Semester-wise Details

Third Year

Year / Semester	Serial Number, Code & Nomenclature of Paper				Duration of Exam	Teaching Hrs/Week & Credit			Distribution of Marks			Min. Pass Marks	
	Number	Code		Nomenclature		L	P	C	Inter-nal Assess.	Sem. Assess.	Total Marks	Internal Assess.	Sem. Assess.
III Year V Semester	5.1	BMB17	DSE	Biosafety & IPR or Enterpreneurship and Startups	3 Hrs	4	--	4	30	70	100	12	28
	5.2	BMB18	DSE	Soil &Agriculture Microbiology or Microbes in Sustainable development	3 Hrs	4	--	4	30	70	100	12	28
	5.3	BMB19	DSE	Tools & Techniques in Microbiology or Bacteriology and Parasitology	3 Hrs	4	--	4	30	70	100	12	28
	5.4	BMB20	DCC	Practicals V	6 Hrs	--	12	6	--	150	150	--	75
	5.7	VAC	VAC		1.5 Hrs	2	---	2	---	50	50	--	20
	Semester Total					**14**	**12**	**20**	**90**	**410**	**500**	**--**	
III Year VI Semester	6.1	BMB21	DSE	Bioinformatics and Biostatistics Or Microbial Biotechnology	3 Hrs	4	--	4	30	70	100	12	28
	6.2	BMB22	DSE	Biophysics & Instrumentation Or Fundamentals of Applied Microbiology	3 Hrs	4	--	4	30	70	100	12	28
	6.3	BMB23	DSE	Industrial Microbiology Or Microbial quality control in Industries	3 Hrs	4	--	4	30	70	100	12	28
	6.4	BMB24	DCC	Practicals VI	6 Hrs	--	12	6	--	150	150	--	75
	6.7	SEC	SEC		1.5 Hrs	2	---	2	---	50	50	--	20
	Semester Total					**14**	**12**	**20**	**90**	**410**	**500**	**--**	
	Third Year TOTAL					**28**	**24**	**40**	**180**	**820**	**1000**	**--**	
Option for exit with Degree in Microbiology (120 credits score)													

S. No.	Nature of Paper / Course	Semesters Wise Papers/Course along with Credits of Theory and Practical Components						
		I	**II**	**III**	**IV**	**V**	**VI**	
1.	Discipline Centric Core (DCC) Course	Subject-I (4T = 4Cr) Subject-II (4T = 4Cr) Subject-III (4T = 4Cr) Subject IV (12P=6Cr	Subject-I (4T = 4Cr) Subject-II (4T = 4Cr) Subject-III (4T = 4Cr) Subject IV (12P=6Cr)	Subject-I (4T = 4Cr) Subject-II (4T = 4Cr) Subject-III (4T = 4Cr) Subject IV (12P=6Cr	Subject-I (4T = 4Cr) Subject-II (4T = 4Cr) Subject-III (4T = 4Cr) Subject IV (12P=6Cr	--	--	**16** **16** **16** **24** **72**
2.	Discipline Specific Elective (DSE) Course	--	--	--	--	Subject-I (4T = 4Cr) Subject-II (4T = 4Cr) Subject-III (4T = 4Cr) Subject IV (12P=6Cr	Subject-I (4T = 4Cr) Subject-II (4T = 4Cr) Subject-III (4T = 4Cr) Subject IV (12P=6Cr	**08** **08** **08** **12** **36**
3.	Ability Enhancement Compulsory (AEC) Course	General Hindi / General English (2 Cr)	General English / General Hindi (2 Cr)	--	--	--	--	**04**
4.	Generic Elective Course (GEC)	--	--	Environmental Science (2 Cr)	Elementary Computer Applications (2 Cr)	--	--	**04**
5.	Value Added Course (VAC)	--	--	--	--	Mulya Pravah (2 Cr)	--	**02**
6.	Skill Enhancement Course (SEC)	--	--	--	--	--	Skill Enhancement Course (2 Cr)	**02**
Total Credits		**20**	**20**	**20**	**20**	**20**	**20**	**120**

Assessment Pattern:

The assessment of the students shall be divided into two parts in which first part is continuous assessment or internal assessment or mid-term assessment (30% weightage of the maximum marks) and second part is semester assessment or external assessment or end-term assessment (70% weightage of the maximum marks). Assessment pattern and distribution of maximum marks is summarized as given below:

(i) Continuous or Internal or Mid Term Assessment:

(a) The continuous or internal or mid-term assessment (30% weightage of the maximum marks) for each theory paper shall be taken by the faculty members of the respective Departments during each semester. There will be three internal assessment tests (*i.e.*first internal assessment test or first mid-term test and second internal assessment test or second mid-term test and third internal assessment test) each of 10% weightage of maximum marks of each theory paper. Each internal assessment shall be of one

hour duration for theory paper and shall be taken according to academic calendar which will be notified by the Department / University.

(b) For practical papers, there will be no continuous or internal or mid-term assessment. There will be only one external or semester or end-term assessment (100% weightage of maximum marks).

