Semester – V							
Course Code	**Course**	**Hrs- of Instructions/wk**	**Exam Duration hrs**	**Marks allotted**			**Credits**
				CIE	**SEE**	**Total**	
Part –II							
16IMBCC17	**Core 13**: Immunology	4	3	30	70	100	4
16IMBCC18	**Core 14:** Medical Microbiology	4	3	30	70	100	4
16IMBCC19	**Core 15**:Phycology -**Self Study**	1	-	30	70	100	4
16IMBCC20	**Core 16**: Computer Based Test (for Core Courses of Semesters I to V)	-	2	50	-	50	1
16IMBDC01/ 16IMBDC02/ 16IMBDC03	**DSE-Core Elective 1** Pharmaceutical Microbiology/Quality Assurance and Quality control/ Bioethics and IPR	4	3	30	70	100	4
16IMBCC21	**Core Practical- 5** Clinical Microbiology	9	6*	40	60	100	3
16IMBDC04/ 16IMBDC05/ 16IMBDC06	**DSE-Core Elective 1 – Practical:** Pharmaceutical Microbiology/Quality Assurance and Quality control/ Bioethics and IPR	3	3	20	30	50	1
16IMBCC22	**Research Project/ Training/Internship**	In the vacation after semester – IV		50	50	100	6
	Generic Elective-1 From Common UG Pool	2	3	100	-	100	2
	TOTAL	27				**850**	**29**
*3 hrs on day 1 and 3 hrs on second day							

Semester – VI							
Course Code	**Course**	**Hrs- of Instructions/wk**	**Exam Duration hrs**	**Marks allotted**			**Credits**
				CIE	**SEE**	**Total**	
Part –II							
16IMBCC23	**Core 17:** Molecular Biology	4	3	30	70	100	4
16IMBCC24	**Core 18**: Genetic Engineering	4	3	30	70	100	4
16IMBDC07/ 16IMBDC08/ 16IMBDC09	**DSE-Core Elective 2** Advances in Microbiology / Microbiology and Health Care / Fundamentals of Research Methodology	4	3	30	70	100	4
16IMBCC25	**Core Practical- 6** Molecular Biology	9	6*	40	60	100	3
16IMBDC10/ 16IMBDC11/ 16IMBDC12	**DSE-Core Elective 2 Practical** Advances in Microbiology / Microbiology and Health Care / Fundamentals of Research Methodology	3	3	20	30	50	1
16IMBCC26	**Microbiology Outreach Activity**	2	-	50		50	2
	Generic Elective-2 From Common UG Pool	2	3	100	-	100	2
		28				**550**	**20**
Total Marks: 4000							
Total Credit: 140+ 8 = 148							

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

Semester – VII							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit Points**
				CIE	**SEE**	**Total**	
Part- I							
16IMBCC27	**Core 19:** Molecular Cell Biology	4	3	30	70	100	4
16IMBCC28	**Core 20:** Microbial Diversity and Evolution	4	3	30	70	100	4
16IMBCC29	**Core 21:** Mycology and Virology	4	3	30	70	100	4
16IMBDA09/ 16IMBDA10	**DSE- Allied- 5 -** Research Methodology and Experimental Design/ Good Laboratory Practice	5	3	40	60	100	5
16IMBCC30	**Core Practical - 7** Molecular Cell Biology and Diversity	9	9	80	120	200	3
Part – II							
16IMBCE01	**Poster/ Seminar Presentation**	1	-	50	-	50	1
Total		**27**				**650**	**21**
16IMBCE02	**Professional Certification Course**	2	-	REMARKS			**2**
Total		**29**				**650**	**23**

Semester – VIII							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit Points**
				CIE	**SEE**	**Total**	
Part –I							
16IMBCC31	**Core 22:** Bioprocess Technology	4	3	30	70	100	4
16IMBCC32	**Core 23**:Microbial Physiology and Energetics	4	3	30	70	100	4
16IMBCC33	**Core 24**: Basic Instrumentation and Biophysics	4	3	30	70	100	4
16IMBDA11/ 16IMBDA12/ 16IMBDA13	**DSE- Allied-- 6-** Soil and Agriculture Microbiology / Food and Dairy Microbiology / Cell Culture Technology	4	3	30	70	100	4
16IMBCC34	**Core Practical - 8** Fermentation Technology	9	6	60	90	150	3
16IMBDA14/ 16IMBDA15/ 16IMBDA16	**DSE- Allied 6 Practical** Soil and Agriculture Microbiology / Food and Dairy Technology// Cell Culture Technology	2	3	20	30	50	1
	Generic Elective – 3	2	-	100	-	100	2
Part-II							
16IMBCE03	**Research Proposal Writing**	1	-	50	-	50	1
Total		**30**				**750**	**23**

Semester-IX							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit Points**
				CIE	**SEE**	**Total**	
Part-I							
16IMBCC35	**Core 25:** Advanced Molecular Technology	4	3	30	70	100	4
16IMBCC36	**Core 26:** Microbial Genetics	4	3	30	70	100	4
16IMBCC37	**Core 27:** Computer Based Test	-	2	100	-	100	1
16IMBDC13/ 16IMBDC14	**DSE Core -3** Genomics / Bioethics	4	3	30	70	100	4
16IMBCC38	**Core Practical – 9** Advanced Molecular Technology	6	6	60	90	150	3
16IMBDC15/ 16IMBDC16	**DSE Core -3 Practical** Genomics / Bioethics	2	3	20	30	50	1
	Project / Training / Internship	10	-	-	-	-	-
		30				**600**	**17**

Semester – X							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit Points**
				CIE	**SEE**	**Total**	
Part – I							
16IMBCC39	**Core 28**: Environmental Biotechnology	4	3	30	70	100	4
16IMBCC40	**Core 29:** Forensic Microbiology	4	3	30	70	100	4
16IMBCC41	**Core – 30:** Advanced Diagnostic Techniques	4	3	30	70	100	4
16IMBDC17/ 16IMBDC18	**DSE Core 4**: Proteomics/ Bio-entrepreneurship	4	3	30	70	100	4
16IMBCC42	**Core Practical 10** Diagnostic Techniques	6	6	60	90	150	3
16IMBDC19/ 16IMBDC20	**DSE- Core-- 4**: **Practical** Proteomics/Bio-entrepreneurship	2	3	20	30	50	1
16IMBCC43	**Project / Internship/Training and Viva Voce**	6	-	120	80	200	12
		30				**800**	**32**
					TOTAL	**2800**	**95**

FOR SEMESTER VII - X

- **TOTAL MARKS & CREDIT DISTRIBUTION**

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

- **PART – I : CORE, DSE**

CORE COURSES [Theory]

S. No	Semester	Course code	Course
1	VII	16IMBCC27	Core 19: Molecular Cell Biology
2		16IMBCC28	Core 20: Microbial Diversity and Evolution
3		16IMBCC29	Core 21: Mycology and Virology
4	VIII	16IMBCC31	Core 22: Bioprocess Technology
5		16IMBCC32	Core 23:Microbial Physiology and Energetics
6		16IMBCC33	Core 24: Basic Instrumentation and Biophysics
7	IX	16IMBCC35	Core 25: Advanced Molecular Technology
8		16IMBCC36	Core 26: Microbial Genetics
9		16IMBCC37	Core 27: Computer Based Test
10	X	16IMBCC39	Core 28: Environmental Biotechnology
11		16IMBCC40	Core 29: Forensic Microbiology
12		16IMBCC41	Core 30: Advanced Diagnostic Technology

CORE COURSES [Practical]

S. No	Semester	Course code	Course
1	VII	16IMBCC30	**Core Practical – 7 –** Molecular Cell Biology and Diversity
2	VIII	16IMBCC34	**Core Practical – 8-** Fermentation Technology
3	IX	16IMBCC38	**Core Practical – 9 –** Advanced Molecular Technology
4	X	16IMBCC42	**Core Practical – 10** Diagnostic Techniques

OTHER CORE COURSES

S. No.	Semester	Course Code	Course
1	IX - X	16IMBCC43	Internship / Training / Project and Viva Voce

DSE CORE COURSES - [Theory & Practical]

S. No	Semester	Theory		Practical	
		Course code	Course	Course code	Course
1.	IX	16IMBDC13	Genomics	16IMBDC15	Genomics
		16IMBDC14	Bioethics	16IMBDC16	Bioethics
2.	X	16IMBDC17	Proteomics	16IMBDC19	Proteomics
		16IMBDC18	Bioenterpreunuership	16IMBDC20	Bioenterpreunuership

DSE ALLIED COURSES - [Theory & Practical]

S. No	Semester	Theory		Practical	
		Course code	Course	Course code	Course
1.	VII	16IMBDA09/ 16IMBDA10	Research Methodology and Experimental Design / Good Laboratory Practice	-	-
2.	VIII	16IMBDA11/ 16IMBDA12/ 16IMBDA13	Soil and Agriculture Microbiology / Food and Dairy Technology / Cell Culture Technology	16IMBDA14/ 16IMBDA15/ 16IMBDA16	Soil and Agriculture Microbiology / Food and Dairy Technology / Cell Culture Technology

GENERIC ELECTIVE:

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

S. No	Semester	Course
1.	VIII	Bioinformatics and Biostatistics

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

S. No	Semester	Course code	Course
1	VII	16IMBCE01	Poster/ Seminar Presentation
2	VII	16IMBCE02	Professional Certification course
2	VIII	16IMBCE03	Research Proposal Writing

5 Years Integrated B. Sc - M.Sc. Microbiology (2016-2017)

SEMESTER - V

16IMBCC17	**Core 13: Immunology**	**4hrs/week**	**4 Credits**

Course Objectives:

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

1. Demonstrate a comprehensive and practical understanding of basic immunological principles involved in protection mechanism.
2. Differentiate between innate and adaptive immunity, primary and secondary responses and identify the role of antigen presenting cells, lymphocytes, and phagocytic cells in immune responses.
3. Differentiate between humoral and cell mediated immunity.
4. Discuss Dysfunctional immunity and its consequences, Process of infection and vaccination
5. Principle and applications of various immune reactions in research and diagnosis

Unit 1: Immunity and Immunogen (10hrs)

- Types of immunity: Natural, Acquired, herd, Innate, specific
- Cells and organs of immune system : An overview
- Primary response and generation of memory
- Antigen
  a. Immunogenicity versus antigenicity
  b. Factors influencing Immunogenicity
  c. Adjuvant, Epitopes and Haptens
  d Antigen processing and presentation (Endogenous and Exogenous Antigens)

Unit 2: Antibody (10hrs)

- Antibody
  a. Basic structure of Antibody
  b. Immunoglobulin classes and their Biological activities.
  c. Epitopes and Receptors on immunoglobulin molecule

- Antibody Diversity and Clonal Selection Theory
- Overview of Monoclonal Antibody

Unit 3: Dysfunctional Immunity **(10hrs)**

- Immunodeficiency Diseases
- Hypersensitivity
- Autoimmune diseases
- Overview of Tumor immunity
- Overview of Transplantation immunity

Unit 4: Infection and Prophylaxis **(10hrs)**

- Introduction to the normal flora of healthy human host
- Host –microbe interactions
    a. Process of Infection,
    b. Pathogenicity
    c. Virulence and infection
    d. Microbial adherence
    e. Penetration of epithelial cell layers,
    f. Events in infection following penetration
    g. Microbial virulence factors
- Vaccines: Conventional and Modern

Unit - 5: Haematology and Serology **(10hrs)**

- Haematology – Study of Blood and Blood groups
    a. Discovery of human blood group system
    b. Blood coagulation
    c. Principle, significance and procedure of blood transfusion
- Serology - In vitro antigen: antibody reaction
    a. Strength of antigen – antibody reaction: Antibody affinity and avidity
    b. Precipitation (in fluid and gel, immunoelectrophoresis)

c. Agglutination (Haemagglutination, Bacterial Agglutination, Passive Agglutination and agglutination inhibition)
d. Radioimmunoassay
e. ELISA
f. Western Blot
g. Immunofluoroscence

Text Books:

- J.Kuby, R. A. Goldsby , T.J.Kindt , B.A. Osborne (2013). Immunology 7th edition. W.H. Freeman and Company , New York
- R. M. Atlas (2015). Principles of Microbiology. 2nd edition. Wm.C.Brown Publishers
- Prescott , Harley , Klein (2007). Microbiology 5th edition. McGraw-Hill Publishers
- P.M. Lyolyard , A. Whelan, M.W. Fanger. (2011) Instant Notes in Immunology. 3rd edition.
  Garland Science Taylor and Francis Group, Newyork

Reference Books:

- C.A.Janeway, P.Travers, M. Walport, M.J. Shlomchick. (2005). Immunology – the immune system in health and Diseases. 6th edition. Garland Science Taylor and Francis Group, Newyork
- K.Murphy, P.Travers, M. Walport. (2008). Janeway's Immunology. 7th edition. Garland Science Taylor and Francis Group, Newyork
- I.Roitt.(1977). Roitt's Essential Immunology, 9th edition Blackwell Science
- J.M.Cruse, R.E.Lewis. (2009). Illustrated Dictionary of Immunology. 3rd edition. CRC Press Taylor and Francis Group, New York.
- A. K. Abbas, A. H.H.Lichtman, S.Pillai. (2017).Molecular and Cellular Immunity. 9th edition. Elsevier

16IMBCC18	Core 14: Medical Microbiology	4 hr/week	4 Credits

Course Objectives:

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

1. Appreciate and understand the concept of medical microbiology.
2. Understand and explain epidemiology of the diseases caused by the various pathogens
3. Understand causes, treatment, pathogenicity of viruses, bacteria fungi and parasites

Unit 1: Epidemiology and host –parasite relationship (09hrs)

- Definitions: Signs, symptoms and syndrome of disease, stages of infectious diseases-incubation period, prodromal phase, Invasive phase, decline phase
- Infection and their types
- Bacteraemia, septicaemia, pyamia, toxaemia and Viremia
- Epidemic, Endemic, Pandemic, Zoonotic and Exotic
- Dynamics of disease transmission: Causative or etiological agents, sources of
- reservoir of infection

Unit 2: Study of pathogenic organisms: Morphology, cultural characteristics, biochemical characteristics, serology, lab diagnosis and treatments (10hrs)

