Faculty of Life Sciences

JSS ACADEMY OF HIGHER EDUCATION & RESEARCH
(DEEMED TO BE UNIVERSITY) MYSURU

JSS Academy of Higher Education & Research
(Deemed to be University)
Re-Accredited "A+" Grade by NAAC
Sri Shivarathreeshwara Nagara Mysuru - 570015, Karnataka

Syllabus

M.Sc. MICROBIOLOGY

As per UGC's Learning Outcome Based Curriculum Framework (LOCF) under the CBCS pattern
Implementation Year 2021-22 onwards

MSc

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M.Sc. Microbiology

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M.Sc. Microbiology

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M.Sc. Microbiology

Foreword

Microbiology is the captivating science that assists in acquiring the knowledge on processes of living systems. This science is emerging and evolving with new stature among all the biological sciences. Increasing issues with climate change, health, environment, industries, agriculture etc., the branch of science participates and pays significant role in balance of the ecosystem as of their ubiquitous nature. Nevertheless, the threats posed alongside the assistance, makes the study exceptionally essential. MSc Microbiology purveyed provides wide array of comprehensive learning that suffice all the essentials among the stakeholders. The proficiency aids in application of the knowledge in various sectors of science viz., food safety, soil health, crop protection, therapeutics etc., and in research, where, in all the aspects of biological disciplines, Microbiology has something that contributes. MSc Microbiology course is designed with concise statement of the contents that emphasize more on the significant amalgamate of basic and applied aspects of research. This facilitates the buildout for the Entrepreneurship, Skilled professionalism in Academia, Research, Industry set-up fraternity and finally to the Society in particular.

Course Overview

Programme Objectives

Microbiology is one of the fascinating and dynamic science. It is constantly being evolved and more information is being added in continuation with the existing literature including all the microbiological techniques being rapidly modified and refined. Microbiologists and other scientists employ the scientific method to understand natural phenomena. It provides a blend of traditional and contemporary knowledge of microbiological science to meet the pedagogical needs of all students pursuing master's in microbiology. The Master degree course covers the studies of microorganisms, their effect on human, environment, society etc., the applied aspects and branches of microbiology. The course is career oriented and precisely towards entrepreneurship after successful completion of the course.

- To provide basic insight on the diversity which intersects with many other disciplines of Life Sciences.
- To facilitate basic research approach in Microbiology that leads to the better understanding of molecular techniques that are used to study and comprehend complex forms from microbes to humans including diagnostic areas like Biotechnology, Synthetic biology, production of therapeutic proteins etc.,
- To enable the stakeholders to explore the intricacies of life forms, cellular, molecular and at Nano level.
- To accelerate the creative power and capability in Microbiology that promotes to apply the advanced principles for managing the accurate diagnostic study
- To promote the stakeholders to design their careers in various branches of Microbiology viz., Food, Diary, Agricultural, Industrial, Environmental sectors in academia, research and development, corporate including entrepreneur set-ups.

Programme Outcomes (PO)

- With the course structure and type of experience and skills the students will benefit profoundly in gaining exposure to the latest trends and concepts that equip them with facility of building successful career
- Microbiologists work for a wide range of employers, including hospitals, universities, industries including pharmaceuticals, agrochemicals, food and drinks, consumer goods and water supply, corporate fields, Agri-Chemical Companies, Environmental Consultancy, etc.,
- Competent with the knowledge obtained with critical and updated version in different fields of microbiology enables to find impetus avenues in different branches of science.

- When the discipline of Microbiology is strong and intellectually vibrant, there exists better avenues in different fields as research officer, food and hygiene quality controller, medical coding trainers, etc.,

M.Sc. Microbiology Course Suitability

- Research and development in the field of Life Sciences
- To design the career towards academics
- The course is suitable to establish the career in Pharmaceutical Industries, Food Processing, Biotechnology and Bioremediation fields.
- Corporate Companies with Life Science literacy

How is M.Sc. Microbiology Course Beneficial?

- The roles of microorganisms in the life of human and the environment are better understood. This favors in focusing towards the area interested to design the career.
- The course gives good base to pursue M.Phil. and Ph.D. degree
- Placement opportunities in hospitals, clinical laboratories, brewing industries, Diary industry, fulfilling different roles depending on their interests and qualifications.
- Microbiology and immunology provide major inputs to physiology and infections associated with the disease hence several organizations involved in microbiological research offer opportunities for microbiologists.
- To handle industrial production organisms or cultures on various aspects including preservation and maintenance and carryout various microbiological operations involved in bacterial and fungal fermentations from Lab-scale to Pilot-Scale to industrial – scale.