(ii) Semester or External or End Term Assessment:

(a) The semester or external or end-term assessment (70% weightage of the maximum marks) shall be three hours duration to each theory paper and twelve hours duration (spread over two days with 6 hours per day) for each practical paper and shall be taken by the University at the end of each semester.

(b) The syllabus for each theory paper is divided into five independent units and question paper for each theory will be divided into three sections as mentioned below:

Section-A *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*

Section-B *will carry 50 marks with equally divided into five long answer type questions. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

(c) The syllabus of practical paper is divided according to main streams of Biotechnology. Marks shall be awarded on the basis of major & minor experiments, spotting, viva-voce, practical record, regularity factor, lab skills, maintain cleanness of workplace, *etc*.

Question Paper Pattern:

(A) Continuous or Internal or Mid Term Assessment:

30% weightage of Maximum Marks (30 Marks out of 100 Maximum Marks).

(i) Continuous or Internal or Mid Term Assessment:

Format

Department of .....
College / University .....
Address.....

First Internal Assessment Test 20… - 20….

Class	**:**	**Max. Marks**	**: 10 Marks**
Semester	**:**	**Duration of Exam.**	**:**
Subject	**:**	**Date of Examination**	**:**
Paper	**:**	**Name of Teacher**	**:**

Note: All questions are compulsory and marks are given at the end of the each question. Two or three sub-divisions may be given in the question.

Q. No. 1. ……..
or……4 Marks
Q. No. 2. ……..
or……3 Marks
Q. No. 3. ……..
or……3 Marks

(B) Semester or External or End Term Assessment:

70% weightage of Max Marks (*i.e.*70 Marks out of 100 Max Marks).

Duration of Examination: 3 Hours **Max. Marks: 70**

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions . Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

SECTION-A

Q. 1.

Unit-I

(i) …… **2 Mark**
(ii) …… **2 Mark**

Unit-II

(iii) …… **2 Mark**
(iv) …… **2 Mark**

Unit-II

(v) …… **2 Mark**
(vi) …… **2 Mark**

Unit-IV

(vii) …… **2 Mark**
(viii) ..…… **2 Mark**

Unit-V

(ix) …… **2 Mark**

(x) …… **2 Mark**

SECTION-B

Unit-I

Q. 2. ……..…… **10 Marks**
or ……....…… **10Marks**

Unit-II

Q. 3. ……...……**10 Marks**
or ……..…..…… **10 Marks**

Unit-III

Q. 4. ……..…… **10 Marks**
or ……..…… **10 Marks**

Unit-IV

Q. 5. . ……..…… **10 Marks**
or ……..…….. **10Marks**

Unit-V

Q. 6. ……...…… **10Marks**
or ……..…..… **10 Marks**

Practical Examinations:

Continuous or Internal or Mid Term Assessment: *Not applicable in practical.*

External or Semester or End Term Assessment:
Duration of Exam : 6 Hours
Maximum Marks : 150 Marks*
Distribution of Maximum Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1 : Major Experiment	12
2.	Exercise No. 2 : Major Experiment	12
3.	Exercise No. 3 : Major Experiment	12
4.	Exercise No. 4 : Minor Experiment	10
5.	Exercise No. 5 : Minor Experiment	10
6.	Exercise No. 6 : Minor Experiment	10
7.	Exercise No. 7: Preparation	8
8.	Exercise No. 8: Preparation	8
9.	Exercise No. 9: Preparation	8
10.	Exercise No. 10 : Spotting Experiment(5 x 3= 15spots)	30
11.	Record (5x3)	15
12.	Viva-voce	15
Total Marks		**150**

Semester Fifth

Paper 5.1. BMB 17 (1) - Biosafety and Intellectual Property Rights

Course Type : **Credits:4**

Duration :3 hrs Continuous/Internal/Assessment : 30 Marks
Semester Assessment : 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Unit I

Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types;Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms.

Unit II

Biosafety Guidelines: Biosafety guidelines and regulations (National and International);GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees for GMO applications in food and agriculture; Environmental release of GMOs.

Unit III

Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights,Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of IPR .Legal protection of biotechnological inventions –World Intellectual Property Rights Organization (WIPO).

Unit IV

Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement, Patent infringement, Rights and Duties of patent owner.

Unit V

Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement.WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV &Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

References Books:

1. Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.
4. Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social Impliocations, Springer India.
5. Goel D &Prashar S (2013).IPR, Biosafety and Bioethics. Pearson.
6. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.

Semester Fifth

Paper 5.1. BMB 17 (2) – Entrepreneurship & Start-ups

Course Type : DSE **Credits:4**

Duration :3 hrs Continuous/Internal/Assessment : 30 Marks
Semester Assessment : 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Unit I

Concept of Entrepreneur - Features - Types - Functions - Entrepreneurship - Characteristics - Evolution - Entrepreneurial process - Dimensions and Paradoxes - Attributes of Strategic Resources - Approaches - Social Entrepreneur - Women Entrepreneur - Role of entrepreneurship in economic development - Constraints for the growth of entrepreneurial culture - Start-up success stories, Myths about entrepreneurs, types of entrepreneurs.