- Enteric pathogens (Shigella and Salmonella)
- Pyogenic organisms – Staphylococcus and Streptococcus
- Mycobacterium tuberculosis and Mycobacterium leprae
- Rickettsia

Unit 3: Study of pathogenic organisms: Morphology, cultural characteristics, serology & lab diagnosis (09hrs)

- Parasites : Plasmodium, Giardia and entamoba
- Fungus : Candida and Aspergillus
- Spirochetes – Treponema, Leptospira
- Metazoan diseases – Ascariasis and Filariasis

Unit 4: Viral diseases and their diagnosis with treatments (10hrs)

- Airborn viral diseases, symptoms diagnosis and treatments
- Hepatitis: Hepatitis A & B viruses
- Influenza and Measles
- AIDS and Ebola viruses

Unit 5: Advanced techniques (10hrs)

- Chemotherapeutic and antimicrobial agents
- Bioavailability of Drug
- Collection, transport and preliminary processing of Clinical pathogens
- Rapid methods of identification, Molecular methods of identification

Text Book

1. C. K. J. Paniker, Anathanarayan and Paniker's text book of Microbiology (2013) 8th Edition, Orient Longman

Reference Book

1. Tortora, G.J., Funke, B.R., Case, C.L, 1992. Microbiology: An introduction 5th Edition, Benjamin Pub. Co. NY
2. Chakraborty, P., 2003 A textbook of Microbiology, 2nd Edition New Central Book Agency, India.
3. Samuel Baron, Medical Microbiology. Fourth edition (1996) University of Texas Medical Branch of Galvesion
4. K. Ryan and C. G. Ray, Sherri's Medical Microbiology: an Introduction to infectious diseases. (2004) McGraw hill Publication 4th edition

16IMBCC19	Core 15: Phycology (Self Study)	1hrs/week	4 Credits

Course Objectives:

The course entitled as above is designed to

1. Enlighten the students about general features of algae ; their distribution;
2. Acquire a consolidated overview on different major groups of algae
3. Recognize the importance of algae from economic values
4. Understand the major differences among varied range of thallus organization and pigment system

Unit 1: General account **(10hrs)**

- General characteristics & distribution
- Classification & range of thallus organization
- Cell components & Pigment system
- Motility & Mode of reproduction
- Economic importance

Unit 2 : Blue Green algae **(10hrs)**

- General features & distribution
- Major groups upto class
- Range of vegetative structure
- Cell structure & special features (heterocyst, hormogone, akinete)
- Mode of reproduction & Economic importance

Unit 3 : Diatoms **(09hrs)**

General characteristics & distribution

- Cell structure and its components
- Motility and mode of reproduction
- Economic importance of diatoms

Unit 4: Green algae (09hrs)

- General characteristics & distribution
- Classification & cell structure
- Pigment system & motility
- Mode of reproduction
- Economic importance

Unit 5 : Brown & Red algae (10hrs)

Highlights on General features

- Major groups upto class
- Cell structure and Pigment system
- Mode of reproduction & Economic importance

Text Books:

- Pelczar, M.J., Chan, E.C.S., Kreig,N.R. (1993).Microbiology, 5th Edition, New Delhi; Tata Mc Graw Hill Publishing Co. Ltd.
- Sundara Rajan S (2003). College Microbiology. Volume 1 & 2. Revised Edition, Vardhana Publications, Bangalore
- Prescott, L.M., J.P. Harley and D.A .Klein (1993). Microbiology, 5th Edition,WM, C Brown Publishers.

Reference Book:

- Dubey RC and Maheswari DK (2005). A Text book of Microbiology. S.Chand &Company Ltd., New Delhi.
- O. P. Sharma (1996) . Textbook of Algae, 1st Edition, McGraw-Hill Education New Delhi

16IMBDC01	DSE-Core 1 -Pharmaceutical Microbiology	4hrs/week	4Credits

Objectives:

1. For better perception in pharmaceutical microbiology standards
2. To understand industrial requirement of microbial technology
3. To get better opportunities in pharmaceutical industry/laboratories/ Research institutes
4. To be equipped with standard operating procedures as per regulatory authorities

Unit 1: Introduction to pharmaceutical industry (9hrs)

- Role of a Microbiology in a pharma industry
- Good Laboratory Practices (GLP) in pharmaceutical industry.
- Microbiology Laboratory and standards in industry
- Regulatory practices and policies: FDA and NGCMA.

Unit 2: Processes in Pharmaceutical Industry (10hrs)

- Good manufacturing practices and Good microbiology laboratory practices.
- QA and QC in industry
- Concepts of pharmaceuticals, biologics and biopharmaceuticals
- Types of pharmaceutical microbiology laboratories : Sterile & Nonsterile
- SOP, clean room, zones, microbial filters, media

Unit 3: Quality control: Microbiology Laboratory (10 hrs)

- Microscopic techniques for particulate matter
- Antimicrobial testing of pharmaceutical products
- Microbial Limit test, Water analysis
- Bacterial Endotoxin Testing (BET)
- Environmental Monitoring

Unit 4: Microbial control in pharmaceutical industries (10hrs)

- Disinfection: Classification, mode of action, factors influencing disinfectants
- Sterilization: Introduction, significance
- Microbiological assessment of various pharmaceutical products
- Fumigation, Growth Promotion test, Biological indicators, chemical Indicators

Unit 5: Role of microbes in pharmaceutical formulations (9 hrs)

- Drug formulations, Carriers and delivery systems, targeted drug delivery,
- Application of microbial enzymes in pharmaceutical industry
- Pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase).
- Microbial production and spoilage of pharmaceutical products

Text Book

1. Vyas S. P., Dixit V. (2007) Pharmaceutical Biotechnology, CBS Publishers & Distributors
2. Quality Assurance in Microbiology by Rajesh Bhatia, Rattan Lal Ihhpunjani. CBS publishers & distributors, New Delhi.
3. Good manufacturing practices for Pharmaceuticals By Sydney H. Willing, Murray M. Tuckerman, Willam S. Hitchings IV. Second edition Mercel Dekker NC New York

Reference Book

1. Stephen P. D., Norman A. H., Sean P. G., Brendan F. G. (2011) Hugo & Russell Pharmaceutical Microbiology 8th Ed. Wiley-Blackwell Publishing house
2. John S. Wolfson and David C. Hooper, (1989) Quinolone antimicrobial agents. American Society for Microbiology, Washington.
3. Cooper M. S. (1972) Quality control in the Pharmaceutical Industry Vol.2 Academic Press Inc.
4. Sidney H.W. Murray M. Tuckerman, W., S. Hitchings IV. Mercel D.,(2007) Good Manufacturing Practices for Pharmaceuticals, Second Edition, NC New York

16IMBDC02	DSE-Core 1 Quality Assurance and Quality Control	4hrs/week	4Credits

Objectives:

1. For better perception in pharmaceutical microbiology standards
2. To understand industrial requirement of microbial technology
3. To get better opportunities in pharmaceutical industry/laboratories/ Research institutes
4. To be equipped with standard operating procedures as per regulatory authorities

Unit 1: Total Quality Management System (8hrs)

- Basic concept of Total quality management
- Importance of quality
- Components of TQM
- Advantages of quality

Unit 2: Quality Assurance (10hrs)

- Hazard and risk analysis in pharmaceutical products
- Personnel's in Quality assurance
- Functions of quality assurance
- Organizational setup in QA

Unit 3: Quality Control

- Definition : Quality Control and its types in various industries
- Principles of quality control
- Methods of quality control in food industry, Pharma industry
- Corrective and Preventive actions

Unit 4: Quality Audits and inspections (10hrs)

- Self inspections and internal assessments
- Audits : Purpose audits and its types
- Regulatory Compliance

Unit 5: Regulatory guidelines on Quality systems in industry (10 hrs)

- Regulatory bodies in industries
- FDA, USFDA, FSSAI and ISO
- Quality Standards in India : ISI, AGMARKS
- Commodity based standards

Text Book

1. Vyas S. P., Dixit V. (2007) Pharmaceutical Biotechnology, CBS Publishers & Distributors
2. Quality Assurance in Microbiology by Rajesh Bhatia, Rattan Lal Ihhpunjani. CBS publishers & distributors, New Delhi.
3. Good manufacturing practices for Pharmaceuticals By Sydney H. Willing, Murray M. Tuckerman, Willam S. Hitchings IV. Second edition Mercel Dekker NC New York

Reference Book

1. Stephen P. D., Norman A. H., Sean P. G., Brendan F. G. (2011) Hugo & Russell Pharmaceutical Microbiology 8th Ed. Wiley-Blackwell Publishing house
2. John S. Wolfson and David C. Hooper, (1989) Quinolone antimicrobial agents. American Society for Microbiology, Washington.
3. Cooper M. S. (1972) Quality control in the Pharmaceutical Industry Vol.2 Academic Press Inc.
4. Sidney H.W. Murray M. Tuckerman, W., S. Hitchings IV. Mercel D.,(2007) Good Manufacturing Practices for Pharmaceuticals, Second Edition, NC New York

16IMBDC03	DSE-Core 1 Bioethics and IPR	4hrs/week	4Credits

Objectives

- This part of the syllabus helps the students to understand the ethical, social, legal aspects in biology and bio containment

Unit 1: Bioethics **(8hrs)**

- Bioethics - legal and socioeconomic impacts
- ethical concerns of biological research and innovation,
- Bioethics committees and guidelines for biosafety, stem cell research, RCGM

Unit 2: Intellectual Property Rights **(10hrs)**

Intellectual property rights-Definition, Types

- Patent
- Copyright
- Trade mark
- Trade Related Aspects in Intellectual Property(TRIPS)
- General Agreement on Tariffs and Trades (GATT)
- Plant Breeders Rights (PBR)
- World Trade Organization (WTO)

Unit 3: Patents and Patent Laws **(10hrs)**

- Patenting laws-Legal development
- Patentable subjects and protection in biology
- The patenting of living organisms

Unit 4: Biosafety **(10hrs)**

- GLP - Containment facilities
- Biosafety levels - Genetically modified organisms and its release

- Genetically modified foods
- Biosafety guidelines in India
- International guidelines

Unit 5: Biodiversity **(9hrs)**

- Elements of Biodiversity
- Ecosystem Diversity
- Genetic Diversity
- Species Abundance & Diversity

Text Books:

1. Sasson Albert, Biotechnologies and Development, UNESCO Publications, 1988.
2. Sasson Albert. Biotechnologies in developing countries present and future, UNESCO publishers, 1993.

Reference book

1. Singh K, Intellectual Property rights on Biotechnology2010, BCIL, New Delhi,

2. Shaleesha A. Stanley, Bioethics, Wisdom educational service, 2008, Wisdom Educational Service

3. Beier, F.K., Crespi, R.S. and Straus, T. 1985 Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi,

4. Biotechnology by U. Sathyanarayana, 2009, Books and allied (p) Ltd

5. Biotechnology by B.D.Singh, 2009 Kalyani publishers,

16IMBCC21	Core Practical- 5 Clinical Microbiology	9hrs/week	3 Credits

Objectives:

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

1. Perform basic test of clinical microbiology.
2. Screen and characterize some pathogens
3. Understand causes, treatment, pathogenicity of various parasites.

List of Practicals:

1. Study of serological and hematological reactions
    a. Agglutination (blood grouping, Serodiagnosis of enteric fever by Widal test)
    b. Serodiagnosis of syphilis by RPR Test
    c. Total count of RBC and WBC
    d. Differential count of WBC
    e. Haemoglobin estimation by Sahli's method
    f. Bleeding time by filter paper technique and clotting time by capillary method
    g. Erythrocyte Sedimentation Rate (ESR-demonstration)
2. Blood Chemistry
    a. Blood sugar estimation by GOD / POD method
    b. Blood urea by DAM method
    c. Serum bilirubin estimation
    d. Cholesterol estimation
    e. Ouchterlony Double Diffusion (Demonstration)
3. Physical, Chemical and Microscopic examination of Clinical samples – urine, stool, pus, Sputum
4. Isolation, identification of following pathogens from clinical Samples:E. coli, Salmonella spp., Pseudomonas spp., Proteus spp., Shigella spp., Staphylococcus spp,
5. Streptococcus spp.(for identification use of keys as well as Bergey's Manual is recommended)

6. Study of growth characters of isolated pathogens on following media: Mannitol Salt Agar, Wilson Blair agar, Salmonella Shigella agar, Glucose azide medium, Cetrimide agar, TSI agar

Reference book

1. Broude AI: Medical Microbiology and Infectious Diseases, WB Saunders Co.
2. Jawetz, Melnick & Adelberg's: Medical Microbiology, 26th Edition, Mc Graw Hill Companies, a LANGE medical book.
3. Chapel and Haeney: Essentials of Clinical Immunology, Blackwell Scientific Publications.
4. Forbes BA, Sahm DF and Weissfeld AS: Bailey & Scott's Diagnostic Microbiology, Mosby

16IMBDC04	DSE-Core 1 –Practical: -Pharmaceutical Microbiology	3hrs/week	1Credits

Course Objectives:

The student shall be able to:

1. Acquire skills to examine microbial load of pharmaceutical products
2. Understand the role of microbes in drugs
3. Identify different microbes associated with products, enumerate them and understand their role
4. Evaluate different parameters affecting pharmaceutical product quality.

List of Practicals

1. Sterility testing by using *B. sterothermophilus / B. subtilis*.
2. Testing for microbial contamination. Microbial loads from syrups and suspensions
3. Determination of antimicrobial activity of chemical compounds (like phenol, resorcinol and formaldehydes) Comparison with standard products.
4. Microscopic analysis of sterile injectables and tablets
5. Quality assessment of pharmaceutical products with special reference to regulatory affairs

Reference Books

1. Quality Assurance in Microbiology by Rajesh Bhatia, Rattan Lal Ihhpunjani. CBS publishers & distributors, New Delhi.
2. Good manufacturing practices for Pharmaceuticals By Sydney H. Willing, Murray M. Tuckerman, Willam S. Hitchings IV. Second edition Mercel Dekker NC New York

16IMBDC05	DSE-Core 1 –Practical: -Quality Assurance and Quality Control	3hrs/week	1Credits

Course Objectives:

The student shall be able to:

1. Acquire skills Quality management system
2. Understand the role of quality in human life and its role in betterment of society
3. Identify different domains of industry in quality systems like food, pharma etc.