M.Sc. Microbiology Employment areas

- Research and development firms
- Educational Institutions
- Food and Beverage Companies
- Food Standard Agencies
- Waste Management Companies
- Pharmaceutical Companies
- Agri-Chemical Companies
- Environmental Consultants
- Water Companies

M.Sc. Microbiology Job Types

- Research Officer
- Microbiologist

- Food & Hygiene Quality Controller
- Associate Consultant - Health Care
- Quality Systems Coordinator
- Professor & Associate Professor
- Trainer Scientific Officer
- Project Assistant and Field Assistant
- Medical Coding Trainer
- Chief Hygienist
- Microbiology Lab Technician
- Executive/Sr. Executive

M.Sc. Microbiology Eligibility

- Any undergraduate Science Degree recognized by UGC with Biology as one of the subjects

Advance Courses in M.Sc. Microbiology

- M. Phil (Microbiology)
- Ph. D (Microbiology)

M.Sc., MICROBIOLOGY

Sl. No.	Study Components and Code	Title of the Paper	Hours of Instruction/ Week	Examination				Total Credit
				Duration in Hours	CIA	Theory/ Practical Exam	Max. Marks	
SEMESTER I								
1	DSC 01	Virology & Parasitology	4	3	30	70	100	4
2	DSC 02	Bacteria & Archaea	4	3	30	70	100	4
3	DSC 03	Mycology & Phycology	4	3	30	70	100	4
4	AECC	Principles of Statistics	2	2	-	50	50	2
5	SEC 01	Research Methodology	2	2	-	50	50	2
6	Practical 01	Virology, Parasitology, Bacteria & Archaea	4	3	15	35	50	2
7	Practical 02	Mycology & Phycology	4	3	15	35	50	2
	Total Marks and Credits						**500**	**20**
SEMESTER II								
1	DSC 04	Microbial Enzymology & Physiology	4	3	30	70	100	4
2	DSC 05	Soil Microbiology & Plant Health	4	3	30	70	100	4
3	DSC 06	Food & Dairy Technology	4	3	30	70	100	4
4	DSE 01a **(OR)** DSE 01b	Intellectual Property Rights, Biosafety & Bioethics **(OR)** Biofertilizers, Biomanure & Biopesticides	4	3	30	70	100	4
5	DSE 02a **(OR)** DSE 02b	Microbial Nanotechnology **(OR)** Pharmaceutical Microbiology	4	3	30	70	100	4
6	SEC 02	Bioinstrumentation & Bioanalytical Techniques	2	2	-	50	50	2
7	Practical 03	Microbial Enzymology & Physiology	4	3	15	35	50	2
8	Practical 04	Soil Microbiology, PlantHealth & Food and Dairy techniques	4	3	15	35	50	2
	Total Marks and Credits						**650**	**26**

SEMESTER III								
Sl. No.	**Study Components and Code**	**Title of the Paper**	**Hours of Instruction / Week**	**Examination**				**Total Credit**
				Duration in Hours	**CIA**	**Theory/ Practical Exam**	**Max. Marks**	
1	DSC 07	Medical Microbiology & Immunology	4	3	30	70	100	4
2	DSC 08	Molecular Biology & Genetic Engineering	4	3	30	70	100	4
3	DSC 09	Industrial Microbiology & Fermentation Technology	4	3	30	70	100	4
4	**DSE 03a** (OR) **DSE 03b**	Advances in Bioremediation & Microbial Technology **(OR)** Disease Diagnostic Technology	4	3	30	70	100	4
5	SEC 03	Introduction to Bioinformatics	2	2	-	50	50	2
6	Practical 05	Medical Microbiology, Immunology & Molecular Biology techniques	4	3	15	35	50	2
7	Practical 06	Industrial Microbiology & Fermentation Technology	4	3	15	35	50	2
8		Internship	-	-	-	-	50	2
	Total Marks and Credits						**600**	**24**
SEMESTER IV								
	Dissertation						**300**	**12**
	Total (Semester I to IV)						**2050**	**82**

Abbreviations:

DSC – Discipline Specific Core

DSE – Discipline Specific Elective

AECC – Ability Enhancement Compulsory Course

SEC – Skill Enhancement Course

Students may choose any one elective course among the choice offered, specific to the discipline

*Project Proposal, Presentations, Teamwork and Professional Ethics, Industrial/Institutional Visits etc.

