of nif genes into non legume transgenic rhizobia ● Modulation of plant microbiomes by agricultural management and plant selection ● In situ microbiome development for optimizing microbial inoculation ● Microbe mediated biofortification of crops using PGPR 3.8 Microbial products influencing plant growth ● Indole acetic acid ● Cytokinins ● Gibberellins ● Ethylene 3.9 Biofertilizers: 3.10 Biopesticides 3.11 Biodegradation of pesticides and other agricultural chemicals	1

Unit-IV	**Plant Pathology** 4.1 Introduction to plant pathology- ● Parasitism and disease development ● Host range of pathogens ● Disease cycle – inoculation and its types, landing, sources ● Penetration and attachment- methods ● Recognition between host and pathogen ● Dissemination of pathogen and causes of plant disease(source of transmission) ● Plant defence mechanism against pathogen(brief) 4.2 Study of plant pathogens (bacterial, fungal and viral) with respect to – Morphology and characteristics, virulence, spread, mechanism of action, symptoms, diagnosis, control measures)	**15NH**
	● Bacterial leaf spots and blights of cereals, beans and grasses ● Red stripe, ratoon stunting of sugarcane ● Fire blight of pear and apple ● Bacterial galls- crown gall ● Pierce's disease of grape Fungal diseases- ● Brown spot disease of maize(*Plasmodiophoromycetes* and *Mastigomycotina*) ● Downy mildew of peas ● Ergot of Cereals(*Acomycotina)* ● Kernal bunt of wheat(*Basidiomycotina)* ● Wilt of cotton(*Deuteromycotina*) 4.3 Relationship between disease cycle and epidemiology, Risk Assessment of Plant Disease Epidemics	

Reference Books

1. Agricultural Biotechnology by S.S. Purohit Second Enlarged Edition [Page No.6 to 49]
2. Principles and Applications of Soil Microbiology, David M. Sylvia, JefFry J. Fuhrmann Peter G. Hartel, David A. Zuberer
3. Prescott, Hurley. Klein-Microbiology, 9th edition, International edition, McGraw Hill
4. Environmental biotech & Cleaner bioprocesses-Euenia J. Olguin, Gloria Sanchez, Elizabeth Hernandex
5. Soil microbial communities K. R. islam, and S. R. wright
6. Bioremediation of pesticides and other agricultural chemicals, Arie Altman

7. Microbial Ecology. Atlas and Bartha
8. Methods in Applied Soil Microbiology and Biochemistry- Kassem Alef, and Paolo Nannipieri
9. Soil Microbiology, Ecology and Biochemistry by Elder Paul
10. Agricultural Microbiology- G. Rangaswami, D.J. Bhagyaraj Second Edition [Page No.265 to 329]
11. Environmental Microbiology- Ian L Pepper, C P Gerba, Terry J Gentry
12. Environmental Microbiology- Maier, Pepper and Gerba
13. Environmental Biotechnology- InduShekhar Thakur
14. Environmental Biotechnology- Allan Scragg
15. Prescott, Hurley. Klein-Microbiology, 9th edition, International edition, McGraw Hill
16. Environmental Microbiology- Maier, Pepper and Gerba
17. Environmental Microbiology, S.K.Agarwal (2009), APH Publishing corporation, New
18. Delhi
19. Environmental Microbiology R.M Maier, I.L. Pepper and C.P.Gerba, Academic Press.
    a. (2000).
20. Recent Advances in Agricultural Microbiology for sustainable Agriculture Production
21. Agriculture Microbiology for sustainable agriculture production, A. K. Lavanya, Minakshi ,Grover, M. Manjunath
22. Methods in Applied Soil Microbiology and Biochemistry- KassemAlef,and Paolo Nannipieri
23. Textbook of Biotechnology- R. C. Dubey
24. Soil Microbiology by Subbarao [2000]
25. Soil Microbiology by Subba Rao 4th Ed. Oxford & IH
26. Plant Pathology by Agrios G. N. Academic Press, San Diego;1997.
27. Plant diseases by R.S.Singh
28. The Nature and practice of Biological Control of Plant Pathogens by Cook R. J. & Baker K. F.; 1983. American Phytopathological Society Press, St. Paul, MN.
29. Environmental Biotechnology by Forster C. F. & John D.A. Ellis Horwood Ltd. Publication;2000. A Manual of Environmental Microbiology by Christon J. H. ASM Publications;2001.
30. Soil Microbiology by Rao, N.S.S. Oxford & IBH Publishing Co., New Delhi;1999.