Unit II

Types of entrepreneurial skills - team work and leadership skill, analytical and problem solving skills, critical thinking skills, branding, marketing and networking skills. Role of entrepreneurship development programmes (EDP).

Unit III

Entrepreneurial opportunity and enterprise planning: Sensing entrepreneurial opportunities, selecting the right opportunity, Site Selection, Feasibility Analysis.

Unit IV

Crafting business models and Lean Start-ups: Introduction to business models; Creating value propositions-conventional industry logic, value innovation logic; customer focused innovation; building and analysing business models; Business model canvas, Introduction to lean start-ups, Business Pitching.

Unit V

Institutions Supporting Small Business Enterprises: Central level institutions. State level institutions. Other agencies. Industry Associations. Class exercise- discussions on current government schemes supporting entrepreneurship and finding out which scheme will most suit the business plan devised by the student.

References Books:

1. Vasant Desai, Small-Scale Enterprises and Entrepreneurship Ecosystem, 6th Edition, Himalaya Publishing House, 2016.
2. Robert Hisrich, Michael Peters, and Dean Shepherd, Entrepreneurship, 11th Edition, McGraw Hill Education, 2019.
3. Poornima M. Charantimath, Entrepreneurship Development and Small Business Enterprises, 3rd Edition, Pearson Education, 2018.
4. Andrew Zacharakis, WiliiamBygrave, and Andrew Corbett, Entrepreneurship, 4th Edition, Wiley, 2016.
5. Marc J. Dollinger, Entrepreneurship: Strategies and Resources, 4th Edition, Marsh Publications, USA, 2008.
6. Rajeev Roy, Entrepreneurship, 2nd Edition, Oxford University Press, 2011.
7. C.V. Bakshi, Entrepreneurship Development, 2nd Edition, Excel Publications, 2010.
8. Guillebeau, C (2015) The $100 Startup: Fire Your Boss, Do What You Love and Work Better To Live.
9. Prasad, Rohit (2013), Start-up sutra: what the angels won't tell you about business and life, Hachette India.
10. Charantimath, P. (2009). Entrepreneurship Development: Small Business Enterprises. Pearson.

Semester Fifth

Paper 5.2 BMB 18 (1)-Soil and Agriculture Microbiology

Course Type : DSE **Credits:4**

Duration :3 hrs Continuous/Internal/Assessment : 30 Marks
Semester Assessment : 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

UNIT-I

Soil: definition, classification, types, physical and chemical properties, soil as a natural habitat for microorganisms,microbial communities in soil.Lithification. Decomposition of organic matter by microorganisms - cellulose, hemicelluloses chitin lignin and pectin.

UNIT -II

Biological nitrogen fixation (BNF)**:** Nitrification, denitrification; symbiotic nitrogen fixation (Rhizobium, Frankia), non-symbiotic nitrogen fixation (Azotobacter, Azospirillum); Nitrogenase enzyme, nif genes and molecular mechanism of nitrogen fixation. Genetic engineering of BNF.

UNIT -III

Biopesticides-introduction, types, mode of action and factors influencing, target pests. Biological control: Introduction, mechanism of antagonism, amensalism, competition, predation and parasitism (mycoparasitism, nematophage, mycophagy), application ofbiological control on field.

UNIT -IV

Biofertilizers: Definition, types- Nitrogen fixing, Phosphate solubilizing Cultivation and mass production of bioinoculants- Azotobacter, Rhizobium,Cyanobacteria, Azolla.-Carrier-based inoculants - production and applications. PGPRs, phytoalexins, PR proteins, Transgenic approaches for crop protection.

UNIT -V

Plant pathology: Historical developments in brief, classification of plant diseases, principles of infection and spread of diseases in general. Soil born diseases – Damping off, root rot and vascular wilts cause, symptoms & their control.

References Books:

1. P.D.Sharma.2006. Plant pathology. Alpha Science International.19.
2. Sharma.P.G. 2006. Plant Pathology. Rastogi Publication.
3. Agrios G.N. (2009), Plant Pathology. 5th Ed. Academic Press.

4. Paul E.A.2007. Soil Microbiology: Ecology and Biochemistry,3Edn. Academic Press.
5. John L. Havlin et al., 2004. Soil Fertility and Fertilizers: An Introduction to Nutrient Management (7th Edition). Prentice Hall.
6. Coyne M. 1999. Soil Microbiology Delmar Cengage Learning
7. Mehrotra, Aggarwal R, Ashok.2004. Plant Pathology. 2nd Edition Tata McGraw-Hill..
8. Rangaswami .Gand D.J. Bagyaraj. (1998) Agricultural Microbiology. 2nd Ed. PHI. India.
9. Subbarao, N.S. and Dommergues, Y.R. (1998) Microbial interactions in agriculture and forestry. Science publishers.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition

Semester Fifth

Paper 5.2 BMB 18 (2)- Microbes in Sustainable Development

Course Type : DSE **Credits:4**

Duration :3 hrs Continuous/Internal/Assessment : 30 Marks
Semester Assessment : 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Unit I

Definition and concepts of sustainable development, issues in Sustainable Development, Strategic Planning for Sustainable Development. Microbes and its suitability in sustainable development: Brief account of bacterial cell structure, metabolic diversity, different niche occupancy.