Semester One

SEMESTER ONE

No. of hours/week	Credits
4	4

DSC 01: VIROLOGY& PARASITOLOGY

Course Objectives: The course

- Enables to understand modern virology including areas of virus biology, pathogenesis and disease control
- Introduces the advanced concepts of parasitology and host-parasite relationship
- Gives a broad perception of epidemiology of virus and parasitic diseases

Course Outcomes: At the end of the course, learners will be able to

- Understand the basic concepts in the field of virology and apply these concepts to problems in the field of virology
- Describe the viral diseases and their etiology.
- Understand and explain the concept of parasitism and apply the same in various human and veterinary parasite control and treatment.
- Describe the parasitic diseases and their etiology.

UNIT I
INTRODUCTION TO VIROLOGY

History, Brief outline on discovery of Viruses, Distinctive properties of Viruses; Morphology & ultrastructure (Capsid Symmetry, Helical Capsids, Icosahedral Capsids, Enveloped and Non enveloped Viruses, Complex Virus Structures, Protein–Nucleic Acid Interactions, and Virus Receptors). Nomenclature and classification of Viruses.
Viral Genetics: Lytic and Lysogenic cycles, Phage Phenotypes, Phenotypic Mixing, Recombination in viruses: Mutations, Recombination and Mapping. Bacteriophage, Bacteriophage typing, application in bacterial genetics.
Sub-viral agents (Satellites and Viroids, Prions), New and Emerging Viruses.

UNIT II
TYPE STUDY OF VIRUSES

Types of viruses: Epidemiology, life cycle, pathogenicity, diagnosis, prevention, and management of diseases - DNA Viruses- Pox viruses (varicella zoster), Herpes viruses (Herpes Simplex 1 and 2), Hepatitis viruses (HBV).
RNA Viruses- Picorna (Polio), Orthomyxo (Influenza), Paramyxo (Measles morbilli, Rubulla measles), Toga virus (Rubella) Flavivirus (Dengue), Corona virus (SARS-CoV- 2), Rhabdo virus (Rabies virus), Retrovirus (HIV), oncogenic viruses (HPV).
Viruses of cyano-bacteria, algae, fungi, plants (TMV and CMV) and insects.

UNIT III
INTRODUCTION TO PARASITOLOGY

Introduction and Classification of Parasites
Epidemiology, life cycle, pathogenicity, diagnosis, prevention, and management of diseases: Intestinal amoebae - Entamoeba histolytica, Free living amoebae – Naegleria fowleri, Intestinal and genital flagellates – Giardia lamblia, Trichomonas vaginalis. Blood and tissue flagellates – Leishmania donovani and Trypanosome cruzi, Malarial parasites – Plasmodium, Coccidian – Toxoplasma gondii.
Laboratory techniques in parasitology - Examination of feces - Direct and concentration methods.

UNIT IV
TYPE STUDY OF PARASITES

Study of Helminthes: Epidemiology, life cycle, pathogenicity, diagnosis, prevention, and management of diseases- Taenia solium, Schistosomes, Ascaris lumbricoids, Trichuris, and Wuchereria bancrofti.
Blood smear examination, cultivation of protozoan parasites, serology, and PCR techniques.

Recommended Textbooks and References:

1. Dimmock NJ, Easton AJ and Leppard KN. (2016). Introduction to Modern Virology . 7th Edition, John Wiley & Sons Inc.
2. Hempel PS. (2011). Evolutionary Parasitology: The Integrated Study of Infections, Immunology, Ecology, and Genetics, 1st edition, Oxford University Press.
3. Hofkin B and Loker ES. Parasitology: A Conceptual Approach.1st edition .Taylor & Francis Inc.
4. Pitt SJ and Gunn A. (2012). Parasitology - an Integrated Approach, 1st edition, John Wiley and Sons Ltd.
5. Roberts LS, Nadler S and Janovy J. (2012). Foundations of Parasitology, 9th edition, McGraw-Hill Education, Europe.
6. Roossinck MJ, Zimmer C. (2016). Virus: An Illustrated Guide to 101 Incredible Microbes, 1st Edition, Princeton University Press.
7. Richman DD, Whitley R and Hayden F. (2017). Clinical Virology. 4th New edition. American Society for Microbiology.
8. Rollinson D, Stothard R. (2017). Advances in Parasitology: Volume 98, 1st edition, Elsevier Science Publishing Co Inc.
9. Payne S. (2018).Viruses.1 st Edition, Elsevier Science Publishing Co Inc.
10. Flint SJ, Enquist LW, Krug RM, Racaniello VR and Skalka AM. (2004). Principles of Virology, Molecular biology, Pathogenesis and Control.2nd edition. ASM press Washington DC.
11. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.

SEMESTER ONE

No. of hours/week	Credits
4	4

DSC 02: BACTERIA AND ARCHAEA

Course Objectives: The course

- Introduces a broad view of bacterial molecular systematics and archaeal groups.
- Discusses the different disease-causing bacterial pathogens and applications o archaebacteria.

Course Outcomes: At the end of the course, the learners will be able to

- **Understand** systematics and general characteristics of bacteria.
- **Identify** different disease-causing bacterial pathogens.
- **Discuss** the characteristics and different groups of archaea.
- **Differentiate** between archaea and bacteria genomic organization.

UNIT I
AN OVERVIEW OF BACTERIA

General discussion on the occurrence, diversity, characteristic features, and significance. Conventional and molecular systematics.
Recent trends in Microbial Taxonomy: Molecular method: DNA homology, DNA-RNA homology, G + C ratio, rRNA sequencing; Genetic methods and Serological methods in taxonomy; Taxonomy based on ecology.
A brief account on general characteristics, classification, diversity, distribution & economic importance of Actinomycetes, Cyanobacteria, Bioluminescent bacteria; Mechanism of bioluminescence and its applications.
Bacterial Genetics: Bacterial Transformation: Types of transformation mechanisms found in prokaryotes, Bacterial Conjugation: properties of the F plasmid, F+ x F - mating, F' x F- conjugation,Hfr conjugation. Transduction: Generalized and specialized transduction, Transposable elements.

UNIT II
MEDICAL BACTERIOLOGY

Morphology, classification, cultural characteristics, pathogenicity, laboratory diagnosis, prevention, and control: Staphylococci, Neisseriae (Gonococci & Meningococci), Corynebacterium, Mycobacterium, and Clostridium.
Studies on Salmonella, Shigella, Vibrios; Gram Negative anaerobes – Spirochetes, Rickettsiae, Chlamydiae, Mycoplasmas and Uredoplasma.

Bacterial Zoonotic diseases (Anthrax and Brucellosis) and their control; Hospital acquired infections, Hospital waste disposal.

UNIT III
AN OVERVIEW OF ARCHAEA

General Characteristics of Classification, Role of Archaebacteria in the evolution of Microbial world.
Cellular organization: cell morphotypes, cell envelopes -archaeal membrane lipids and cell wall, appendages -pili, flagella, cannulae, hami.
Nutrition, growth and growth kinetics and physiological versatility, genera belonging to *Nanoarchaeota (Nanoarchaeum); Crenarchaeota (Sulfolobus; Thermoproteus) Methanogens (Methanobacterium thermoautotrophicum); Halophiles (H. salinarum); Thermophiles (Thermoplasma acidophilum); Thermoacidophiles (Sulfolobus acidocaldarius); Psychrophilic archaea (Methanogenium frigidum, Methanococcoides burtonii); Methanotrophs.*

UNIT IV
GENOME ORGANIZATION IN ARCHAEA

Genome structure, Size of genome, G + C content, associated proteins, archaeal histones and nucleosomes, introns in archaea, archaeal RNA polymerases, reverse DNA gyrase.
lasmids, transposons -IS elements. Modifications in tRNA and rRNA structure. Novel 7S rRNA. DNA replication, translation, and transcription in archaea.
Applications of archaebacteria in various fields.