Laboratory Sessions

PGMBP301: Practicum of Core Course 1 & 2

By the end of this course, the students will be able to

CO1: Perform enrichment, isolation of viruses and further visualize using SEM [3]*
CO2. Evaluate in vitro systems to design the immunology experiments [5]*

Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating

CO-PO Matrix Mapping												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	3	-	3	3	2	2	3	3	-	1	-	-
CO2	3	-	3	2	2	3	2	2	-	2	-	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Core Course Code	Title	Credits (60 lectures)
PGMBP301	**Practicum of Core Course 1**	**4**
Practicum of Core Course 1	1. Enrichment and isolation of bacteriophage 2. Bacteriophage assay 3. One step growth curve of virus 4. Plant virus 5. Identification of virus infected plants 6. Isolation and extraction of plant virus nucleic acid 7. Identification using PCR. 8. Preparing phage for SEM analysis and observation 9. Case study on recent epidemic (E.g. - Lumpy skin disease virus)	2 Credit
Practicum of Core Course 2	1. Immunoelectrophoresis-Human Serum 2. UV Mutagenesis 3. Single Radial Immunodiffusion Assay 4. Immuno-Histo-Chemistry (IHC) Technique in diagnosis of Cancer. 5. Collection of human blood & separation of mononuclear cells by ficoll hypaque density gradient centrifugation. 6. Study of virulence factors-Phagocytosis & Phagocytic index Visit to ACTREC	2 Credit

Laboratory Sessions

PGMBPDSEC301: Practicum of DSEC301 A

By the end of this course, the students will be able to

CO1: Design primers for PCR [6*]

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Matrix Mapping												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	3	1	1	3	2	-	3	3	-	-	-	-

Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Core Course Code	Title	Credits (60 lectures)
PGMBDSEC 301	**Practicum of PGMBDSEC**	**2**
Practicum of PGMBDSEC 301	1. Workshop on Instrumentation 2. Visit to SAIF/ SASMIRA/ BAIF (Pune), Other Institutes 3. Workshop on Proteomics 4. Primer design of plant virus 5. PCR 6. Cloning	2 Credit

PGMBDSEC 301	**Practicum of Discipline Specific Elective (A or B)** 1. Analysis of soil – A. pH, Moisture content and water holding capacity B. Determination of sand, silt, clay content of soil (Particle size analysis) 2. Estimation of organic, Chloride, calcium carbonate, Phosphorus content of soil 3. Estimation of organic, Chloride, calcium carbonate, Phosphorus content of soil 4. Demonstration of biodegradability testing 5. Estimation of soil enzymes- Urease and Phosphatase 6. Isolation and Screening of Phytase Producing Microorganisms: An Essential Bioinput for Soil Fertility. 7. Screening and isolation of plant growth promoting endophytic bacteria 8. Estimation of plant growth hormone- IAA 9. Isolation and Screening of Zinc Solubilizing Microbes: As Essential Micronutrient Bio-Inputs for Crop Visit to Canabiosis	2 Credit

Laboratory Sessions

PGMBPDSEC301: Practicum of DSEC301 B

By the end of this course, the students will be able to

CO1.Students will able to solve problems related to plant diseases and its effect on crop yield.

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Matrix Mapping												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	-	-	3	-	-	-	2	-	-	-	-

Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Core Course Code	**Title**	**Credits (60 lectures)**

PGMBDSEC 301	**Practicum of Discipline Specific Elective (B)** 1. Analysis of soil – **a.** pH, Moisture content and water holding capacity b. Determination of sand, silt, clay content of soil (Particle size analysis) 2. Estimation of organic, Chloride, calcium carbonate, Phosphorus content of soil 3. Estimation of organic, Chloride, calcium carbonate, Phosphorus content of soil 4. Demonstration of biodegradability testing 5. Estimation of soil enzymes- Urease and Phosphatase 6. Isolation and Screening of Phytase Producing Microorganisms: An Essential Bioinput for Soil Fertility. 7. Screening and isolation of plant growth promoting endophytic bacteria 8. Estimation of plant growth hormone- IAA 9. Isolation and Screening of Zinc Solubilizing Microbes: As Essential Micronutrient Bio-Inputs for Crop 10. Visit to Canabiosis	2 Credit