Unit II

Microbes in environmental management: Bioremediation and phytoremediation, Biosensors. Microbes in healthcare: antibiotics and drug developments. Microbes in agriculture: crop improvement and protection, Microbes in food processing, Microbes in bio-hydrometallurgy and fuel industry

Unit III

Soil as Microbial Habitate, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil, Soil organic matter Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus. Microbial activity in soil and green house gases Carbondioxide, methane, nitous oxide, nitric oxide – production and control

Unit IV

Biofertilization, Phytostimulation, Bioinsecticides, Plant growth promoting bateria, biofertilizers – symbiotic (Bradyrhizobium*, Rhizobium, Frankia*), Non Symbiotic (*Azospirillum, Azotobacter, Mycorrhizae,* MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs.

Unit V

Secondary Agriculture Biotechnology: Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters; GM crops: Advantages, social and environmental aspects, BT crops, golden rice, transgenic animals.

References Books:

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning. 8. Altman A (1998). Agriculture Biotechnology, ist edition, Marcel decker Inc.
8. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
9. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
10. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

Semester Fifth

Paper 5.3. BMB 19 (1)-Tools and Techniques in Microbiology

Course Type : DSE **Credits:4**

Duration :3 hrs
Continuous/Internal/Assessment : 30 Marks
Semester Assessment : 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Unit-I

Microscopy: Basic idea of light microscopy, Principle, types and applications of - bright field, dark field, fluorescence and phase-contrast microscopes.
Electron microscope-Basic idea of structure and functioning of E.M., Preparation of material for electron microscopy, Types-TEM, SEM

Unit-II

Spectrophotometer:Principles and applications. Colorimetry and turbidometry.
Principle and applications of agarose gel electrophoresis and SDS-PAGE.

Unit-III

Principles, working and applications of- Autoclave, Laminar Airflow, Hot Air Oven, pH meters.
Centrifuge:Types ,principles and applications.

Unit-IV

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Gel filtration chromatography, ion exchange chromatography and affinity chromatography, GLC, HPLC.

Unit-V

Microbiological stains and Staining techniques for light microscopy: Types of stains and principles of staining . Preparation of bacterial smears for light microscopy: Fixation, Simple staining (positive and negative), differential staining (Gram's staining and acid – fast staining), structural staining (Capsule, Flagella, Cell wall and Endospore of bacteria), nuclear staining. Wet mounting method – staining of algae and fungi. Hanging drop method.

References Books:

1. Advances in Chromatography. Eli Grushka and Nelu Grinberg (2007). Publisher: CRC: 1st edition. ISBN-10: 1420060252, ISBN-13: 978-1420060256, Volume 46.
2. Understanding NMR Spectroscopy. James Keeler (2005). Publisher: Wiley; 1st edition ISBN-10: 0470017872, ISBN-13: 978-0470017876.27
3. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM. Ray F. Egerton (2005). Publisher: Springer; 1st ed.. ISBN-10: 0387258000, ISBN-13: 978-0387258003.
4. Fundamentals of Light Microscopy and Electronic Imaging. Douglas B. Murphy (2001). Publisher: Wiley-Liss; 1st edition ISBN-10: 047125391X, ISBN-13: 978-0471253914.
5. Principles and Techniques of Practical Biochemistry. Keith Wilson & John Walker(2000). Cambridge University Press.
6. Introduction to Spectroscopy. Donald L. Pavia, Gary M. Lampman, and George S. Kriz (2000).Publisher: Brooks Cole; 3rd edition. ISBN-10: 0030319617, ISBN-13: 978-0030319617

Semester Fifth

Paper 5.3. BMB 19 (2)- BACTEROLOGY AND PARASITOLOGY

Course Type : DSE **Credits:4**

Duration :3 hrs Continuous/Internal/Assessment : 30 Marks
Semester Assessment : 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

UNIT-I

Bacteriology: Brief introduction to bacteriology, Biological properties of etiological agents of diseases, Pathogenic Mechanisms, Epidemiology and transmission of nosocomial infections. Study of normal flora of human body and its importance to host. Parasitology: Parasitism and vectors Parasitism and Vectors: Brief introduction of Parasitism and Vectors, Host parasite relationship, Transmission, Life cycle, Diagnosis and Treatment.

UNIT-II

Bacterial Diseases: Study of morphological, physiological characteristics, pathogenesis, clinical manifestations, laboratory diagnosis, prevention and treatment of diseases caused by: *Staphylococcus, Streptococcus, Bacillus, Clostridium, Corynebacterium Mycobacterium, Neisseria, Salmonella and Escherichia coli*

UNIT-III

Aim and principles of Bacterial 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.