List of Practicals:

1. To check the quality of packed food products as per standard protocol of microbiology.
2. Testing for microbial contamination and sterility of the food products in packed food and packaged drinking water
3. Check regulatory guidelines on packaging materials and codes for assurance in quality
4. Study of various pharmaceutical packaged products

Reference Books :

1. Quality Assurance in Microbiology by Rajesh Bhatia, Rattan Lal Ihhpunjani. CBS publishers & distributors, New Delhi.

16IMBDC06	DSE-Core 1 –Practical: - Bioethics and IPR	3hrs/week	1Credits

Course Objectives:

The student shall be able to:

1. Acquire knowledge about patent laws.
2. Understand the role of different government bodies
3. Identify different domains of biodiversity

List of Practical

1. Case study of Patenting (Bt-Cotton).
2. To study various biodiversity hot spots.
3. Patent prior art search.
4. Patent drafting / claim drafting.

Reference books:

1. K.C. Kankanala, Indian Patent Law and Practice, Oxford India Publication, 2012
2. M. B. Rao & Manjula Guru, Patent Law in India, Wolters Kluver Publication, 2010
3. Ademola A. Adenle, E. Jane Morris, Denis J. Murphy, Genetically Modified Organisms in Developing Countries, Cambridge University Press
4. K. D. Raju, Genetically Modified Organisms: emerging law and policy in India, Tata Energy Research Institute Publication, 2007

5 Years Integrated B. Sc - M.Sc. Microbiology (2016-2017)

SEMESTER - VI

16IMBCC23	Core 17: Molecular Biology	4hrs/week	4 Credits

Objectives

After completion of this course, student will be able to:

- Understand the basic concept and scope of recombinant DNA technology
- Understand the function of various Enzymes and Vectors used in Gene manipulation
- Describe the methods used in selection, screening & analysis of recombinants
- Develop knowledge of the genomic and cDNA cloning strategies
- Understand the application and ethical aspects of using RDT in developing products.

Unit: 1 Molecular genetics and organization of genetic materials (10hrs)

- Concept of central dogma
- DNA as genetic material: experimental evidences
- Different forms of DNA
- Genomic organization of Eubacteria and Archaebacteria
- Mendelian Laws

Unit: 2 Replication and Recombination (10 hrs)

- Experimental evidences of Replication and enzymes involved in DNA Replication
- Process of Replication in Prokaryotes
- Regulation of Replication
- Process of Recombination- mechanism of gene transfer- Transformation, Conjugation, transduction and transposable elements

Unit: 3 Transcription (10 hrs)

- Enzymes involved in Transcription of Prokaryotes
- Process of Transcription in Prokaryotes and its inhibitors
- Types of RNA molecules and Post transcriptional modification
- Regulation of gene expression at transcriptional level in prokaryotes

Unit: 4 Translations (8 hrs)

- The machinery of Protein synthesis-Genetic code, role of t-RNA and Ribosome
- Process of Translation in Prokaryotes and its inhibitors
- Post translational modification
- Distinguishing features of prokaryotic translation

Unit: 5 Mutations and Repair (10 hrs)

- Occurrence, kinds of Mutation, spontaneous & induced Mutation
- Mutagens, detection of Mutation Lethal Mutations, Biochemical Mutations
- Phenotypic effects of Mutation and Molecular basis of Mutation
- Significance & Practical applications of Mutation
- DNA Repair-Types and mechanism

Text Books

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia

Reference books

1. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
2. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
3. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
4. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

16IMBCC24	Core 18: Genetic Engineering	4hrs/week	4 Credits

Objectives

After completion of this course, student will be able to:

- Understand the basic concept and scope of recombinant DNA technology
- Understand the function of various Enzymes and Vectors used in Gene manipulation
- Describe the methods used in selection, screening & analysis of recombinants
- Develop knowledge of the genomic and cDNA cloning strategies
- Understand the application and ethical aspects of using RDT in developing products.

Unit 1: Introduction to Recombinant DNA Technology (8 hrs)

- Introduction to RDT
- History and relevant landmarks in the development of RDT
- Scope of RDT in biotechnology and human welfare
- Terminologies associated with RDT: Overview of cDNA, Clone, Gene, Genome, Vector, Recombinant, Genemap, Transgenics

Unit 2: Tools for RDT: Enzymes, Vector and Host (12 hrs)

- Enzymes:
  a) Restriction Endonuclease: Definition, nomenclature, mechanism, types and application
  b) Ligase: Definition, mechanism, application
  c) Other essential enzymes: DNA and RNA polymerase, Reverse Transcriptase.
- Vectors: Definition, properties, types.
  a) Plasmid vector
  b) Bacteriophage vector
  c) Shuttle Vector
  d) Cosmid Vector
  e) Yeast Vector: YAC
  f) Vector for Plant: Agrobacterium
  g) Vector for animal: SV40
- Selection of suitable host

Unit 3: Isolation of target DNA and Cloning Strategies (10 hrs)

- Isolation of DNA and selection of target gene.
- Construction of genomic Library
- Construction of cDNA Library
- Methods of Cloning
- PCR: As alternative to genomic DNA/ cDNA cloning

Unit 4: Expression, Screening and Selection of recombinants (10 hrs)

- Transformation of r-DNA to suitable host
- Expression of recombinant in suitable host: prokaryotic and eukaryotic.
- Basic techniques for screening and selection of the clones
- Sequence-dependent screening of recombinants: Hybridization and PCR
- Identification of DNA marker: RAPD, AFLP

Unit 5: Application and Ecosocial impact of RDT (10 hrs)

- Development of Transgenic plants: BT cotton
- Genetically modified Food
- Genetically Modified Organism
- Gene Therapy
- Scientific and ethical issues regarding GM food/organism

Reference book

1. S.B. Primrose, R.M. Twyman and R.W.Old.(2001) *Principles of Gene Manipulation. 6th Edition*, S.B.University Press,.
2. B.D. Singh (2010) Biotechnology Expanding Horizons. Kalyani Publishers.
3. J. Sambrook and D.W. Russel.(2001) Molecular Cloning: A Laboratory Manual

16IMBDC07	DSE-Core 2 Advances in Microbiology	4hrs/week	4 Credits

Course Objectives:

- After successfully completing this course the student should be able to:
- Understand the Principles of evolution of Microbial genome
- Understand the concept of non cultivable microbes and Metagenomics as a tool to study such living forms
- Explain the molecular basis of Host – Microbe interactionship
- Acknowledge the Networking in biological systems and Synthetic biology

Unit 1: Unit 1 Evolution of Microbial Genomes (10hrs)

- Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pangenome,
- Horizontal gene transfer (HGT),
- Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics

Unit 2: Metagenomics (10hrs)

- Brief history and development of metagenomics,
- Understanding bacterial diversity using metagenomics approach,
- Prospecting genes of biotechnological importance using metagenomics
- Basic knowledge of viral metagenome, metatranscriptomics, metaproteomics and metabolomics.

Unit 3: Molecular Basis of Host-Microbe Interactions (10hrs)

- Epiphytic fitness and its mechanism in plant pathogens,
- Hypersensitive response (HR) to plant pathogens and its mechanism,
- Type three secretion systems (TTSS) of plant and animal pathogens,
- Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance

Unit 4: Systems and Synthetic Biology (10hrs)

- Networking in biological systems,
- Quorum sensing in bacteria,
- Co-ordinated regulation of bacterial virulence factors,
- Basics of synthesis of poliovirus in laboratory,
- Future implications of synthetic biology with respect to bacteria and viruses

Unit - 5: Overview of Omics Technology (10hrs)

- Genomics
- Transcriptomics
- Proteomics
- Metaboliomics

Text Books:

1 Fraser CM, Read TD and Nelson KE. (2004,). Microbial Genomes, Humana Press

2 Miller RV and Day MJ. (2004). Microbial Evolution- Gene establishment, survival and exchange, ASM Press

3 Bull AT. (2004). Microbial Diversity and Bioprospecting, , ASM Press

4 Sangdun C.(2007). Introduction to Systems Biology, Humana Press

5 Klipp E, Liebermeister W. (2009). Systems Biology – A Textbook, Wiley –VCH Verlag

Reference Books:

1 Caetano-Anolles G. (2010). Evolutionary Genomics and Systems Biology, John Wiley and Sons

2 Madigan MT, Martink JM, Dunlap PV and Clark DP (2014). Brook's Biology of Microorganisms, 14th edition, Pearson-Bejamin Cummings

3 Wilson BA, Salyers AA Whitt DD and Winkler ME (2011)Bacterial Pathogenesis- A molecular Approach, 3rd edition, ASM Press,

4 Bouarab K, Brisson and Daayf F (2009) Molecular Plant-Microbe interaction CAB International

5 Voit EO (2012) A First Course in Systems Biology, Ist edition,Garland Science

16IMBDC08	DSE-Core 2 Microbiology and Health Care	4hrs/week	4 Credits

Course objective

This course is designed to provide instruction about,

1. Microorganisms are beneficial for Human health care
2. Role of Microorganisms in different fields
3. Role of Microbes in day to day life

Unit: 1 History of Microbiology **(10 hrs)**

- History of microbiology and Health care
- Spontaneous generation verses Bio-generation
- Germ theory of disease
- Koch Postulate

Unit: 2 Microorganisms as probiotics **(10 hrs)**

- Probiotics
- Characteristics of probiotics
- Commercially available probiotic products
- Benefits of probiotic products

Unit: 3 Microorganisms as food **(10 hrs)**

- Microorganisms as a food source-Mushroom, Single cell protein, Functional Food
- Mushroom as a complete food and Nutritional level of mushroom
- Microorganisms in Dairy (Cheese, Yogurt, Buttermilk, Kefir)
- Microorganisms in fermented food (Pickles, Sauerkraut, Silage, Sausage, Bread)

Unit: 4 Microorganisms as Bio-fertilizer and Bio-pesticides **(10 hrs)**

- Microorganisms as a Bio-fertilizer and Bio-pesticides
- Types of Bio-fertilizer and Bio-pesticides
- Benefits of bio-fertilizer and Bio-pesticides

Unit: 5 Microorganisms as Vaccines (10 hrs)

- Vaccines
- Microorganisms as Vaccines
- Types of Vaccines: Live, attenuates vaccines, inactivated vaccines, Toxid vaccines, Recombinant Vaccines, DNA Vaccines
- Production of Vaccines

Text book:

- Frazier .W.C Westhoff, D.C., (1978). Food Microbiology. Tata McGraw-Hill Publication Company
- Subba Rao, N.S., (1999). Bio-fertilizers in Agriculture and Agro forestry. New Delhi:Oxford IBH
- Pelczar, M.J., Chan, E.C.S., Kreig, N.R. (1993). Microbiology 5th Edition, Tata McGraw-Hill Publication Company

Reference book:

- Tortora, G.J., Funke, B.R., Case, C.L., (2004). Microbiology Introduction .Singapore: Pearson Education.
- Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology 5th edition, New York: WCB Mc GrawHill publication

16IMBDC09	DSE-Core 2 Fundamentals of Research Methodology	4 hrs/week	4 Credits

Objectives

- After completion of this course, student will be able to:
- Understand the concept of research and importance of studying research methodology
- Gain knowledge regarding various components of research
- Distinguish between various scientific documents
- Understand the concept of thesis writing
- Gain elementary knowledge regarding application of statistics in research

Unit 1: Introduction to Research Methodology (10 hrs)

- Introduction to Research and Research Methodology
- Objective of Research
- Types of research
- Significance of research
- Process of Research

Unit 2: Components of Research (10 hrs)

- Defining research problem
- Designing research
- Sample and sampling
- Data Collection
- Data Analysis

Unit 3: Scientific documents and standards (10 hrs)

- Scientific Documents: Types
- Journals: types and properties.
- Publication: Types, Ethics and standards
- Quality of Journal: Impact Factor, Citation.

Unit 4: Dissertation/Thesis Writing and Presentation (10 hrs)

- Modes of presenting scientific data
- Basics of Poster Presentation
- Thesis/Dissertation writing: overview, components and order of presentation.
- Ethics of Publication and Thesis writing

Unit 5: Elementary statistics for Research (10 hrs)

- Hypothesis
- Hypothesis testing
- Measures of central tendency: Mean, Mode, Median
- ANOVA , Chi Square test

Reference book:

1. C.R. Kothari.(2004) Research Methodology. *2nd Edition*, New Age International Publisher.

16IMBCC25	Core Practical- 6 Molecular Biology	9hrs/week	3 Credits

Objectives:

At the end of the course, the students will be able to:

1 Use the techniques used in biotechnology that are based on DNA-Protein and Protein-Protein interactions.

2 Students can perform protein engineering and drug designing.

List of Practicals

1 Isolation of genomic DNA from bacteria

2 Isolation of plasmid DNA from bacteria

3 Agarose gel electrophoresis of isolated DNA

4 Isolation of RNA from yeast cells

5 Quantitation of DNA by specrophotometry

6 Determination of Tm value of DNA

7 Bacterial Transformation

8 Bacterial Conjugation

9 U.V induced mutagenesis

10 Plasmid curing by Acridine orange

Reference books

1 T.A.Brown, Molecular Biology Lab Fax

2 Sambrook and Russel, Molecular Cloning.

3 Frederick M. AusubelCurrent Protocols in Molecular Biology

16IMBDC10	DSE-Core 2 Practical Advances in Microbiology	3hrs/week	1 Credits

Objectives:

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

1. Understand the concept of non cultivable microbes and Metagenomics as a tool to study such living forms
2. Explain the molecular basis of Host – Microbe interactionship
3. Acknowledge the Networking in biological systems and Synthetic biology

List of Practicals:

1. Extraction of metagenomic DNA from soil
2. Understand the impediments in extracting metagenomic DNA from soil
3. PCR amplification of metagenomic DNA using universal 16s ribosomal gene primers
4. Case study to understand how the poliovirus genome was synthesized in the laboratory
5. Case study to understand how networking of metabolic pathways in bacteria takes place

Reference books

1. R. J. Slater (1986). Experiments in Molecular Biology. Humana Press

16IMBDC11	DSE-Core 2 Practical : Microbiology and Health Care	3hrs/week	1 Credits

Objectives:

At the end of the course, the students will be able to:

1. Isolate microbes from food samples
2. Isolate microbes from soil/plant samples
3. identification of fungus from bread.