SEMESTER IV

CORE COURSE

PGMB401- CC: Medical & Clinical Microbiology

By the end of this course, the student will be able to -

CO1: Investigate the history and spread of emerging diseases affecting globally [4*]
CO2: Evaluate the phases of clinical research
CO3: Understand the detailed knowledge of Fungal and Parasite infections [2*]
CO4: Demonstrate the laboratory diagnostic tools [3*]

CO-PO Matrix Mapping												
CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	-	-	1	-	-	-	1	-	2	2	1	3
CO2	1	-	2	2	-	-	3	-	-	-	-	-
CO3	1	-	-	-	-	-	-	2	-	-	-	3
CO4	1	-	-	-	-	3	-	3	-	-	-	2

Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Course Code	Title	Credits

PGMBCC-401	Medical & Clinical Microbiology	4
Unit I	**Emerging Diseases**	**15NH**
	Detailed Study of following infections including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab. diagnosis, Prophylaxis and Treatment. ● Chickengunia ● Listeriosis ● Hepatitis non A ● Swine flu ● Leptospirosis ● SARS a. *Helicobactor pylori* :Gastroenteritis	1
Unit-II	**Parasitology and Mycology**	**15NH**
	a. Introduction to parasitology and Mycology b. Types of parasites and host c. Medically important protozoa: Amoebae- morphology, life cycle, pathogencity and lab diagnostics d. Medically important flagellates . Classification based on habitat a. Giardia lambia- Morphology, life cycle, pathogenicity and lab diagnostics b. Helminths: General features and classification; ● Cestodes, Trematodes, Nematodes 2.1 Pathogenesis of fungal diseases (Mycoses) . Fungal Pathogenicity (virulence factors): a. Factors predisposing to fungal infections b. Immunity to fungal infections Laboratory diagnosis of mycoses	1
Unit-III	**Immunopathology**	**15 NH**
	3.1 Immunity to infection – immune mechanisms to intracellular and extra-cellular infectious agents (with examples of bacterial, protozoan and parasitic infections, strategies for vaccine development) 3.2 Immunodeficiency disorders (pathophysiology, diagnosis and prognosis)	

	● Infective disorders: HIV-AIDS, Herpes infections ● Non-infective disorders: Phagocytic deficiencies, humoral deficiencies, T-cell deficiencies, and combined deficiencies, complement deficiencies 3.3 Therapeutic aspects in immunopathology ● Strategies for immunotherapy (cytokine and vaccine therapy) ● Stem cell therapy a. Plasmapheresis	1
Unit-IV	**Clinical Research and Modern diagnostics**	**15NH**
	ntroduction to Clinical Research Concepts .2 Essential Characteristics of Clinical Research .3 Overview of Clinical Research Study Designs .4 Commercial identification systems & Automation ● Nucleic acid based analytic methods for microbial identification & characterization .5 Characterization of microbes beyond identification .6 Investigation of strain relatedness .7Automation & advances in Molecular Diagnostic Instrumentation 4.8 4.8 Diagnosis of Viral infections	1

Reference Books

1. Immunology- Kuby 5th edition W. H. Freeman and company- New York.
2. Textbook of Microbiology. 8 Edition. Ananthanarayan & Paniker- University Press.
3. Textbook of Clinical trials-editors David Machim, Simson Day & Sylvan green-John Wiley &Sons
4. Clinics in laboratory medicine, Emerging Infections and their causative agents, September 2004

CORE COURSE

PGMB402-CC: Environmental Microbiology

By the end of this course, the student will be able to -

CO1: Understand basic concepts of Soil microbiology
CO2: Develop methods of bioremediation of soil
CO3: Students will able to do evaluation of activities in soil
CO4: Student will learn and apply sustainable practices in agriculture.
CO5: Students will able to learn and classify diseases affecting crop plants.
CO6: Students will able to solve problems related to plant diseases and its effect on crop yield.