UNIT- IV

Protozoa: Study of Morphology, Life Cycle, Prevalence, Epidemiology, Diagnosis, Prophylaxis and Treatment of *Entamoeba histolytica, Giardia intestinalis,* Blood flagellates (*Leishmania donovani*) & *Plasmodium sps.*
Cestodes: Study of Morphology, Life Cycle, Diagnosis, Prophylaxis and Treatment of *Taenia solium*. Nematodes: Study of Morphology, Life Cycle, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides, Ancylostoma duodenale & Wuchereria bancrofti*.

UNIT-V

Medical entomology: Role of arthrophods in the spread and causation of parasite diseases. Classification and general characteristics of important insects vectors. Mode of transmission of various diseases.

References Books:

1. Topley & Wlson's: Principles of Bacteriology, Virology and Immunology, 8th Edition.
2. Medical microbiology by Patrick R Murray; Rosenthal KS, Kobayashi GS and P faller MA. Mosby Inc. St Louis Missouri. 2012.
3. Bacterial Pathogenesis; A Molecular Approach by Slayers AA and Whitt DD, ASM Press Washington DC. Arora, D. R and Arora, B. (2001). Medical Parasitology. II Edition. CBS Publications and Distributors. ISBN # 8123915497
4. Chatterjee, K. D. (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd. ISBN #-8123918100 6th edition Saunders Publication, Philadelphia.
5. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
6. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
8. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.

Semester Fifth

Paper 5.4. BMB 20 PRACTICALS V

BIOSAFETY AND IPR

1. Study of components and design of a BSL-III laboratory.
2. Filing applications for approval from biosafety committee (IBSC).
3. Filing primary applications for patents.
4. Study of steps of a patenting process.
5. A case study.

ENTREPRENEURSHIP & START-UPS

1. Preparation of Report on Process selection for new startup
2. Market survey for setting up new Start up
3. Case study on Risks associated with enterprise
4. A Case study on Technology life cycle of any successful entrepreneur.
5. A case study based on Unique selling Proposition (USP) of any successful enterprise

SOIL AND AGRICULTURE MICROBIOLOGY

1. Study soil profile
2. Study microflora of different types of soils.
3. Isolation and identification of fungi from soil.
4. Isolation and enumeration of bacteria from soil by serial dilution method
5. Rhizobium as soil inoculants characteristics and field application
6. Azotobacter as soil inoculants characteristics and field application
7. Design and functioning of a biogas plant
8. Isolation of cellulose degrading organisms
9. Study of VAM.
10. Study of the plant diseases: Gram staining of citrus canker specimen and mounting of fungal specimens

MICROBES IN SUSTAINABLE DEVELOPMENT

1. Study soil profile
2. Study microflora of different types of soils
3. *Rhizobium* as soil inoculants characteristics and field application
4. *Azotobacter* as soil inoculants characteristics and field applications
5. Design and functioning of a biogas plant
6. Isolation of cellulose degrading organisms

TOOLS AND TECHNIQUES IN MICROBIOLOGY

1. Study of organization and working of microscopes.
2. Optical Microscopes : dissecting and compound

3. Exposure to organization and working of phase contrast microscope and electron microscopes.
4. Sterilization of glassware and media (use of autoclave). Asepticstransfer.
5. Study and use of micro analyticaltechniques.
6. Separation of sub- cellular organelles (use of centrifuge and othertechniques)
7. Separation of cell organelles by sucrosegradient.
8. Electrophoresis : SDS – PAGE
9. Thin layer chromatography
10. Paper chromatography : circular and vertical
11. Visit to microbiological laboratory for exposure of various advanced tools and techniques.

BACTEROLOGY AND PARASITOLOGY

1. Identification and differentiation of *Staphylococcus sp* and *Streptococcus sp.*
2. Differentiation of streptococci on the basis of haemolysis on blood agar.
3. Perform antibacterial sensitivity by Kirby-Bauer method
4. Determination of minimal inhibitory concentration (MIC) of an antibiotic.
5. Determination of normal Microflora of skin
6. To identify following protozoa/heliminths in fecal samples: *Entamoeba histolytica, Giardia intestinalis, Taenia solium, Hymenolepis nana, Ascaris lumbricoides, Ancylostoma duodenale & Entrobius vermicularlis*
7. To study the morphological characteristic of blood parasites *Plasmodium vivax & Plasmodium falciparum* through permanent slides/microphotographs

Semester Sixth

Paper 6.1. BMB 21 (1)- Bioinformatics & Biostatistics

Course Type : DSE **Credits:4**

Duration :3 hrs
Continuous/Internal/Assessment : 30 Marks
Semester Assessment : 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

UNIT-I

Basics of computers, Types of computers and generations, operating systems, memory types, Introduction to MS Office: word,Excel,Power point. Types of networking- LAN, WAN and VPN, Benefits of internet.

UNIT-II

Introduction to Bioinformatics and Biological Databases - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways,
Mode of data storage - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB.

UNIT-III

Basic concepts in Statistics: Terms and Definitions in Statistics, Collection of Data, Types of variables: Continuous and discrete, Frequency Distribution, Classification of tabulation.

UNIT-IV

Sample and Sampling techniques.
Measurements of central tendency: Mean, Median, Mode
Standard Deviation, Variance, Chi- Square test.