List of Practicals

1 Isolation and identification of microorganisms from butter milk

2 Isolation and identification of Probiotics from commercially available probiotic food

3 Isolation of Nitrogen fixing bacteria from root nodules

4 Isolation of non- symbiotic bacteria from Rhizospheric soil

5 Isolation and identification of fungus from fermented food (Bread)

Reference book:

1. Tortora, G.J., Funke, B.R., Case, C.L., (2004). Microbiology Introduction .Singapore: Pearson Education.
2. Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology 5th edition, New York: WCB Mc GrawHill publication

16IMBDC12	DSE-Core 2 Practical : Fundamentals of Research Methodology	3hrs/week	1 Credits

Objectives:

At the end of the course, the students will be able to:

- Draft research proposal
- Prepare experimental protocol
- Statistically analyze experimental data.

List of Practicals:

1. Writing research proposal
2. Protocol filling and submission
3. Making data analysis using statistics

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SEMESTER - VII

16IMBCC27	Core 19: Molecular Cell Biology	4hrs/wk	4 Credits

Course Objectives:

Upon successful completion of this course, Students will be able to**:**

1. Understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
2. Understand how these cellular components are used to generate and utilize energy in cells
3. Understand the cellular components underlying mitotic cell division.
4. Apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

Unit 1: Cellular Ultrastructure (09hrs)

- Ultrastructure: Plasma Membrane and Cell Wall (Eukaryotic and Prokaryotic).
- Ultrastructure and functions of Lysosome, Peroxisomes & Glyoxisomes.
- Ultrastructure of Ventriole, Flagellum & Cilium, Vacuoles and their role in cell structure and function.
- Ultrastructure of Mitochondria and Chloroplast

Unit 2: Cell cycle and DNA packaging (10hrs)

- Cell Cycle, G_1/S Transition, Cyclines and cyclin dependent kinases. Regulation of CDK - cycline activity
- Ultrastructure of Nucleus and Nucleolus. Pore Complex of Nuclear envelop
- Ultrastructure of Chromosome & Chromosomal Models; Histone proteins: evolutionary trend and structure of nucleosomes; Histone like proteins in prokaryotes and genome organization in prokaryotes and archaea

Unit 3: Cytoskeleton (09hrs)

- Cytoskeleton: Ultrastructure and functions of Microtubules, microfilaments and associated proteins
- Ultrastructure and functions of Actin, Myosin, IF and associated proteins
- Intracellular Junctions and their functions. Ca^{++} dependent homophillic and non-homophillic cell-cell adhesion.

Unit 4: Cellular Transport (10hrs)

- Transport across cell membrane: diffusion, active transport and pumps, uniports, symports and antiports; Phenomenon of exocytosis and endocytosis
- Cell surface receptors and their mode of action;
- Secondary messenger system
- Overview of Apoptosis and Necrosis

Unit 5: Cancer Biology (10hrs)

- Cancer biology: Types of cancers; Cancer biology; Oncogenes versus Tumor suppressor genes
- Mutation: Mutagens/ carcinogens (chemical and physical agents); biological agents
- RAS signaling in cancer; Familial cancer syndromes and the discovery of tumor suppressors; Control over cell cycle; Apoptosis and the p53 tumor suppressor
- DNA repair mechanisms; DNA repair defects and their relationship to cancer
- Diagnosis and Treatment of Cancers: Chemotherapy, Immunotherapy, Newer targeted techniques

Reference Books:

1. Lodish, H., Berk, A., Kaiser, C.A. (2008). Molecular Cell Biology, 7th Edition. W.H. Freeman publication.
2. Cassimeris, L., Plopper, G., Lingappa, V.R. (2010). Lewin's Cell, 2nd Edition. Johns & Bartlett Publishers
3. Bolsover, S.R., Shephard, E.A., White, H.A., Hyam, J.A. (2011). Cell Biology, A Short Course, 3rd Edition. New York: Wiley publicationSingh, R.P. (2007). General Microbiology. New Delhi: Kalyani Publishers.

16IMBCC28	Core 20: Microbial Diversity and Evolution	4hrs/wk	4 Credits

Course Objectives:

The broader aims of the course are to provide:

1. In-depth knowledge about microbial evolution process, classification and phylogeny analysis
2. Understanding about vast diversity in various groups of bacteria
3. Understanding of the morphology, physiology and other features of Archaebacteria and Extremophiles
4. Understanding of uncultivable microorganisms.

Unit 1: Microbial Evolution (09hrs)

- Microbial evolution and phylogeny
- Chronometers and chronological distances, paradox in establishing evolutionary distances
- Phylogenetic trees and its types
- Molecular basis of microbial classification : Methods of 16S r-RNA analysis, (Signature Sequence), FAME Analysis, Density Gradient Gel Electrophoresis (DGGE), Thermal Gradient Gel Electrophoresis (TGGE), Amplified Ribosomal DNA Restriction Analysis (ARDRA).

Unit 2: Bacteriology (10hrs)

- Diversity of Gram positive bacteria
- Diversity of Gram negative bacteria
- Diversity of Actinobacteria
- Diversity of Cyanobacteria and Microalgae

Unit 3: Archaebacteria (09hrs)

- Archaebacteria - taxonomic position, distinguishing features and Phylogenetic groups
- Ecology and habitats of Archaebacteria
- Physiology and adaptive strategies of Archaebacteria
- Biotechnological potential of Archaebacteria

1 **Unit 4: Extremophiles (10hrs)**

- Introduction to extremophiles; Extreme Environments and distribution and types of
- Thermophiles: Types, adaptation mechanisms, biotechnological significance
- Halophiles: adaptation mechanisms, Industrial importance
- Methanogens: Classification, habitats and its applications

Unit 5: Uncutivable Microorganisms (10hrs)

- Concept of Metagenomics
- Methods of isolating Metagenomic DNA
- Application of Metagenomic DNA

Reference Books:

1. Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology, 5th Edition, New York: WCB Mc GrawHill publication.
2. Madigan, M.T., Martinko, J.M., Stahl, D.A., Clark, D.P. (2011). Brock Biology of Microorganisms, 13th ed.: Benjamin-Cummings publication
3. Stanier, R.Y. (1987). General Microbiology, 5th Edition: Macmillan publication.

16IMBCC29	Core 21: Mycology and Virology	4hrs/wk	4 Credits

Course Objectives:

This course is aimed at providing students:

1. To understand general features and properties of fungi
2. To provide awareness about different classes of fungi
3. To understand basics of viruses
4. To acquire knowledge regarding economic aspects of Fungi and virus

Unit . 1: Fungi – General Characters (09hrs)

- Morphological features of fungi; Fungal nutrition and growth; Fungal associations
- Fungal classification: Natural and Artificial
- Four Class Classification of Fungi; Nine class Classification of Fungi; Five Class
- Classification of Fungi
- Sexuality in fungi: Asexual reproduction; Sexual reproduction; Parasexual cycle
- Fungal nutrition: Mode of fungal nutrition; Omnivorous nature of fungi

Unit . 2: General features of different classes of Fungi (10hrs)

- Zygomycotina
- Ascomycotina
- Basidiomycotina
- Deuteromycotina
- Slime molds

Unit . 3: General Characteristics of Virus (09hrs)

- Morphology, Ultra structure, Chemical composition and classification of virus
- Physical, chemical and structural components of viruses.
- Isolation and purification of viruses, Detection of viruses: physical, biological,
- Immunological and molecular methods
- Sub-viral Particles – Viroid, Satellite Virus, Prions

Unit . 4: General features of different classes of Virus (10hrs)

- Viruses of Anima
- Viruses of Plants
- Bacterial viruses
- Viruses of Eukaryotic Microorganisms
- Viruses and Cancer

Unit . 5: Economic importance of Fungi and Virus (10hrs)

- Role of Fungi in agricultural sector: biofertilizers, biopesticides, fungal diseases of plants
- Fungi as foe: Fungi in food spoilage and toxication; Fungi as deteriorating agent; Fungal diseases
- Industrial Applications of fungi
- Viral diseases of plants and animals
- Use of Viral as therapeutic agents, Gene transfer tool in plant biotechnology

Reference Books:

1. Deacon, J. (2006). Fungal Biology, 4th ed: Wiley publication.
2. Gow, N.A., Gadd, G.M. (1995). The Growing Fungus. Springer publication.
3. Kendrick, B. (2001). The Fifth Kingdom, 3rd edition: Focus Publishing.
4. Carlile, M.J., Watkinson, S.C., Gooday, G.W. (2001). The Fungi, 2nd edition: Academic Press.
5. Collier, L., Balows, A., Sussmann, M. (1998). Topley & Wilson's Microbiology and Microbial Infections, Volume 4: Hodder Education Publishers.
6. Alexopoulos, C.J., Mims, C.W., Blackwell, M.M. (1996). Introductory Mycology: Wiley publication.
7. Wanger, E.K., Hewlett, M.J. (2004). Basic Virology: Blackwell Science.
8. Matthew, R., Hull, R. (2002). Matthew's Plant virology: Elsevier Academic press.
9. Acheson, N.H. (2011). Fundamentals of molecular virology, 2nd Edition: Wiley publication.

16IMBDA09	DSE- Allied- 5 - Research Methodology and Experimental Design	5hrs/wk	5 Credits

Objectives:

Upon completion of the course the student will be able to

1. Conduct effective search for research literature, selection of the suitable journal & manage the process of publication steps.
2. Understand basic descriptive and inferential statistics including the concepts and principles of research design and statistical inference.
3. Perform and interpret descriptive and inferential statistical tools including the construction of tables and graphs, t-tests, Chi-square tests, and regression analysis using different statistical packages.

Unit 1: Introduction to Research Methods & Literature Survey (10 hrs)

- Research: Meaning, Purpose, Types (Descriptive, Analytical, Applied, Fundamental, Quantitative, Qualitative, Conceptual, Empirical) & Objective of Research
- Defining and formulating the research problem: Selecting the problem, Necessity of defining the problem
- Literature Survey: Use of Library, Books and Journals- Medline, Patent Search and reprints of articles as a source for Literature survey
- Primary and Secondary sources: Reviews, Treatise, Monographs, Patents
- Literature Search: Search engines- Google Scholar, Pubmed, INFLIBNET

Unit 2: Kinds of Scientific Documents & Thesis Writing (10 hrs)

- Definition and kinds of Scientific documents: Research paper, Review paper, Book reviews, Thesis & Technical reports
- Standards of research journal: Impact factor, Citation index, H index, I10 index, Eigen factor
- Components of a research paper: Title, Authors and addresses, Abstract, Acknowledgements, Tables and illustrations, References
- Different steps in the preparation: Layout, Structure and Language of typical reports, Illustrations and tables, Bibliography, Referencing and Footnotes
- Dealing with publishers: Submission of Manuscript, Ordering reprints

Unit 3: Data Analysis Using Statistical Tools-I (10 hrs)

- Introduction and Basic concepts in Biostatistics
- Measure of Central tendency (Mean, Median and Mode)
- Measure of Dispersion (Range, Mean Deviation, Variance and Standard Deviation
- Skewness: Measure of Skewness, Karl Pearson's Coefficient of Skewness
- Kurtosis: Measure of Kurtosis

Unit 4: Data Analysis Using Statistical Tools-II (9 hrs)

- Correlation: Types & Methods of measuring Correlation
- Regression: Regression line and Equations
- Non parametric test: Chi square Test (Goodness of fit, Test of Independence)
- Parametric Test: Comparison of means of two samples: T test
- Comparisons of Means by three or more samples: F Test, ANOVA

Unit 5: Experimental Designs (9 hrs)

- Completely Randomized Design (CRD)
- Randomized Complete Block Design (RCBD)
- Latin Square Design (LSD)
- Factorial Experiments
- Split Plot and Strip Plot Design

Reference Books:

1. Khan, I. A., & Khanum, A. (2004). Fundamentals of Biostatistics. Ukaaz Publications.
2. Holmes, D., Moody, P., & Dine, D. (2011). Research methods for the Biosciences. Oxford University Press.
3. Ruxton, G., & Colegrave, N. (2010). Experimental design for the life sciences. Oxford University Press.
4. Glass, D. J. (2014). Experimental Design for Biologists. Cold Spring Harbor Laboratory Press.
5. Dutta, N. K. (2002). Fundamentals of Biostatistics: Practical Approach. Kanishka Publishers.
6. Gurumani, N. (2004). An introduction to Biostatistics. MJP publisher.

16IMBDA10	DSE- Allied- 5 - Good Laboratory Practice	5hrs/wk	5 Credits

Course Objectives:

1. To bridge the gap between academics and industries
2. To inculcate skills of GLP as per regulatory authorities.
3. To equip students with instrumentation and validation studies

Unit 1 Introduction to GLP (10 hrs)

- Overview of GLP and GMP and its importance
- Principles and their applications in GLP
- Regulatory authorities in industry and their roles: USFDA, WHO, EPA, ISO, FSSAI, NGCMA
- Terminologies and their definitions in GLP

Unit 2 Instrumentation: Practices and Applications (10 hrs)

- Qualification of the Instruments in laboratory : Types and its applications

  a. IQ b. OQ c. PQ
- Calibration and preventive maintenance of equipments in laboratory
- Validation and approval of protocols, analysis test protocols
- Execution and Reporting writing of instrumentation
- Maintenance of instrumentation

Unit 3 Quality management system and standard procedures (10 hrs)

- Quality control : Introduction types and role in industry
- Quality Assurance : Importance and its role in compliance
- Standard Operating Procedures and their importance e.g. Entry Exit Procedures
- Overview of Deviation, Change control, CAPA, CFR's
- Quality management and Standards in quality control departments

Unit 4 Documentation and reports in GLP (9 hrs)

- Method Validation and reporting documentation skill
- Media, Reagents Preparation, Storage & its documents
- Reference standard maintenance and records archival
- Accuracy, Precision, Repeatability of methods in QC
- General laboratory in safety, Designs and lab development

Unit 5 Review and Quality audits (9hrs)

- Self-inspection and internal assessment
- Quality audits : Types and roles
- Review of quality documents, Maintenance of Log book and review
- Record keeping, labeling files and folders, documentation in GMP
- Health Safety and Environment, Waste disposal management

References

1. World Health Organization. Handbook: good laboratory practice (GLP): quality practices for regulated non-clinical research and development. World Health Organization, 2010.
2. Selvakumar, R. (2010). Good Laboratory Practices. Indian Journal of Clinical Biochemistry. 25 (3): 221-224.
3. Weinberg, S. (2007). Good Laboratory Practice Regulations: CRC Press.