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Matrix Mapping												
CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	2	1	-	-	3	-
CO3	-	-	-	2	-	-	-	1	-	-	3	-
CO4	1	-	-	-	-	-	-	2	-	-	3	-
CO5	-	-	-	-	-	-	-	1	-	-	2	-
CO6	1	-	-	3	-	-	-	2	-	-	-	-

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Course code	Title	Credits
PGMB402	**PGMB402-CC Environmental Microbiology**	**4**
Unit I	**Concept of Ecology**	**15NH**
	1. Introduction of ecology: 1.1 Autecology, synecology, population, community, ecosystem, biome, biotic stresses, abiotic stresses 1.2 Classification of ecosystems; (Review). **2.** Physiological ecology of microorganisms: Adaptation to environmental condition, Abiotic growth limiting factors-Leibig's law of minimum, Shelford law of tolerance. Microbial community succession-biofilm communities. 1. Biodiversity: Index of diversity and dominance, Biological indices, relationship between species diversity, dominance and stability	1
Unit II	**Biodegradation**	**15 NH**
	2.1 Introduction : ● Overall processes of Biodegradation ● Contaminant structure ● Genetic Potential ● Bioavailability ● Toxicity and Biodegradability ● Environmental Factors affecting Biodegradation ● Redox Condition ● Organic Matter Content ● Nitrogen ● Other (Temperature, pH, Salinity and Water Activity) **2.2 Degradation of Xenobiotic compounds** ● Pollutant source and type ● Recalcitrant Hydrocarbons ● Synthetic Polymers ● Pesticides *a.* 2,4-Dichlorophenoxyacetic Acid	1
Unit III	**Bioremediation**	15NH
	3.1. Concept, principal and mechanism of bioremediation, acclimatization, detoxification, transformation, degradation, mineralization, co-metaboilsm, metabolism, biostimulation, bioaugmentation	

	3.2 Factors affecting bioremediation, nature of pollutants, bioavailability of pollutants, production of bioremediation metabolites and intermediates, Growth kinetics of organisms. **3.3 Approaches to bioremediation** ● Environmental Modification for Bioremediation ● Microbial Seeding and Bioengineering for Removal of Pollutant ● Sequential Anaerobic-Aerobic degradation, Addition of oxygen and other gases, Addition of Surfactants, Addition of Nutrients **3.4 Bioremediation – Efficacy Testing** **3.5 Microbial Enhanced Oil Recovery** **3.6 Microbial accumulation of heavy metals** ● Heavy metal toxicity in the environment ● Microbes in metal containing habitats ● Metal-Microbe interactions ● Microbial immobilization and transformation of metals 1.Microbial Applications for Metal removal	
Unit IV	**Advanced Environmental Microbiology**	**15 NH**
	4.1. Microbial communication activities: 4.1.1. Activities and interactions with environment and nutrient cycling. 4.1.2 Microbial source tracking methods 4.1.3. Common bacteria used in source tracking studies: Bacteroides. 4.1.4 Applications of source tracking. 4.2. Extreme Environment: 4.2.1. Low Temperature: McMurdo dry valley, Antarctica. 4.2.2. High Temperature: Geothermal hot springs. 4.2.3. Desiccation and UV stress: The Atacama Desert, Chille. 4.2.4. Aphotic environment based Chemolithoautotrophy: Deep-sea hydrothermal vent, An acid mine drainage system, A desert carbonate caves.	1

Reference Books:

1. Microbial Ecology –Atlas and Bartha (579.17)
2. Prescott, Hurley. Klein-Microbiology, 9th edition, International edition, McGraw Hill (576/pre/har)
3. Biological Wastewater Treatment. Vol. 5. Activated Sludge and Aerobic Biofilm Reactors. Marcos von Sperling. IWA Publishing. London, New York. © 2007 IWA Publishing (