UNIT-V

Correlation: types and methods.
Regression analysis, multiple linear regressions.
Standard error, Concept of Hypothesis, t-test, One way ANOVA.
Probability: Definition and basic formula and theories.

References Books:

1. Snedecar, G.W. and Cochram WG. (1967) Statistical Methods, OxfordPress.
2. Danial, W.W. (1995): Biostatistics : A Foundation for analysis in Health Sciences (6^{th} Ed.) John Wiley.780pp
3. Cotton T. (1974); Statistics in Medicine, Little Brown,Boston.
4. Compbell, R.C. (1989): Statistics for Biologists, Cambridge University Press. 464p

Semester Sixth

Paper 6.1. BMB 21(2)- Microbial Biotechnology

Course Type: DSE **Credits: 4**

Duration :3 hrs
Continuous/Internal/Assessment : 30 Marks
Semester Assessment : 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

UNIT-I

Microbial Biotechnology: Scopes and challenges; Industrial microorganisms: Growth metabolism regulation, Isolation and preservation of industrially important microorganisms. Production of metabolites: Microbial production and applications of primary metabolites: Citric acid, Ethanol, L Glutamic acid, L Lysine,Vitamins B; Industrially important microbial enzymes: Types, mode of action and industrial applications of microbial amylases and proteases

UNIT-II

Production of important microbial products: Antibiotics (Penicillin and Streptomycin), Ergot alkaloids; Biotransformations of steroids: Hydroxylations and dehydrogenation, Sterol biotransformations; Probiotics, prebiotics and synbiotics: Products of Probiotics, health benefits, Vaccines production by bacteria.

UNIT-III

Microbes in agro biotechnology; microbial pesticides; integrated pest management, nano fertilizers, environmental biotechnology; food production involving microorganisms and their products, microbes in medical biotechnology, microbes in alternative energy, microbes in detergent, textile industries.

UNIT-IV

Plastics vs. Bioplastics; History, chemical nature and production of bioplastics, health benefits of bioplastics; Microplastics: Microbial degradation of microplastics; Bioterrorism/bioweapons – History, microbes used an bioterrorism, threats and policy to control bioterrorism.

UNIT-V

Biosurfactants: History, Characteristics, Sources, types and production, application in Agriculture, food, medical and paper industries; Biosensors: History, types, characteristics and Application in food quality monitoring, soil quality monitoring, water quality monitoring, environmental monitoring and environmental monitoring.

References Books:

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.
3. Swartz, J. R. (2001). Advances in *Escherichia coli* production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.
5. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press
6. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
7. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.
8. R.C. Dubey (2014), Advanced Biotechnology, S. Chand, New Delhi, ISBN: 9788121942904
9. Alexander N. Glazer (2012), Microbial Biotechnology: Fundamentals of Applied Microbiology, Cambridge University Press, ISBN : 9780511811227

Semester Sixth

Paper 6.2. BMB 22 (1)- Biophysics and Instrumentation

Course Type : DSE **Credits:4**

Duration :3 hrs Continuous/Internal/Assessment : 30 Marks
Semester Assessment : 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

UNIT-I

Bioenergetics: concept of energy,enthalpy in biological systems.Free energy and equilibrium in biological systems. Scope and importance of biophysics in microbiology.

UNIT-II

Membrane conductivity, Diffusion, Active transport, Osmosis, Diffusion pressure deficit, Biosorption, Electrical properties of biological compartments, Electrochemical gradients, membrane potentials.

UNIT-III

Radioactivity: types,detection,safety measure. Application of radioisotopes in microbiology. Radioimunoassay. Radioactive tracer techniques, Autoradiography.

UNIT-IV

Raman spectroscopy: Raman effect, Raman spectra, Nuclear magnetic Resonance spectroscopy - Basic principles.X ray Crystallography.

UNIT-V

Principle, construction and working of GM counter. Scintillation Counter (Solid and liquid). Elucidation of intact biological structures in living organisms: Ultrasound. Optical filters, Computerized Axial Tomography, Electrocardiography, Electro- encephalography.

Reference Books:

1. Fundamentals and Techniques of Biophysics and Molecular Biology" by Pranav Kumar.
2. Biophysics: A Physiological Approach" by Patrick F Dillon.
3. Fundamental of Biophysics By , S. K. Agrawal.
4. Bioinstrumentation by Wiley.

Semester Sixth

Paper 6.2. BMB 22 (2)- Fundamentals of Applied Microbiology

Course Type : DSE **Credits:4**

Duration :3 hrs
Continuous/Internal/Assessment : 30 Marks
Semester Assessment : 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

UNIT-I

Basics in Medical microbiology : Infectious diseases overview, Medically important microbes, Microbial diseases - sources, route of transmission, Pathogenesis - adhesion, invasion, host cell damage, release of pathogens. Microbial virulence and virulence factors - Signs and symptoms of microbial diseases, Treatment, Prevention and control of microbial infections, Immune response to microbial diseases, Diagnosis of microbial diseases - Collection, transport and preliminary processing of clinical samples.