16IMBCC30	Core Practical - 7 Molecular Cell Biology and Diversity	9hrs/wk	3 Credits

Course Objectives:

The course is designed to impart

1. Skill related to study of intracellular and extracellular structures of Eukaryotic and Prokaryotic cells
2. Knowledge related to isolation and study of various cellular components
3. Familiarity with methods for measuring this diversity and monitoring changes due to both anthropogenic and natural factors
4. Hands-on training of latest techniques to the study of biodiversity, with an emphasis on genomics methods and digital tools for exploiting museum collections

Cell Biology

1. Mitosis and the Cell Cycle in Onion Root-Tip Cells
2. Cell Counting and viability
3. Isolation of mitochondria from plant sample
4. Isolation of chloroplast
5. Isolation and estimation of chlorophyll pigment
6. Permeability assessment of the plasma membrane
7. Cytological staining : Gram Staining, Endospore staining, Capsule staining, Cell wall staining
8. Bacterial motility test : Hanging drop method

Microbial Diversity

1. Isolation of extremophilic bacteria from natural habitats
2. Isolation of actinobacteria/ actinomycetes
3. Calculation of various diversity indices, such as Dominance Index, Shannon Index
4. Morphological study of fresh water and marine micro algae
5. Isolation of extremophilic fungi from natural habitats

Mycology and Virology

1. Isolation and Identification of various fungi
2. Isolation and Identification of various yeasts
3. Germ tube detection in *Candida albicans*
4. Isolation of plaques from the sewage sample
5. One step growth curve of bacteriophage

Reference Books:

1. Sambrook, J., Russell, D.W. (2001). Molecular Cloning – A Laboratory Manual: Cold spring Harbor Laboratory Press
2. Cappuccino, J.G., Sherman, N. (2004). International student edition: Microbiology- A laboratory Manual 4th edition: Benjamin Cummings publications
3. Brown, A.E. (2009). Benson's Microbiological Applications: Laboratory Manual in General Microbiology. New Delhi: McGraw Hill publication.
4. Benson, H.J. (2001). Microbiological applications: a laboratory manual in general microbiology. New Delhi: McGraw Hill publication.

5 Years Integrated B. Sc - M.Sc. Microbiology (2016-2017)

SEMESTER - VIII

16IMBCC31	Core 22: Bioprocess Technology	4hrs/wk	4 Credits

Course Objectives:

On successful completion of this course students should have

1. An understanding of the variety of fermentation and subsequent processing approaches available for the manufacture of biological products
2. Knowledge about design and operation of these systems,
3. Appreciation of the regulatory framework under which the industry operates

1 **Unit 1: Strain improvement and development (09hrs)**

- Basic concept of fermentation
- Screening of industrially important microorganisms
- Strain improvement: Molecular approaches, Directed evolution & selection; Preservation of industrial microorganisms
- Substrates for microbial fermentations, antifoam agents

Unit 2: Bioreactor Design (09hrs)

- Design and construction of bioreactor
- Major types of bioreactors; Enzyme reactors
- Mass transfer of oxygen: Agitation and aeration, Determination of KLa, factors affecting KLa, fluid rheology
- Medium engineering by Response Surface Methodology (RSM)

Unit 3: Sterilization, control and Economics (10hrs)

- Sterilization of media and air; Scale up and Scale down
- Bioprocess kinetics: Kinetics of growth and substrate utilization in batch, fed batch and continuous systems
- Control of process parameters
- Fermentation economics

Unit 4: Types of fermentation processes (10hrs)

- Antibiotic production: Penicillin
- Biomass: SCPs, Mushrooms and probiotics
- Alcohol fermentation
- Citric acid & Vitamin B12 fermentation
- Enzymes: Protease & Amylase
- Amino acids: Lysine & Glutamic acid
- Microbial production of polysaccharides: Xanthan & Dextran

Unit 5: Downstream Process (10hrs)

- Bioseparation- Filtration, Centrifugation, Sedimentation, Flocculation
- Cell disruption; Liquid-liquid extraction
- Purification by Chromatographic techniques : Reverse Osmosis and Ultra filtration
- Drying; Crystallization, Storage and Packaging
- Immobilization and applications of whole cells and enzymes

Reference Books:

1. Pepler H.J., Perlman, D. (1979). Microbial Technology. Volume-1 & 2. New York: Academic Press.
2. Casida, L.E. (1968). Industrial Microbiology. New Delhi: New Age International Pub. (P) Limited.
3. Stanbury, P.F., Whittaker, A. (1984). Principles of Fermentation Technology, 2nd Edition. Pergamon Press.
4. Waites, M.J., Morgan, N.L., Rockey, J.S., Higton, G. (2001). Industrial Microbiology: An Introduction: Wiley-Blackwell scientific publication.
5. Okafor, N. (2007). Modern Industrial Biotechnology & Microbiology. Edenbridge: Science Publishers.

16IMBCC32	Core 23:Microbial Physiology and Energetic	4hrs/wk	4 Credits

Course Objective:

The overall aim of this course is to

1. Instill in students an appreciation for, and a working knowledge of, the diverse mechanisms that allow bacteria to survive and grow in ever-changing environments.
2. Understand the structure and function of the bacterial cell
3. Understand how bacterial growth is possible due to, and as an outcome of, the flow of genetic information (DNA to RNA to Protein).
4. Understand the range of bacterial metabolism (diverse metabolic capabilities) and energy production in the bacterial cell
5. Understand the ability of bacteria to sense and respond to environmental conditions

Unit . 1: Microbial Physiology (09hrs)

- Flagella, motility and process of chemotaxis- uptake and utilization of substrates
- Sporulation and germination
- Microbial biofilms; physiology and collective recalcitrance of microbial biofilm communities: Quorum sensing and quenching mechanisms
- Microbial stress responses: Heat, temperature, pH, Microbial energy stores, Microbial fuel cells and applications

Unit . 2: Carbohydrate Metabolism (10hrs)

- Carbohydrates: Classification, chemical structure, functions
- Carbohydrate Metabolism: Aerobic and anaerobic pathways: Glycolysis and its regulation, Gluconeogenesis and its regulation.TCA cycle, anaplerotic reactions.
- Electron Transport chain, Oxidative phosphorylation, & production of ATP, balance sheet of glucose oxidation, Pentose phosphate pathway

Unit . 3: Lipid Metabolism (10hrs)

- Lipid: Classification, chemical structure, functions
- β-oxidations of saturated even chain fatty acids.

- Biosynthesis of fatty acids – Acetyl-CoA carboxylase reaction, Fatty acid synthase complex
- Regulation of fatty acid biosynthesis
- Biosynthesis of cholesterol, regulation

Unit . 4: Protein metabolism (10hrs)

- Amino acids & Proteins: Classification, chemical structure, functions
- Biodegradation of amino acids–deamination, transamination, decarboxylation
- Urea cycle including its regulation
- Biosynthesis of amino acids, Disorders of amino acid metabolism (phenylketonuria, alkaptonuria, Biologically active amines

Unit . 5: Bioenergetics (09hrs)

- Bioenergetics: Gibbs free energy, endergonic & exergonic reactions, Standard state free energy changes, Feasibility of reactions
- ATP Structure, properties and energy currency of the cell, Importance of Coupled reactions, High energy compounds
- Bioenergetics of glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducer, aerobic and anaerobic respiration, fermentation,
- Photosynthesis bacteria and algae

Reference Books:

1. Nelson, D.L., Cox, M.M. (2013). Lehninger Principles of Biochemistry. W.H. Freeman publication.
2. Voet, D., Voet, J.G., Pratt, C.W. (2012). Fundamentals of Biochemistry, 4th Edition: Wiley publications
3. Moat, A.G., Foster. J.W., Spector, M.P. (2009). Microbial Physiology, 4th Ed: Wiley India Pvt Ltd.
4. Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology, 5th Edition. New York: WCB Mc GrawHill publication.

16IMBCC33	Core 24: Basic Instrumentation and Biophysics	4hrs/wk	4 Credits

Course Objectives:

1. To understand the basic principles of biophysical instrumentation applied in diverse field of Microbiology
2. To understand the way of studying the biological molecules using analytical techniques
3. To study the application of the biophysical instruments

Unit 1: Microscopy and Radio isotopic techniques

- Light Microscopy: - Bright field, Dark field, Fluorescent microscopy, Phase contrast microscopy
- Electron Microscopy (TEM & SEM), Atomic Force Microscopy
- Flow cytometry (FACS)
- Radioisotopes & half life of isotopes, Units & measurement of radiation, Autoradiography, Application of radioisotopes in biological study, Interaction of radiation with matter

Unit 2: Spectroscopy

- Spectroscopic techniques:- Beer Lambert's law, Extinction coefficient, Principles & applications of visible & U.V. spectroscopic technique
- Electromagnetic spectrum, interaction of electromagnetic radiation with matter, Physical phenomenon:- Absorption, Emission, Refraction, Diffraction, Transmission
- Absorption & Emission Spectroscopy
- CD spectroscopy, Raman's Spectroscopy, IR & NMR
- X-ray diffraction & crystallization

Unit 3: Chromatography techniques

- Chromatography : Theory & Principles
- Understating of basic terminology: Stationary phase, mobile phase, Retention time, column efficiency, Peak shape
- Types of chromatography, partition, adsorption, ion exchange, size exclusion, affinity, Paper chromatography,

- Hydrophobic chromatography, Gas chromatography, Ultra high performance chromatography, Liquid chromatography combine with Mass spectroscopy, Thin layer chromatography, High performance thin layer chromatography

Unit 4: Centrifugation & Electrophoresis

- Basics, principles and classification of electrophoresis
- Zone Electrophoresis : Paper electrophoresis, Thin layer electrophoresis, Cellulose acetate electrophoresis, gel electrophoresis, affinity electrophoresis
- Moving boundary electrophoresis: Capillary electrophoresis, Immuno electrophoresis
- Basics, principles and classification centrifugation
- Types Centrifugation, Sedimentation, Relative centrifugal force, preparative and analytical centrifuge, ultracentrifugation and its applications in molecular size determination.

Unit 5: Advanced Biophysics

- Aspects of advanced biophysics : Concepts, principles and applications.
- Electrophysical techniques in diagnostics: Single neuron recording, patch-clamp recording, electrocardiogram, Brain activity recording, lesion and stimulation of brain, PET, MRI, fMRI, CAT, Density.
- CT Scanners and Their Applications, Overview of Digital Subtraction Radiography and Mammography
- Role and applications of biophysics in nuclear medicines, Principle of localization & usages of radiopharmaceuticals
- Practical aspects of Implementation of Radiation Protection in Medical Applications, Regulatory Aspects of Radiation Protection.

Reference Books:

1. Sambrook, J., Fritsch, E. F., &Maniatis, T. (1989). *Molecular cloning* (Vol. 2, pp. 14-9). New York: Cold spring harbor laboratory press.
2. Blau, K., & King, G. S. (Eds.). (1993). *Handbook of derivatives for chromatography* (Vol. 2). New York: Wiley.
3. Kindt, T. J., Goldsby, R. A., Osborne, B. A., &Kuby, J. (2007). *Kuby immunology*.

Macmillan.

4. Hayat, M. A. (1974). *Principles and techniques of scanning electron microscopy. Biological applications. Volume 1*. Van Nostrand Reinhold Company.
5. E Alpen (1997) *Radiation Biophysics,* 2nd Edition academic press
6. R.N. Roy. (2001) A *Textbook of Biophysics*. New Central Book Agency, 2001

16IMBDA11	DSE- Allied 6 - Soil and Agriculture Microbiology	4hrs/wk	4 Credits

Course Objectives:

The course is designed to make student aware about:

1. Soil and its characteristics
2. Microorganisms in soil and their role in agriculture
3. Sustainable agriculture and its impact
4. Plant Microbe interaction and Molecular Plant Pathology

Unit 1 : Microbes and Soil Fertility **(10hrs)**

- Physical and Chemical properties of soil
- Role of Microbes in soil fertility
- Soil fertility Evaluation and Improvement
- Interactions among soil microorganisms
- Organic Farmimg

Unit 2:Plant Microbe Interaction **(09hrs)**

- Rhizosphere Microorganisms : Phyllosphere, Spermosphere and Rhizoplane
- Methods of Enumeration, Rhizosphere Effect,
- Factors affecting Rhizosphere Microorganisms
- PGPR, Siderophore, Mycorrhiza and VAM

Unit 3: Biological Nitrogen Fixation **(10hrs)**

- Nitrification, Dinitrification
- Symbiotic Nitrogen Fixation *(Rhizobium, Frankia)*
- Asymbiotic Nitrogen Fixation *(Azotobacter, Azospirillum)*
- Nitrogenase enzyme, *nif* genes and Molecular mechanism of Nitrogen fixation
- Role of nodulin genes in nodule development and symbiosis
- Genetic engineering of BNF

Unit 4: Biofertilizers and Biopestisides (10hrs)

- **Biofertilizers** – Types, Production and Quality control
- Cultivation and mass production of Bioinoculants – Azotobacter, Rhizobium, Azospirillum, Cyanobacteria, Azolla and Phospahte Solubilizing Microorgansms – Production and applications
- Carrier based inoculants
- **Biopesticides –** Types and applications (*Psedomonas Fluoroscence, Bacillus thuringiensis, Trichoderma harzianum, Trichoderma viridae, Nuclear Polyhedrosis Virus)*

Unit 5: Molecular Plant Pathology (09 hrs)

- Recognition and entry of pathogens into host Cell, Alteration of host behavior by pathogen
- Molecular mechanism of Disease establishment; enzymes, phytotoxins, growth regulators, involvement of elicitors; role of R and r genes in disease development
- Molecular mechanism of disease diagnosis.
- Resistance Mechanism in Plants, Systemic Resistance, Resistance genes, Phytoalexins. PR Proteins, Signaling Mechanisms.