Online)
4. Environmental biotech & Cleaner bioprocesses-Euenia J. Olguin, Gloria Sanchez, Elizabeth Hernandex (Online)
5. Environmental Microbiology- Ian L Pepper, C P Gerba, Terry J Gentry (576/mai/pep)
6. Environmental Biotechnology- Indu Shekhar Thakur (620.8/tha)
7. Environmental Biotechnology- Allan Scragg (628.52/scr) (620.8/scr)
8. Wastewater Engineering- Mecalf & Eddy (628.119/met/edd)
9. Water supply and pollution control (6^{th})- Warren Viessman, Jr., Mark. J. Hammer (620.8/vie/ham)
10. Environmental biotech & Cleaner bioprocesses-Euenia J. Olguin, Gloria Sanchez, (online)
11. Water & waste water technology by Mark J Hammer, Mark J Hammer Junior (600/ham) (628.119/nam/ham)
12. Introduction to Environmental biotechnology, A.K.Chatterji (2011), PHI Learning private limited, New Delhi.
13. Biodegradation and Bioremediation- Martin Alexander, 2^{nd} edition, 2014, Elsevier (628.5/mar)
14. Prescott's Microbiology- Willey, Sherwoods, Woolverton(579/wil/she)
15. Microbial Ecology- Barton, Dianae (579.17/Bar/Nor)

References for Practicals:

1. APHA.AWWA.WEF
2. http://www.who.int/water_sanitation_health/dwq/2edvol3d.pdf
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5395623/

CORE COURSE

PGMB-DSEC-401 Waste Management

By the end of this course, the student will be able to –

CO1: explain the hierarchical structure in waste water management and a requirement for an integrated solution [2*]
CO2: apply the legal legislation related to biomedical waste management. [3*]
CO3: Compare & contrast between advanced waste water treatment methods [4*]
CO4: Apply knowledge of waste management system [3*]
CO5: Design waste disposal units. [6*]

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Matrix Mapping												
CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1		-	2	-	-	-	-	-	-	-	3	-
CO2	-	-	-	-	-	-	-	1	-	-	2	3
CO3	-	-	-	2	-	-	-	1	-	-	3	3
CO4	1	-	-	-	-	-	2	-	-	-	3	-
CO5	-	-	-	-	-	-	1	-	-	-	2	3

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Course code	Title	Credits
PGMB403-SEC	**Waste Management**	**6**
Unit I	**Waste Water Management Systems**	**15NH**
	.1 Fundamentals of biological treatment: - 1. Suspended growth biological treatment processes- Biological removal of phosphorus, nitrogen 2. Attached growth and combined biological treatment processes- Trickling filters/solids contact, Trickling filters/activated sludge process, activated biofilters and biofilters activated sludge process, series Trickling filter-activated sludge process, activated sludge with fixed film packing, Fludised bed bioreactors, attached growth denitrification processes **1.2 Advanced, Combined and Innovative waste water treatment Processes:-** 3. Wastewater treatment system (Unit process): 4. Physical Screening: Flow Equalization, Mixing, Flocculation, Flotation, Sedimentation, Granular Medium filtration, 5. Carbon adsorption 6. Removal of volatile organic compound 7. Oxygen transfer 8. Membrane filtration process 9. Gas stripping 10. Distillation 11. Ion-Exchange for heavy metal removal. **1.3 Chemical Unit process**:– 12. Chemical precipitation 13. Phosphorus removal 14. Nitrogen removal 15. Heavy metal removal. **1.4 Disinfection**: – by using chlorine , Ozone, UV, Dechlorination **1.5 Anaerobic suspended and attached growth biological treatment**:- 16. Anaerobic sludge blanket processes, attached growth anaerobic processes **1.6 Sludge Processing-Stabilization methods**	1
Unit II	**Industrial Waste Management**	**15NH**

	2.1 Industrial Waste Management •Introduction to Industrial waste management •Objectives of industrial waste management •Constituents of industrial waste, classification of industrial waste **2.2 Treatment and disposal of effluent** •Lagoons (oxidation ponds) •Land filling •Incineration- Methods •In Sewers •Composting process,Cambithermal hydrolysis •Analidic conversion •Eutrophic fermentation **2.3Application of Biosolids to Land** •Application methods •Pathogens of concerns in organic residuals, •Potential microbial hazards associated with class bio solids •Antibiotic resistance bacteria(Microbial issues with animal manure) •Conveyance and storage a. •Oduor management	1
Unit III	**Biomedical Waste Management**	**15 NH**
	.1 Biomedical Waste ● Introduction ● Constituents of Biomedical waste ● Classification of Biomedical waste transportation and storage, transportation at final disposal site **3.2 Medical Waste Risks and Impact on Health and the Environment** ● Overview of Hazards, Public sensitivity, Public Health impact **3.3 Policy Aspects**: Legislative, Regulatory, Health-care waste **3.4 Disposal of biomedical waste:** ● Treatment and Disposal Treatment and disposal methods, Incineration Chemical disinfection, Needle extraction or destruction, Encapsulation. **3.5 Staff Protection Measures**: a. Personal protective equipment, Personal hygiene, , Emergency measures, Training.	1
Unit IV	**Environmental Management**	**15 NH**