UNIT-II

Introduction to soil and agriculture microbiology: Distribution of soil microorganisms in soil, Factors influencing the soil micro-flora, Role of microorganisms in soil fertility, Biological nitrogen fixation, Biofertilizers, Bio-pesticides, Diseases of agricultural plants.

UNIT-III

Industrial microbiology: Process of fermentation, Stirred tank fermenter, Industrial fermentation of alcohol, microbial bioconversions, enzyme and antibiotic production by microorganisms.

UNIT–IV

Food Microbiology: Importance of food and dairy microbiology, Primary sources of microorganisms in foods, Food spoilage & contamination, Principles of food preservation, Food borne diseases, Microbiology of milk & dairy products.

UNIT-V

Nutraceuticals: Probiotics, Prebiotics, Synbiotics, PUFA, Antioxidants, Vitamins, Polyphenols, SCP, Applications.

References Books:

1. Nehra, S. (2013). Applied Microbiology. 1st Edition. Pointer Publishers Watson, D. (2016). Applied microbiology and biotechnology.1stEdition.
2. Syrawood Publishing House Sastry, A.S. and Bhat, S. (2023). Essentials of medical microbiology. 4th Edition. Jaypee brothers med Pub Pvt Ltd.
3. Mishra, B.B., Nayak, S.K., Mohapatra, S., & Samantaray, D. (Eds.). (2021). 1st Edition. Environmental and agricultural microbiology: applications for sustainability.
4. John Wiley & Sons. Waites, M. J., Morgan, N. L., Rockey, J. S., &Higton, G. (2009). 1st Edition. Industrial microbiology: an introduction.
5. John Wiley & Sons. Glick, B. R., & Patten, C. L. (2022).1st Edition. Molecular biotechnology: principles and applications of recombinant DNA. John Wiley & Sons.

Semester Sixth

Paper 6.3. BMB-23(1) Industrial Microbiology

Course Type : DSE **Credits:4**

Duration :3 hrs
Continuous/Internal/Assessment : 30 Marks
Semester Assessment : 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

UNIT-I

Brief history and developments in industrial microbiology. Types of fermentation processes. Physicochemical standards used in fermentors /Bioreactor. Components of a typical bio-reactor, Types of bioreactors**.**

UNIT-II

Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration. Primary and secondary screening of industrial strains, preservation and maintenance of industrial strains, strain improvement, media.

UNIT-III

Fermentation in batch culture: Microbial growth kinetics, measurement of growth (cell number direct and indirect method) Continuous culture system, Aeration, Agitation, Oxygen transfer kinetics. Sterilization.

UNIT-IV

Downstream processing: Filtration, Precipitation, cell disintegration, solvent extraction, chromatographic separation, solvent recovery, drying, crystallization.

UNIT-V

Biotransformation: Development of inoculum, Industrial production of Penicillin, ethyl alcohol, acetic acid, amylase and vitamin B_{12}, Single cell protein.

References Books:

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2ndEdition. Panima Publishing Company, New Delhi.
2. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India.
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. Pearson Education.
4. Willey JM, Sherwood LM AND Woolverton CJ (2013), Prescott, Harley and Klein's Microbiology.9thEdition. McGraw Hill Higher education.
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

Semester Sixth

Paper 6.3. BMB-23(2)- Microbial Quality Control in Industries

Course Type : DSE **Credits:4**

Duration :3 hrs Continuous/Internal/Assessment : 30 Marks
Semester Assessment : 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Unit-I

Biohazards- definition, sources, types, risk group. Risk assessment of biohazardous agents. Good laboratory practices and Good microbiological practices. Biosafety cabinets: working of biosafety cabinets, using protective clothing. Biosafety levels- procedurs and practices, safety equipment and laboratory facilities for BSL1, BSL-2, BSL-3 and BSL4. Discarding biohazardous waste- Methodology of disinfection, autoclaving and incineration.

Unit-II

Microflora of Air: Bioaerosols. Airborne microorganisms (bacteria, viruses, fungi) and their impact on human health and environment. Significance air microflora in food and pharma industries and operation theatres. Aeroallergens. Collection of air sample and analysis: Bioaerosol sampling, air samplers and methods of analysis. Identification characteristics of bioaerosols. Bioaerosols inactivation mechanisms- UV light, desiccation, incineration.

Unit- III

Pathogenic Microorganisms of Importance in Food & Water: SOP for water and food sampling. Culture media to detect specific microorganisms- XLD agar, Salmonella Shigella agar, Manitol salt agar, EMB agar, McConkey agar and Saboraud agar. Methods of analysis for foods and water: Aerobic Plate Count (APC), Most Probable Numbers (MPN), Direct Microscopic Counts (DMC). Immunological and molecular methods of detection of microbial contaminants in food and water.

Unit -IV

Introduction to food safety. Role of microbiologist in food industries. Food Safety and Standards Act, 2006- scope, salient features and general principles. Food Safety Management Systems: GMP and GHP. HACCP- principles, flow diagrams, applications. FSSAI- structure, statutary power, initiatives, functions, landmark cases and challenges. FDA and BIS. BIS standards for common foods and drinking water.