Reference Books:

1. Atlas, R.M., Bertha, R. (1997). Microbial Ecology, 4th Edition: Benjamin Cummings publication
2. Pelczar, M.J., Chan, E.C.S. and N.R. Kreig (1993). Microbiology, 5th Edition. New Delhi: Tata Mc Graw Hill Publishing co. Ltd.
3. Alexander, M. (1977). Introduction to soil microbiology, 2nd edition. Wiley publication.
4. Purohit, S.S. (2007). Microbiology-Fundamentals and Applications, 6th Edition. New Delhi: Agrobios Publications.
5. Rangaswami, G., Mahadevan, A. (2004). Diseases of Crop plants in India: PHI publication.
6. Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology, 5th Edition. New York: WCB Mc GrawHill publication.

16IMBDA12	DSE- Allied 6 - Food and Dairy Microbiology	4hrs/wk	4 Credits

Course Objectives:

The course will impart the students with the knowledge about:

1. The interactions between microorganisms and the food and milk environment, and factors influencing their growth and survival.
2. Explain the significance and activities of microorganisms in food and milk.
3. Describe the characteristics of food borne, diseases and spoilage microorganisms, and methods for food and milk preservation.
4. Fermented food and milk products

Unit 1: Food Microbiology (9 hrs)

- Introduction to Food Microbiology
- Factors affecting interactions of microorganisms with food: intrinsic and extrinsic factors
- Objectives, Importance and functions of quality control.
- Food quality standards and control system. Food industries and QA in production, ISO certifications
- Food standard and safety regulations: BIS, ISI, FSSAI, FDA, CODEX, HACCP

Unit 2: Food Processing and Packaging Technology (9 hrs)

- Microbial flora associated with fresh foods.
- Scope, importance and principles of food processing.
- Application of enzymes in food processing
- Processing of fruits, vegetables, cereals, pulses, meat and fishes.
- Introduction to packaging, principles of development of protective packaging

Unit 3: Food spoilage and Preservation (10 hrs)

- Microbial spoilage of food: fresh food and canned food.
- Physical and chemical factors influencing microbial spoilage of food.
- Types of microbes normally associated with spoilage and biochemical change.
- Preservation of foods: General principles & methods of food preservation
- Physical methods: Low temperature, high temperature, osmotic dehydration, blanching, canning, dielectric heating, microwave processing, membrane technology, irradiation.

- Chemical Methods: preservatives, salts, sugars, antioxidants and spices.
- Food additives and adulterants

Unit 4: Dairy technology (10 hrs)

- Composition of Milk, types of microbes in milk
- Microbial analysis of milk: SPC, Direct count, MBRT, Resazurin test
- Types of spoilage of milk and milk products, Milk borne infections affecting human and milking animal.
- Processing of milk products: Cheese, yoghurt, dahi, shrikhand, paneer, skimmed milk
- Preservation of milk and its products

Unit 5: Advancement in Food technology (10 hrs)

- Introduction to neutraceuticals and functional foods.
- GM Foods and issues concerning GM foods.
- Bioactive foods: prebiotics, probiotics and synbiotics.
- Interaction between food and genes.

Reference Books:

1. Frobisher, M. (1974). Fundamentals of Microbiology 9th edition. Philadephia. Sanders Company.
2. Pelczar, M.J., Chan, E.C.S. and N.R. Kreig (1993). Microbiology, 5th Edition. New Delhi: Tata Mc Graw Hill Publishing co. Ltd.
3. Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology, 5th Edition. New York: WCB Mc GrawHill publication.
4. Frazier, W.C., Westhoff, D.C. (1978). Food Microbiology. Tata McGraw-Hill Publishing Company.
5. Swaminathan, M. (1990). Food Science, Chemistry and Experimental Foods. Mysore: Bappco Book Publishing Company.
6. Jay, J.J., Loessener, M.J., Golden, D.A. (2005). Modern Food Microbiology: Springer publication.
7. Prajapati, J.B. (1995). Fundamentals of Dairy Microbiology: Ekta Publication.

16IMBDA13	DSE- Allied 6 - Cell Culture Technology	4hrs/wk	4 Credits

Objectives:

1. Understand the principle and application of Plant and Animal Cell culture, describe components of Plant and Animal tissue culture medium and methodology of preparation of medium.
2. Independently establish *in vitro* culture of Plant and Animal Cell lines.
3. Explain the principle of Genetic engineering and methodology of development of transgenic plants and Transfection methods in Animals.

Unit 1: Basics of Plant Tissue Culture **(9 hrs)**

- Plant cell culture– Basic concept, History and Scope
- Concept of Asepsis and methods of Sterilization
- Tissue culture media
- Role of Plant growth regulators in tissue culture
- Pathways and different stages of Clonal Micropropagation

Unit 2: Protoplast isolation and culture **(9 hrs)**

- Protoplast - Isolation, Culture, Regeneration and fusion
- Selection of hybrid and Regeneration of hybrid
- Symmetric and Asymmetric hybrid
- Cybrid
- Embryo culture and Embryo rescue

Unit 3: Variation in Tissue Culture **(10 hrs)**

- Variation in Plant tissue culture: Origin and causes
- Cryopreservation and Germplasm storage
- Methods of Gene transfer in Plants and Animals
- Transgenic Plant with special reference to Biotic and Abiotic stress
- Transgenic animal: Transfection methods and application

Unit 4: Basics of Animal Cell Culture I **(10 hrs)**

- Animal cell culture – Introduction, History and Scope
- Brief discussion on Chemical, Physical and Metabolic functions of different constitution of Animal cell culture media
- Balanced salt solutions and Simple growth medium
- Different growth factors promoting proliferation of Animal cells in culture
- Serum and Protein-free defined media and their applications

Unit 5: Animal Cell Line **(10 hrs)**

- Primary culture and Animal Cell lines
- Characterization and biology of cultured cells
- Measuring parameter of Growth and Test of viability
- Transformed Animal Cells– Established/continuous Cell lines
- Commonly used Animal Cell lines– Their origin and characteristics

References Books:

1. Bhojwani, S. S., &Razdan, M. K. (1986). Plant tissue culture: Theory and practice. Vol. 5. Elsevier.
2. Chawla, H.S. (2002). Introduction to Plant Biotechnology. Oxford & IBH Publishers.
3. Freshney, I. (2010). Culture of Animal Cell (6^{th}edition). John Wiley.
4. Gamborg, O. L., & Phillips, G. (Eds.). (2013). Plant cell, tissue and organ culture: fundamental methods. Springer Science & Business Media.
5. Masters, J. (2005). Animal Cell Culture (3^{rd} edition). Panima Publishing Corporation.
6. Narayanaswamy, S. (1994). Plant cell and tissue culture. Tata McGraw-Hill Education.
7. Smith, R. (2012). Plant tissue culture: Techniques and Experiments. Elsevier Science.
8. George, E. F., Hall, M. A., & De Klerk, G. J. (Eds.). (2007). Plant propagation by tissue culture: volume 1. The background (Vol. 1). Springer Science & Business Media.

16IMBCC34	Core Practical - 8 Fermentation Technology	9hrs/wk	3 Credits

Objectives:

1. Skill related to operation of fermentation process and its various control aspects
2. Knowledge related to isolation and preservation of industrially important microbial strains
3. Hands-on training in analysis of various biomolecules
4. Hands-on training in handling fungal culture and its microscopic observation
5. Ability to identify various fungal culture on the basis of its morphology

Bioprocess Technology

1. Primary and Secondary screening for various extracellular enzymes by microorganisms
2. Single cell protein production
3. Ethanol fermentation and yield assessment by *S. cerevisiae*
4. Citric acid production and recovery by *A. niger*
5. Glutamic acid production and purification
6. Purification and Immobilization of enzyme
7. Determination of thermal death point of given isolates
8. Determination of thermal death time of given bacterial isolates
9. Effect of various physical factors on bacterial growth

Physiology and Energetic

1. To study Km, Vmax, K cat of some selected enzymes viz, Amylase
2. To derive Line Weaver Burk Plot of selected Enzymes
3. Determination of enzyme activity
4. Study of enzyme induction
5. Study of various metabolic activities of bacteria
    a. Carbohydrate fermentation
    b. OF test
    c. Urea hydrolysis
    d. H_2S production
    e. Lipid hydrolysis

Basic Instrumentation and Biophysics

1. Analysis of compound by U.V. spectroscopic technique
2. Analysis of compound by IR spectroscopic technique (Demonstration)

Reference Books:

1. Thimmaiah, S.K. (2006). Standard Methods of Biochemical Analysis: Kalyani publishers.
2. Sawhney S.K., Singh, R. (2005). Introductory Practical Biochemistry: Alpha Science International.
3. Rehm, H.J., Reed, G. (1983). Biotechnology: A Comprehensive Treatise in 8 Volumes. Vol. 3: Biomass, Microorganisms for Special Applications, Microbial Products I, Energy from Renewable Resources. Verlag Chemie, Weinheim –Deerfield Beach–Basel.

16IMBDA14	DSE- Allied 6 Practical Soil and Agriculture Microbiology	2hrs/wk	1 Credits

Objectives:

This laboratory course will make student understand the principle and the procedure

1. Skill related to isolation and cultivation of agriculturally important microbes
2. Ability to identify citrus pathogen
3. To check the ability of microbes as PGPR

List of Experiments:

1. Isolation of nitrogen fixing bacteria
2. Cultivation of cellulose decomposing microorganisms from soil (Demo)
3. Demonstration of oozing, and isolation of pathogen from diseased specimen of lemon leaf showing citrus canker and isolation of Xanthomonas *spp.*
4. Isolation of phosphate solubilizing microorganisms.
5. Isolation and study of PGPR attributes of soil microorganisms
6. Isolation of symbiotic and non-symbiotic Nitrogen fixers
7. Isolation of phosphate solubilizers
8. Production of liquid biofertilizers
9. Cultivation of nitrifying and denitrifying bacteria (Demo)

Reference Book:

1. Cappuccino, T.G. and Sherman, N. (1996). Microbiology; A Laboratory Manual. The Benjamin-Cummings Publishing Co.

16IMBDA15	DSE Allied 6 Practical: Food and Dairy Technology	2 hrs/wk	1 Credits

Objectives:

The student shall be able to:

5. Acquire skills to examine food and milk for its microbial load.
6. Understand the role of microbes in milk and food
7. Identify different microbes associated with food, enumerate them and understand their role
8. Evaluate different parameters affecting food quality and methods of preparation of different dairy products.

List of Experiments:

1. Detection and enumeration of various microbes in processed and unprocessed foods.
2. Efficiency of pasteurization and sterilization of milk by Phosphatase Test.
3. Preparation of Cheese, sauerkraut by microbial fermentation process.
4. Determination of common adulterants in different food sample.
5. Determination of antimicrobial activity of various spices.
6. Isolation of *Aspergillus flavus* and detection of aflatoxin from infected peanuts.
7. Determination of antioxidant activity of citric fruits.

Reference Books:

1. Baker, F.J., Breach, M.R. (1967). Handbook of Bacteriological Technique: Butterworth & Co Publishers Ltd.
2. Smith, S (2010) Food Biotechnology Practical Manual, Deakin University.
3. Dietrich, W. K. (2004) Food Science and technology by Taylor and Fransis.
4. Cappuccino, J. G. and Sherman, N., (1983) Microbiology: A Laboratory Manual.

16IMBDA16	DSE Allied 6 Practical: Cell Culture Technology	2 hrs/wk	1 Credits

Objective:

After completion of the course students will be able to prepare Plant Tissue Culture medium, independently establish Plant cell cultures and prepare Synthetic seeds.

List of Experiments

1. Introduction to plant tissue culture laboratory, instruments, growth room and aseptic technique.
2. Preparation of Plant tissue culture medium.
3. Explant preparation and Sterilization.
4. Aseptic inoculation of explant for establishment of nodal culture/Callus culture from study of pathways of Micropropagation.
5. Anther culture for production of Haploids.
6. Establishment of Cell suspension culture.
7. Study of Callus characteristics.
8. Preparation of Synthetic seeds.
9. Isolation of plant protoplast from Leaf.
10. Preparation of Animal tissue culture medium and Balanced salt solution.

Reference Books:

1. Chawla, H.S. (2002). *Introduction to Plant Biotechnology*. Oxford & IBH Publishers.
2. Purohit, S.D. & Joshi, N. (2007). *Plant Biotechnology: Practical Manual.* Apex Publication.
3. Giri, C. & Giri, A. (2007). *Plant Biotechnology: A practical Manual.* I.K. Publication.
4. Helgason, C. D. & Miller, C.L. *Basic cell culture protocols. Vol 290.* Humana press

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SEMESTER – IX

16IMBCC35	Core 25: Advanced Molecular Technology	4hrs/wk	4 Credits

Objectives:

After the completion of the course the student will be able to:

1. Describe different techniques used for detecting specific DNA segment and for gene expression analysis
2. List out techniques used in biotechnology that are based on DNA-Protein and Protein-Protein interactions and will be able to design experiments based on them
3. Understand the principals of protein folding and realize its significance in biotechnology and neurodegenerative diseases
4. Understand the basis of protein engineering and drug designing and different approaches used in these

Unit 1: Techniques used in gene detection and gene expression studies (10 hrs)

- Blotting and hybridization studies:Southern hybridization, Northern hybridization, Westernhybridization, Fluorescent in situ hybridization
- Subtractive hybridization, Differential display
- RT PCR, Real time PCR, RNA arbitrarily primer (RAP)-PCR
- SAGE, DNA microarray

Unit 2: DNA-protein interaction techniques (9 hrs)

- DNA-protein cross-linking assay, Gel mobility shift assay, Dnase I foot printing and Sl nuclease mapping, Chromatin immunoprecipitation (ChIP)
- Protein- protein interactions: Chemical cross-linking, Co-immunoprecipitation (CIP), Tandam affinity tags (TAT), Phage display, Fluorescent resonance energy transfer (FRET), Yeast-2-hybid, Yeast-3-hybid and their various version

Unit 3: Reporter and marker genes **(10 hrs)**

- Introduction to reporter and marker genes
- Application of reporter and markers in biotechnology
- Green Fluorescent Protein (GFP), Chloramphenicol acetyl transferase (cat), Neomycin phosphoryl transferase II (nptII), Luciferase, β- galactosidase, β – lactamase gene and β-glucuronidase

Unit 4: Protein folding **(10 hrs)**

- Introduction to protein folding
- Principals governing protein folding
- *In vitro* Vs *In vivo* protein folding
- Assisted protein folding and molecular chaperones
- Relevance of protein folding to biotechnology
- Diseases due to defective protein folding

Unit 5: Protein engineering and drug design **(09 hrs)**

- Rationale of protein engineering
- Methods and approaches: Directed evolution and gene shuffling, random mutagenesis and selection of engineered proteins, gene modification at specific sites, synthesis of complete gene. Engineering by gene fusion.
- Drug design and various approaches: Blocking enzyme activity, Inhibitor for Dihydroxyfolate reducase (DHFR), Renin. HIV reverse transcriptase. Drug design by blocking hormone receptors, propanolol for norepinephrine and epinephrine and drug design by inhibiting nucleic acid synthesis using antisense RNA technology.