	4.1 Introduction and scope of environmental management, basic concepts of sustainable development, industrial ecology and recycling industry. **4.2** Role of natural products and bio-diversity in international trade, energy production and trade, energy balance and energy audit. Eco-marketing. **4.3** Environmental Impact Assessment (EIA), general guidelines for the preparation of environmental impact statement (EIS), scope and types of environmental audit, cost benefit analysis, environmental management plan (EMP), international organization for standardization (ISO), ISO 14000 standards and certification, environmental clearance for establishing industry, environmental safety, risk management and emergency preparedness	1

Reference Books:

1. Prescott, Hurley. Klein-Microbiology, 9th edition, International edition, McGraw Hill. (576/pre/har)
2. Wastewater Engineering- Mecalf & Eddy.
3. Water supply and pollution control (6th)- Warren Viessman, Jr., Mark. J. Hammer.(628.164/VIE/HAM)
4. Biological Wastewater Treatment. Vol. 5. Activated Sludge and Aerobic Biofilm.
5. Environmental Microbiology- Maier, Pepper and Gerba
6. Water & waste water technology - Mark J Hammer, Mark J Hammer Junior (600/HAM)
7. Environmental Microbiology- Ian L Pepper, C P Gerba, Terry J Gentry
8. Environmental biotech & Cleaner bioprocesses-Euenia J. Olguin, Gloria Sanchez, Elizabeth Hernand. (628.5/OLG)
9. Environmental Biotechnology by Allan Scragg, 2nd ed
10. Environmental Biotechnology, Scragg, alan (620.8/SCR)
11. Wealth from Waste, S. C. Bhatia (574.83/BHA)
12. Evaluation of Biomedical Waste Management System By: Khalid Maryam Pub.: LAP Lambert Academic Publishing
13. Infectious and Medical Waste Management B-: Peter A. Reinhardt Pub.: CRC Press
14. Environmental Waste Management By: Ram Chandra Pub.: CRC Press
15. Hospital Waste Management: A Guide for Self-Assessment and Review By: Shishir Basarkar Pub.: Jaypee Brothers, Medical Publishers Pvt. Limited (641.579/JHA)
16. Water & waste water technology by Mark J Hammer, Mark J Hammer Junior (600/ham) (628.119/nam/ham)

SPECIFIC ELECTIVE (DSE-A)

PGMBSEC-401-Bioinformatics

By the end of this course, the student will be able to –

CO1: Understand the fundamental concepts of Bioinformatics [2]*
CO2: Classify and evaluate various data bases [4]*
CO3: Understand & evaluate characteristics of a Transcriptomics [5]*
CO4: Enlist different Protein computational biology tools [1]*
CO5: Evaluate & predicate Secondary and tertiary structure of protein [5]*
CO6: Describe features of proteomics [2]*

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creatin**

CO-PO Matrix Mapping												
CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	-	-	1	-	-	-	-	-	-	3	3
CO2	-	-	-	3	-	2	-	1	-	-	-	-
CO3	-	-	-	3	-	2	-	1	-	-	-	-
CO4	1	-	-	3	-	2	1	-	-	-	-	-
CO5	1	-	-	3	-	2	1	-	-	-	-	-
CO6	1	-	-	-	-	3	2	-	-	-	-	-

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Course code	Title	Credits
PGMBEC401	**Bioinformatics**	**4**
Unit 1	**Introduction to Bioinformatics**	**15NH**
	Introduction to Bioinformatics Introduction to Bioinformatics: Overview, Internet and bioinformatics, Applications Databases: Databases in Bioinformatics, various biological databases, Protein and Nucleotide sequence Data bases. Protein sequence, structure and Classification databases 1. Sequence analysis: Pairwise alignment, local and global alignment, Scoring matrices, multiple sequence alignment, tools for sequence alignment, programming algorithms	1
Unit II	**Gene Prediction & Transcriptomics**	**15NH**
	Gene Prediction & Transcriptomics Gene prediction: Gene structure in Prokaryotes and Eukaryotes, Gene prediction methods: Neural Networks, Pattern Discrimination methods, Signal sites Predictions, Evaluation of Gene Prediction methods. Transcriptomics: Complete transcript cataloguing and gene discovery-sequencing based approach, Microarray based technologies and computation based technologies. 1. RNA secondary structure prediction	1
Unit III	**Protein Computational Biology & Tools**	**15NH**