Unit-V

Basic idea about pharmaceutical products (bulk drugs/ dosage forms, vaccines, diagnostics) and quality requirements. Quality Assurance (QA) and validation in Pharmaceutical Industry. Good

Laboratory Practice (GLP), Good Manufacturing Practice (GMP), Quality Control (QC), Regulations, Practices & Procedures, Statistical validation. Quality Management System.

References Books:

1. Atlas, R. M. and Bartha, R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
2. Baird, R. M., Hodges, N. A. and Denyer, S. P. (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.
3. da Silva, N., Taniwaki, M. H., Junqueira, V. C., Silveira, N., Nascimento, M. S. and Gomes, R. A. R. (2012) Microbiological Examination Methods of Food and WaterA Laboratory Manual, CRC Press.
4. Food Safety and Standards Authority of India (FSSAI) Food Safety and Standards Authority of India, Government of India. Retrieved 2 April 2012.
5. Garg, N., Garg, K. L. and Mukerji, K. G. (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
6. Harrigan, W. F. (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press.
7. Hurst, C. J, Crawford, R. L., Garland, J. L. and Lipson, D. A. (2007) Manual of Environmental Microbiology, 3rd edition, ASM press.
8. Jay, J. M., Loessner, M. J., Golden, D. A. (2005) Modern Food Microbiology, 7th edition. Springer.
9. Maier, R. M., Pepper, I. L. and Gerba, C. P. (2009). Environmental Microbiology. 2nd edition, Academic Press.

Semester Sixth

Paper 6.4. BMB 24 PRACTICALS VI

BIOINFORMATICS AND BIOSTATISTICS

1. Creating charts in excel using different data.
2. Design a worksheet for numeric entries and perform required calculation.
3. Design a worksheet enter required data and perform aggregate function like sum, average, count etc.
4. Changing settings of keyboard, mouse and display.
5. Perform file operation like copy, save, rename, delete using window explore.
6. Calculate mean, mode and median
7. Calculate correlation & regression.
8. Pair wise alignment, multiple alignment and data-base searching.
9. Molecular Phylogenetics: Tree construction methods (Distance and character based methods). Suffix tree construction.
10. DNA and protein sequence analysis: online and local tools like EMBOSS package and expasy online prediction tools
11. Programming basics, tool development and software quality assurance and monitoring.

MICROBIAL BIOTECHNOLOGY

1. Study yeast cell immobilization in calcium alginate gels
2. Study enzyme immobilization by sodium alginate method
3. Pigment production from fungi (*Trichoderma / Aspergillus / Penicillium)*
4. Isolation of xylanase or lipase producing bacteria
5. Study of algal Single Cell Proteins
6. Isolation of amylase producing bacteria from soil.
7. Isolation of plastic degrading microbes
8. Isolation and screening of bioplastic producing microorganisms.
9. Demonstration of isolation and production of microbial pesticides
10. Demonstration of vaccine production by bacteria.

BIOPHYSICS & INSTRUMENTATION

1. Principles and application of instruments:
    a. pH meters (digital).
    b. Light and phase contrast microscope.
    c. Colorimeter.
    d. Spectrophotometer (Visible and UV).
    e. GM counter and Scintillation counter
    f. Incubator
    g. Shaker
    h. Laminar flow bench

2. Demonstration of Radioimmunoassay.

FUNDAMENTALS OF APPLIED MICROBIOLOGY

1. Microbiological testing of water for its portability.
2. To study rhizospheric microbial flora (fungal & bacterial).
3. Isolation of crop pathogens from soil.
4. Isolation of bacteria from soil
5. Saccharolytic b) Proteolytic c) Lipolytic microorganisms.
6. Phosphatase test for milk.
7. Determination of thermal death point (TDP) of an organism.
8. Determination of thermal death time (TDT) of an organism.
9. Microbial analysis of food products-bacterial and fungal.
10. Microbial spoilage of refrigerated food.
11. Extracellular enzyme activities-cellulase, protease, lipase and phosphatase
12. Milk microbiology-direct microscopic count-standard platecount-reductase test resazurin/methylene blue).
13. Quantification of microorganisms in air-solid and liquid impingement techniques.

INDUSTRIAL MICROBIOLOGY

1. Microbial fermentation for the production and estimation of amylase.
2. Culturing of Spirulina / Chlorella.
3. Fermenter design and components.
4. Microbial fermentation for the production of Acetic acid.
5. Microbial fermentation for the production of Vitamin B_{12}

MICROBIAL QUALITY CONTROL IN INDUSTRIES

1. Current Good Laboratory Practices (GLP),
2. Good Manufacturing practices (GMP) and Good Documentation Practices (GDP) in Quality Control.
3. Document preparation for QA/QC norms of different sectors.
4. Quality control in Microbiology laboratory, assessment of aseptic condition, evaluation of possible channels of contamination, QA/QC norms for handling pathological samples
5. Assessment of quality of various grains, seeds, food and food products, microbial media, water samples, Assessment of quality of pharmaceutical samples
6. Visit to Pharma, Food and food processing, alcoholic beverage Industries. Tour/Project Report should be submitted.