Reference Books:

1. Mark A Strauch. Protein–DNA Interactions: Techniques Used. John Wiley & Sons, Ltd. All rights reserved.
2. T.A. Brown. Gene cloning and DNA analysis. Blackwell Publishing Ltd.
3. J.W. Dale and M. von Schantz. From genes to genomes. John Wiley & Sons, Ltd.

16IMBCC36	Core 26: Microbial Genetics	4hrs/wk	4 Credits

Course Objectives:

Upon successful completion of this course, the student will be able to:

1. Understand the importance of microbial genetics;
2. Explain how microorganisms are used to understand the genetic mechanisms
3. Relate microbial genetics to Microbiology
4. Understand microbial genes, genomes, and gene expression and its importance for understanding the biology and evolution of microorganisms and their interactions with the environment.

Unit 1: Classical Genetics (09 hrs)

- Principles of Mendelian genetics, Linkage & Pedigree Analysis
- Hardy-Weinberg genetic equilibrium, Natural selection, genetic drift
- Genetics of Speciation
- Extra-chromosomal inheritance

Unit 2: Gene and Gene expression (10 hrs)

- Gene, Genome and Genomics
- DNA replication: Mechanism and regulation in prokaryotes
- Transcription in prokaryotes
- Translation in prokaryotes
- Post transcriptional and post translational modifications

Unit 3: Regulation of Gene expression (10 hrs)

- Regulation of gene expression in prokaryotes: The Operon model of regulation
- Inducible and repressible operons with the examples of lac, trp and arabinose operons
- Genetic analysis and positive and negative control of lac operon; 3- Dimensional structure of lac repressor and mechanism of its binding to DNA
- Regulation of gene expression in bacteriophage λ

Unit 4: Mutation **(10 hrs)**

- Mutational Theory of Evolution
- Molecular basis and Types of mutations
- Mutagenesis
- DNA damage and repair
- Chromosomal aberration

Unit 5: Gene Transfer **(09 hrs)**

- Genetic exchange in Prokaryotes
- Molecular basis of conjugation among prokaryotes, Genetic exchange by conjugation involving prokaryotes and eukaryotes, Conjugation in *Paramecium*
- Molecular mechanism of transformation and transduction
- Plasmid Biology: Control of replication, Plasmid distribution and stability
- Transposable elements

Reference Books:

1. Snustad, D.P., Simmons, M.J. (2012) Principles of Genetics, 6th Edition. Wiley publications.
2. Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A. (2006). Concepts of Genetics, 10th Edition: Pearson publication
3. Hartl, D.L. (2014). Essential Genetics, A Genomics Perspective, 6th Edition: Jones & Bartlett publications.
4. Lewin, B. (2004). Gene-VIII. Pearson Prentice Hall publications.

16IMBDC13	DSE Core -3 Genomics	4 hrs/wk	4 Credits

Objectives:

Upon completion of this course students will be able to

1. Explain the major steps in genomics.
2. Edit raw Sanger sequence data for phylogenetic analysis.
3. Obtain basal knowledge of DNA based theory as well as various analytic tools which will enable them to analyze different kind of data and interpret the result.

Unit 1: Introduction to Genome (10 hrs)

- Introduction to Genome and Gene structure
- History of genome projects
- Gene families
- Functional domains
- Biodatabases

Unit 2: Genome Analysis (10 hrs)

- Genome sequencing techniques and applications
- Next-Generation sequencers and Sequencing strategies
- Massive parallel sequencing and its applications
- Genome assembly
- Genome annotation

Unit 3: Population Genomics (08 hrs)

- Basis of population genomics
- Allelic frequency, Heterozygosity, Haplotypes
- Linkage disequilibrium
- Genetic drift
- Natural selection

Unit 4: Comparative and evolutionary Genomics (10 hrs)

- Comparative and evolutionary genomics
- Gene duplication and Genome duplication
- Paralogous and orthologous genes
- Molecular evolution, Evolutionary rate and Molecular clock
- Phylogenetic tree

Unit 5: Functional Genomics (10 hrs)

- Functional Genomics (Transcriptome assembly, annotation and analysis)
- Forward and reverse Genetics
- Ecological genomics
- Systems Biology
- Protein-DNA interactions

Reference Books:

1. Lesk A. M. (2007) Introduction to Genomics, Oxford University Press
2. Primrose S. B. & Twyman R. (2008) Principles of Genome Analysis and Genomics, Blackwell Publishing, 2008.
3. Helms V. (2008) Principles of Computational Cell Biology: From Protein Complexes to Cellular Networks, Wiley Publication.
4. Brown T. A. (2006) Genomes 3, Garland Sciences.

16IMBDC14	DSE Core -3 Bioethics	4 hrs/wk	4 Credits

Objectives:

1. Able to recognize and distinguish the Bioethical issue from other issue and also able to explain the principles of bioethics and how to balance these principles in practice.
2. Understand the principles, function and basic legal rules of IP Law.
3. Recognize the relevant criteria for generating and protecting intellectual works.
4. Understand the different forms of infringement of intellectual property rights.
5. Demonstrate and develop basic skills of legal issue related with IPR.

Unit 1: Bioethical issues (10 hrs)

- Introduction to bioethics, incidences and types of unethical practices.
- Ignorance of laws, codes, policies and procedures.
- Professional ethics-professional conduct. Ethical decision making.
- Ethical Issues: Human cloning, Designer baby, Cord banking, GMO, Abortion, Sex determination, Usage of lab animals, human clinical trials.
- Ethical practices of scientists, scientific/ research organization, business houses, medical practice, regulatory bodies.

Unit 2: General Regime of Intellectual Property Rights & patenting (10 hrs)

- History and general concept of Intellectual Property Rights, type, Major International treaty and their role.
- Need for Protecting Intellectual Property, Policy Consideration: National Perspectives and
- International demands.
- Introduction to Patent, Indian Patent Law**,**The Patents Act 1970**,**Amendments to the Patents Act 1970.
- Patentable Subject Matter, Patentability Criteria, Procedure for Filing Patent Applications, Patent Granting Procedure.
- Patent Infringement and Remedies, patent information system, patent search

Unit 3: Patenting in Biotechnology (10 hrs)

- Concept of Novelty in Biotechnological Inventions, current issues in patenting of live form with special reference to biotechnological product.
- Patenting of microorganism, higher plants and animals: Transgenic organisms and isolated genes.
- Patenting of genes and DNA sequences, plant breeder's rights and farmer's right.
- Plant Varieties Protection, the Protection of Plant Varieties and Farmer's Rights Act, 2001. Justification for Protection, Plant Protection Varieties in India.
- Biotechnology and International Treaties.

Unit 4: Copyright and Industrial Designs (10 hrs)

- Introduction of copyright, Protection of Copyright and Related rights, Indian Copyright Law ,The Copyright Act, 1957 with its amendments
- Copyright works, Ownership, transfer and duration of Copyright ,Renewal and Termination of Copyright, Neighbouring Rights, Infringement of copyrights and remedies
- Industrial Designs: Need for Protection of Industrial Designs, Subject Matter of Protection and Requirements, The Designs Act, 2000.
- Procedure for obtaining Design Protection, Revocation, Infringement and Remedies

Unit 5: Trademarks & Trade secret (8 hrs)

- Introduction to Trademarks & service mark, Need for Protection of Trademarks.
- Kinds of Trademarks, Indian Trademarks Law, the Trade and Merchandise Marks Act, 1958
- Trademarks Act, 1999, Procedural Requirements of Protection of Trademarks.
- Content of the Rights, Exhaustion of Rights, Domain Names and Effects of New Technology (Internet).
- Introduction of trade secret, conditions of protection, Subject matter

Reference Books:

1. P. Narayana, Patent Law, Wadhwa Publication.
2. Intellectual Property Rights: Unleashing the Knowledge Economy by PrabuddhaGanguli.
3. Merges, (1996) Patent Law and Policy: Cases and Materials,
4. Brian C. Reid, (1993) A Practical Guide to Patent Law, 2nd Edition,
5. Feroz Ali Khader, The Law of Patents – with a special Focus on Pharmaceuticals in India, LexisNexis Butterworths Wadhwa, Nagpur.
6. Gopalakrishnan, N.S. &Agitha,T.G., (2009)Principles of Intellectual Property, Eastern Book Company, Lucknow

16IMBCC38	Core Practical – 9 Advanced Molecular Technology	6 hrs/wk	3 Credits

Objectives:

At the end of the course, the students will be able to:

1. Use the techniques used in biotechnology that are based on DNA-Protein and Protein-Protein interactions.
2. Students can perform protein engineering and drug designing.

Laboratory Experiments:

1. DNA extraction from plant tissue
2. Extraction of total RNA
3. DNA cloing and expression (Blue-white selection)
4. Bacterial conjugation
5. Bacterial transduction (Demonstration)
6. Southern blotting (Demonstration)
7. Detection of DNA Polymorphism using PCR
8. Protein gel electrophoresis
9. Western blotting
10. Expression of green fluorescent protein (Demonstration)

16IMBDC15	DSE Core -3 Practical Genomics	2 hrs/wk	1 Credits

Objectives:

At the end of the course, the students will

1. get a brief know how on *in silico* techniques for nucleic acid data generation and analysis
2. get familiarize with consolidation of generated *in silico* data and its application from gene to genome level

Laboratory Experiments:

1. Design of primer sequence
2. Discovery of ORF sequence from genome
3. Assembly and alignment of small genome sequences
4. BLAST analysis
5. Discovery of gene from genome
6. Discovery of tandem repeats

16IMBDC16	DSE Core -3 Practical: Bioethics	2 hrs/wk	1 Credits

Objectives:

At the end of the course, the students will

1. Get acquainted with exemplary case studies of bioethics.
2. Get familiarize with specific national law related to bioethics.

List of experiments:

1. Case study related to stem cell.
2. Case study related to GMOs.
3. Case study related to biosafety.

Reference books:

1. L. Vaughan Bioethics – Principles, Issues and Cases, 3rd Edition, Oxford University Press
2. A. V. Campbell, Bioethics – The Basics. Routledge Publication, USA, 2013
3. T. L. Beauchamp, J. F. Childress, Principles of Biomedical Ethics, 5th Edition, 2016

5 Years Integrated B. Sc - M.Sc. Microbiology (2016-2017)

SEMESTER - X

16IMBCC39	Core 28: Environmental Biotechnology	4hrs/wk	4 Credits

Objectives:

1. To understand various methods of solid and liquid waste management.
2. To know the use of microbes in biominerelization and biohydrometallurgy for extraction of metals from ores.
3. To be acquainted with the principles and process of removal of toxic substances and degradation of xenobiotics using microbes.
4. To get familiarize the role of Biotechnology in solving global environmental problems.

Unit1: Basics of Environmental Biotechnology (8 hrs)

- Introduction to Environmental Biotechnology
- Global environmental problems: Ozone depletion, Greenhouse effect and Acid rain
- Biodeterioration
- Eutrophication and Biomagnifications
- Toxic chemicals in the environment and their effects - air, water & soil

Unit 2: Waste Management (10 hrs)

- Solid waste - Sources, generation and classification
- Management methods of solid- Sanitary land filling, Recycling, Composting and Incineration
- Liquid waste – Sources and types of liquid waste
- Treatment schemes for waste waters- Aerobic processes: Activated sludge, Oxidation ditches, Trickling filter, Towers, Rotating discs, Rotating drums
- Anaerobic digestion

Unit 3: Biodegradation and Bioremediation (10 hrs)

- Bioremediation- processes/strategies and organisms involved
- Bioremediation: Degradation of pesticides & Xenobiotics
- Degradation of Basic Structures found in Hydrocarbons & Oil spills
- Overview of Phytoremediation
- Biomining : Use of microbes in biohydrometallurgy and biomineralization

Unit 4: Biosensors and Biofuels (10 hrs)

- Application of microbes as Biofertilizers
- Bioinsecticides for productivity improvement and crop protection
- Principles of Biomonitoring
- Applications of Biosensors for detection of environmental pollutants
- Biofuels: production and applications

Unit 5: Microbiology of Soil, Water and Air (10 hrs)

- Concepts of habitat and niche, Microbial communities: nature, structure and attributes, levels of species diversity, Succession and stability, r and K selection.
- Ground water types and their contamination.
- Zonation of water ecosystem, Potability of water, Microbial assessment of water, Water purification.
- Air flora in different layers of atmosphere**,** Bioaerosol, Assessment of air quality using principles of Sedimentation, Impaction, Impingement, Suction and Filtration.
- Brief account of transmission of airborne microbes, Allergy: Causes and tests for detection of allergy.

Reference Books:

1. Agarwal, S. K. (1998). Environmental biotechnology. APH Publishing.
2. Alexander, M. (1999). Biodegradation and Bioremediation. Academic Press San Diego CA.
3. Chatterji, A. K. (2011). Introduction to Environmental Biotechnology. PHI Learning Pvt.Ltd..