	Protein Computational Biology: Structural classification of proteins, Protein structure analysis, structure alignment and comparison, Secondary and tertiary structure prediction and evaluation, prediction of specialized structures, Active site prediction, Protein folding, Protein modeling and drug design Tools in Bioinformatics: ProtParam, Translate, BioEdit, FindMod, COILS, TMHMM, RasMol, DeepView	
Unit IV	**Genomics, Proteomics & Phylogenetic analysis**	**15NH**
	Genomics: Comparative Genomics Proteomics: Types of proteomics, tools for proteomics- separation and isolation of proteins, acquisition of protein structure information, databases and applications 1. Phylogenetic analysis: molecular basis of evolution, Phylogenetic trees & different methods for phylogenetic inference	1

References Books:-

1. Developing Bioinformatics Computer Skills: Cynthia Gibas & Per Jambeck (2001). Shroff Publishers & Distributors Pvt. Ltd (O'Reilly), Mumbai.
2. Bioinformatics Basics: Applications in Biological Science and Medicine, H.H. Rashidi & L.K Buehler (2002). CRC Press, London.
3. Bioinformatics: Sequence, structure and databanks, Des Higgins & Willie Taylor (2002). Oxford University Press.
4. Bioinformatics: A practical guide to the analysis of genes and proteins, Baxevanis A.D & Ouellette B.E.F (2001) Wiley Interscience - New York
5. Bioinformatics: A Beginners Guide, Clavarie and Notredame
6. Bioinformatics: David Mount
7. Bioinformatics: Rastogi
8. Introduction to Bioinformatics: Arthur M. Lesk
9. Bioinformatics: Principles and applications, Ghosh and Mallick
10. Bioinformatics: Genes, Proteins and Computer, C A Orengo

Laboratory Sessions

PGMBP401: Practicum of Core Course 1 & 2

By the end of this course, the students will be able to

CO1: Demonstrate the laboratory diagnostic tools [3*]
CO2: Determine the quality standards for air, drinking water and waste
CO3: Design waste disposal units. [6*]

CO-PO Matrix Mapping												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	-	-	-	-	3	-	3	-	-	-	2
CO2	-	-	-	1	-	-	-	-	-	-	3	-
CO3	-	-	-	-	-	-	1	-	-	-	2	3

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(All Results have to be done with proof unless otherwise stated).

Core Course Code	Title	Credits
PGMBP401	**Practicum of Core Course 1 & 2**	**4**
Practicum of Core Course 1	1. Identification of fungus including direct microscopy, culture methods including slide culture,fungal staining. 2. Processing and identification of ova and cysts in stools samples including Wet mount & staining. 3. ELISA 4. Case studies related to Emerging diseases. 5. Visit to Pathology Laboratory	2 Credit
Practicum of Core Course 2 PGMB402	1. Enrichment and isolation of cellulose & lignin degraders from mangrove soil. 2. Microbial Conversion of Vegetable Wastes for Bio fertilizer Production 3. Pollutant analysis: 4. Determination of nitrate concentration by phenol disulphonic acid method 5. Estimation of sulphate by turbidimetric method 6. Estimation of oil & grease by partition gravimetric method. 7. Estimation of chloride by argentometric method 8. Biodegradation of Dyes and Heavy metals	2 Credit

Practicum of Core Course PGMB401 (DSE-A)	1. Waste water analysis 2. Estimation of nitrogen by Nessler's method. 3. Estimation of Manganese by persulphate method. 4. Estimation of dissolved oxygen, BOD by Wrinkler's method 5. Determination of COD 6. Determination of TS and MLSS. 7. Audit survey- EIA 8. Academic visit to Sewage treatment plant/ ETP of any industry /water purification unit/ Pollution Control Board Lab, CETP, landfill, Electronic waste treatment etc.	2 Credit