4. Cookson Jr, J. T. (1995). Bioremediation engineering: design and application. McGraw-Hill, Inc..
5. Foster, C. F. (1987). John Ware DA, Environmental Biotechnology.
6. Jogdand, S. N. (2010). Environmental biotechnolog.
7. Kamely, D., Chakrabarty, A., &Omenn, G. S. (1989). Biotechnology andbiodegradation. Gulf Publishing Co.

16IMBCC40	Core 29: Forensic Microbiology	4hrs/wk	4 Credits

Course Objectives:

To enable the student to

1. get acquainted with the forensic science
2. get familiarize biological methods of crime investigation
3. make learn forensic applications of molecular techniques

Unit 1: Introduction to Forensic Science (09 hrs)

- Introduction and historical perspectives of Forensic Science
- Basic Principles of Forensic Science
- Approaches and considerations for forensic microbiology
- Sampling methods
- Medico-legal aspects of forensic sampling

Unit 2: General Methods of Microbiological Investigation (10 hrs)

- Role of metagenomic data in microbial forensic
- Importance of molecular markers
- Taxonomic profiling of microbes
- Methods of culturing
- Strategies for storage of microbes

Unit 3: Biologic evidence (10 hrs)

- Collection of blood, cerebrospinal fluid, tissue, urine and feces samples
- Serological, biochemical and molecular tests and risk of infections
- Bacterial translocations in humans
- Effect of physiological conditions (temp., anaerobic etc.) after death on commensal bacteria.
- Microbial impacts in postmortem toxicology and death time prediction

Unit 4: Microbial decomposition **(10 hrs)**

- Soil microbiology of decomposition
- Freshwater and marine decomposition
- Microbiology of nonhuman models of terrestrial decomposition
- Microbiology of terrestrial human decomposition
- Importance of postmortem interval for microbial investigation

Unit 5: Advanced Tools for Forensic Analysis **(09 hrs)**

- Comparison microscope, IBIS
- AFIS, ESDA
- XRF, EDXRF
- Bioinformatics DNA sequencing and digital matching – NCBI
- Future use of microorganism as physical evidence

Text Books:

1. Carter, D. O., Tomberlin, J. K., Benbow, M. E., Metcalf J. L. Forensic Microbiology, Wiley Publication
2. Curry, A. S Methods of Forensic Science Interscience, New York
3. Chowdhari, S Forensic Biology B P R & D, Govt of India
4. Richard saferstein, Forensic Science Hand book; Prentice Hall

16IMBCC41	Core – 30: Advanced Diagnostic Techniques	4hrs/wk	4 Credits

Course Objectives:

1. Specialized technologist in diagnostic laboratories.
2. Expose technologist for Medical Laboratory Technology.
3. Make students acquainted with concepts, theories and principles of laboratory science.

Unit 1: Cytological diagnostics methods (09 hrs)

- G-banded chromosomal preparations for detection of autosomal/sex chromosomal disorders.
- in situ hybridization (FISH and on-FISH)
- hybridization (CGH).
- Cancer cytogenetics: spectral karyotyping.
- DNA diagnostics: PCR based diagnostics

Unit 2: Molecular Diagnostics Methods (07 hrs)

- ELISA
- CIA,RIA
- MALTOUX test
- Tuberculin test
- Antibody markers, CD Markers

Unit 3: Biochemical and Cell Based Diagnostics (07 hrs)

- Inborn errors of metabolism, haemoglobinopathies, mucopolysaccharidoses,
- lipidoses, lipid profiles, HDL, LDL
- Glycogen storage disorders, amyloidosis.
- Enzymes and Signal Amplification Systems, Separation and Solid-Phase Systems,
- Case studies elated to bacterial, viral and parasitic infections.

Unit 4: Imaging Diagnostics (9 hrs)

- Imaging Techniques (Basic Concepts), Invasive and Non-Invasive.
- X-ray technique
- Electrocardiography (ECG), Uses of ECG, Electroencephalography (EEG), Use of EEG, Computerized Tomography (CT), Uses of CT,
- Magnetic Resonance Imaging (MRI), uses of MRI, Ultrasound Imaging (US), Uses of Ultrasound, Planning and Organization of Imaging Services in Hospital,
- Introduction, Planning, Physical Facilities, Layout, Organization, Organization and Staffing, Records, Policies, Radiation Protection.

Unit 5: Product Development:

- Immunoassay Classification and Commercial Technologies, Assay Development, Evaluation, and Validation
- Reagent Formulations and Shelf Life Evaluation, Data Analysis,
- Documentation, Registration, and Diagnostics Start-Ups.
- Biosensors : Concepts and applications, Biosensors for personal diabetes management,
- Noninvasive Biosensors in Clinical Analysis, Introduction to Biochips and their application in Health.

16IMBDC17	DSE Core 4: Proteomics	4hrs/wk	4 Credits

Course Objectives:

1. To make students familiarize with proteomics.
2. To make students acquainted with common tools and techniques of proteomic study.
3. To give students exposure about concepts, theories and principles of advance proteomic instruments.

Unit 1: Introduction to Proteomics (08 hrs)

- Introduction to proteins
- Methods of protein isolation, purification, quantification
- Use of peptides as probes
- Proteomics databases, Proteome functional information
- The Proteome – Mining proteomes- Bridging Genomics and Proteomics- Proteomics and the new biology.

Unit 2: Analysis of proteomes (08 hrs)

- SDS – PAGE
- IEF with IPG – IPG gel preparation
- Rehydration of IPG strips, sample application and running conditions and optimization of PH gradient for IPG IEF, equilibration between dimensions
- Two-dimensional polyacrylamide gel electrophoresis
- 2D for soluble samples, tissue samples, cells and sample fractionation.

Unit 3: Protein identification (07 hrs)

- Liquid chromatography for protein
- Basics of mass spectrometry
- MALDI – MS
- ESI – MS
- De novo sequencing using mass spectrometric data

Unit 4: Novel approaches to protein expression analysis (08 hrs)

- Introduction, the scope of functional proteomics
- Protein chips.
- Application of proteome analysis to drug development and toxicology
- Comparative analysis-detection of biomarkers
- Detailed analysis of the regulation of gene expression, prediction of protein function.

Unit 5: Proteomics as tool for plant genetics and breeding (08 hrs)

- Introduction – Genetic diversity analysis – inter and intra – specific genetic differentiation
- Distinction of varieties, lines and cultivars, genome expression – mutant characterization,
- Variability between organs and developmental stages
- Identification and characterization of abiotic stresses responsive proteins genetic mapping and candidate proteins – genetic mapping of proteins markers
- PQL and candidate protein, technological advances and plant protein databases

Reference Book:

1. D. C. Liebler & J. R. Yates, Introduction to Proteomics - Tools for the New Biology, Humana Press, 2002.
2. Pennington & Dunn, Proteomics from protein sequence to function, I edition, Bio Scientific Publishers ltd. 2005.
3. A. M. Campbell, L. J. Heyer, Discovering Genomics, Proteomics and Bioinformatics, 2nd edition, Pearson Publication, 2007.
4. M. Hamacher, et al. Proteomics in Drug Research, Wiley Publication, 2006
5. F. Azuaje & J. Dopazo, Data Analysis and Visualization in Genomics and Proteomics, Wiley Publication, 2005.
6. J. Sanchez, G. L. Corthals, D. F. Hochstrasser, Biomedical Applications of Proteomics, Wiley Publication, 2005.

16IMBDC18	DSE Core 4: Bio-entrepreneurship	4hrs/wk	4 Credits

Objectives:

1. Student will be able to integrate and make autonomous use of their knowledge.
2. Understand the concept and need of entrepreneurship development and develop qualities of entrepreneur.
3. Identify various avenues of entrepreneurship and able to describe role of various central and state government agencies
4. Explain the role of entrepreneurship in economic development.
5. Explain the importance of innovation for entrepreneurship.
6. Understand the role of entrepreneur in modern economy.
7. Describe social responsibility and relate with economic performance.

Unit 1: Basics of Entrepreneurship (8 hrs)

- Entrepreneurship definition, Characteristics of Entrepreneurship, factors necessary for entrepreneurship, Functions of Entrepreneurship, Types of Entrepreneurship,
- Entrepreneurship and Intrapreneurship, Entrepreneurship Strategy
- The Business Plan: Creating and Starting the Venture: The Marketing Plan, The Financial Plan, Sources of Capita, Market Survey Concept, Risk Management
- Legal Issues for the Entrepreneur: Licensing, Product Safety and Liability Registration, Process, Insurance, Contracts, Advertising, Supply Chain Management, Retail& FDI
- Industry Size & Current schemes: Micro, Small, Medium- Industry

Unit 2: Importance of innovation for entrepreneurship (9 hrs)

- Entrepreneurship and Innovation: The Innovation Concept, Source of Innovation for Opportunities.
- The Innovation Process, Product life cycle, new product development process, mortality curve.
- Creativity and innovation in product modification/ development
- Entrepreneurship and Economic Development: Role of Entrepreneurship in Modern, Economy Managers Vs Entrepreneurship

- Characteristic of Managers & Characteristic of Entrepreneurs, Similarities and differences between Managers and Entrepreneurs

Unit 3: Concept of Management and Organization (10 hrs)

- Introduction of Industry, Commerce and Business
- Types of ownership in the organization :Definition, Characteristics, Merits & Demerits
- Single ownership, Partnership, Cooperative Organizations, Joint Stock Companies,Government owned Management and Administration
- Differences between Management and Administration
- Management as a science and as an art Leadership Models, Different Leadership Models

Unit 4: Functions of Management and social responsibility (9 hrs)

- Function of Management: Planning, What is planning?
- Definition and Types of Planning - Strategic Plan, Tactical Plan and Operation Plan
- Basic Steps and process in the Planning
- Function of Management: Definition, types, emerging issues, merits and demerits of Planning, Organizing, Staffing and Directing.
- Social Responsibility: What is Social Responsibility, Social Responsibility and Economic Performance, Social Obligation, Social Responsibility Managerial Ethics in Modern Times

Unit5: Entrepreneur in Biotechnology (10 hrs)

- Innovation, Strategy and Strategic Thinking in Biotechnology Entrepreneurship.
- Funding of biotech business, support mechanisms for entrepreneurship, Bio-entrepreneurship efforts in India, difficulties in India experienced.
- Biotech growth, Biotechnology Industry and Firm Structure, The Biotechnology Value Chain areas of scope, biotech policy initiatives
- The biomedical drug, diagnostic, and devices industries and their markets, The Biotechnology Value Chain
- Role of knowledge centers and R & D: Knowledge centers like universities and research institutions, role of technology and upgradation.

Reference Books:

1. Roy, R. (2011)Entrepreneurship, Oxford University Press India
2. Shimasaki, C. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies: Academic
3. Gordon .E & Natarajan ,K, (2008), Entrepreneurship Development ,Himalaya
4. Khanka S. S. S Chand & Co. Entrepreneurial Development,
5. Lal, A. K. (2012) Entrepreneurship Development and Management, Vayu Education Of India.
6. Basu, S.K., Sahu, K.C. & Rajiv ,B. (2012). Industrial Organization and Management, PHI Learning Private Limited-New Delhi (2012)
7. Mohanty, S.K.(2005). Fundamentals of Entrepreneurship, PHI Learning Private Ltd.

16IMBCC42	Core Practical 10 Diagnostic Techniques	6hrs/wk	3 Credits

Objective:

To enable the student to

1. Perform and analyze various environmental monitoring parameters.
2. Evaluate environmental (water and air) quality.
3. Estimate various serological parameters
4. Generate and analyze DNA fingerprints

Practical List:

1. Isolation of nitrogen fixing bacteria
2. Cultivation of nitrifying and denitrifying bacteria
3. Estimation of DO
4. Isolation and identification of coliform from water by MPN test
5. Isolation and identification of air flora
6. Karyotyping of human diseases
7. Blood genomic DNA isolation
8. ELISA (Demonstration)
9. Estimation of serum bilirubin, creatininine
10. Profiling of blood lipids
11. Diagnosis of *H. pyoleri*
12. Blood grouping by absorption- inhibition method
13. Sampling of microbial evidences from demo crime scene
14. DNA fingerprinting
15. Identification of common Diatoms species from drown death bodies for death time prediction (Demonstration)

Reference Books:

1. Richard saferstein, Forensic Science Hand book; Prentice Hall
2. Curry, A. S Methods of Forensic Science Interscience, New York
3. Chowdhari, S Forensic Biology B P R & D, Govt of India

16IMBDC19	DSE Core 4: Practical Proteomics	2hrs/wk	1 Credits

Objectives:

At the end of the course, the students will be able to:

1. To make students acquainted with common tools and techniques of proteomic study.
2. Use the techniques to be used related to DNA-Protein and Protein- Protein interactions.
3. Students can understand basic techniques of protein engineering and drug designing.

Laboratory Experiments:

1. To derive the amino acid sequences from PDB.
2. To derive protein structure from amino acid sequences.
3. To study protein ligand interaction by docking.
4. Introduction to various online softwares for protein structure prediction.
5. Phylogeny prediction on the basis of amino acid sequences.

16IMBDC20	DSE Core 4: Practical Bio-entrepreneurship	2hrs/wk	1 Credits

Objective:

To enable the student to

1. Familiar with basic requirements for setting up bioenterprise
2. Aware with challenges and needs for setting up bioenterprise.
3. Make competent to manage a bioenterprise.

Experiments:

1. Perform market survey for setting up business opportunities in life sciences
    a. Market potential of product
    b. Costing of production and marketing
    c. Customer survey
2. Prepare a detailed plan for setting up and managing a bioenterprise

Reference Books:

1. D. Hine & J. Kapeleris, Innovation and entrepreneurship in Biotechnology, An International Perspective – Concepts, Theories and Cases. Kdward Elgar Publication, 2006.
2. C. Shimasaki, Biotechnology Entrepreneureship – Starting, Managing and Leading Biotech Companies, Academic Publisher, 2014.
3. M. O'neill & M. M. Hopkins, A Biotech Manger's Handbook – A Practical Guide, Woodhead Publishing, 2012.