Recommended Textbooks and References:

1. Pommerville, J.C. (2013). Alcamo's Fundamentals of Microbiology. 10th edition. Jones and Bartlett Learning, USA.
2. Ricardo Cavicchioli, R. (2007). Archaea Molecular and Cellular Biology. American Society of Microbiology, USA
3. Sherwood, and Woolverton Willey (2007), Prescott, Harley, and Klein's Microbiology (7th
4. International Edition), McGraw-Hill
5. Michael T. Madigan, David P. Clark, David Stahl, John M. Martinko, 2012, Brock Biology of Microorganisms 13th Edition.
6. Jacquelyn G. Black (2012) Microbiology: Principles and Explorations ,8th edition, Wiley
7. Michael J. Leboffe, Burton E. Pierce , David Ferguson (2012) Microbiology Laboratory Theory& Application, Brief, 2nd Edition, Morton Publishing Company
8. Richard Tanner Hewlett, 2011, Bacteriology, ,1st edition, Nabu Press, ISBN10: 1248153510, ISBN13: 9781248153512
9. Frederick Carl Zapffe, 2016. Bacteriology, 1st edition, Palala Press, ISBN10:135879412X, ISBN13:9781358794124
10. Blum, P., Archaea: New Models for Prokaryotic Biology, Academic Press.
11. Barker, D. M., Archaea: Salt-lovers, Methane-makers, Thermophiles and Other Archaeans, Crabtree Publishing Company.
12. Munn, C., Marine Microbiology: Ecology and Applications, Garland Science, Taylor and Francis Group, N.Y.
13. Boone, D. R. and Castenholz, R. W., Bergey's Manual of Systematic Bacteriology: The Archaea and The Deeply Branching and Phototrophic Bacteria, Springer Science and Business Media.

SEMESTER ONE

No. of hours/week	Credits
4	4

DSC 03: MYCOLOGY & PHYCOLOGY

Course Objectives: The course

- Introduces to the concept of mycology including classification, structure, life cycle, genetic, growth, nutrition, and economic importance of fungi
- Outlines the classification and general overview and ecology of algae
- Imparts knowledge of the beneficial and harmful effects of algae, their economic importance, and applications in various fields

Course Outcomes: At the end of the course, learners will be able to

- Understand the role of fungi in ecology and its economic importance.
- Explain the significance of fungi in human health and diseases.
- Classify algae based on their characteristics, ecology, and classification.
- Understand and analyze thallus organization, reproduction, and life cycles of different groups of algae.

UNIT-I
INTRODUCTION TO MYCOLOGY

History and development of Mycology, General characteristics of fungi : Morphology and somatic structures (thallus , organization, fungal cell, nuclear components, specialized somatic structures; Aggregation of hyphae, tissues, mycangia); fungal nutrition and reproduction (Asexual, Sexual reproduction, Heterothalism and Parasexuality) Taxonomy, Classification of fungi. Fungal Associations: Lichens – ascolichens, basidiolichens, deuterolichens; Mycorrhiza – ectomycorrhiza, endomycorrhiza, vesicular arbuscular mycorrhiza. Fungi as insect symbiont.

Salient features: Myxomycota, Phycomycota, Plasmodiophoromycota, Hypochytriomycota, Labyrinthulomycota, Oomycota, Chytridiomycota, Zygomycota, Ascomycota, Basidiomycota, Deuteromycota.

Economic importance of fungi: Importance of fungi in agriculture, industry and medicine. Fungi as biocontrol agent, Fungi as SCP, Fungi as parasites of human and plants. Role of fungi in biodeterioration of wood and paper. Note on mycotoxins.

UNIT-II
CLINICAL MYCOLOGY

Clinical classification of fungi- Superficial, subcutaneous, systemic and opportunistic mycoses; pathogenesis and spectrum of diseases. Immunity to fungal infections. Note on mycotoxins.
General characteristics, epidemiology and pathogenesis, spectrum of disease of mucorales (Mucor), dermatophytes (Trichophyton), systemic (Candida), superficial (Tinea sp) and opportunistic mycoses (Aspergillus).
Fungal Genetics: Neurospora- Tetrad analysis and linkage detection - 2 point and 3 point crosses,chromatid and chiasma interference, Mitotic recombination in Neurosporaand Aspergillus.
Diagnostic Mycology: Lab diagnosis- Collection, transport and culturing of clinical specimens; Culture media and incubation. Direct microscopic observation, serologic testing, molecular methods and MALDI TOF; Antifungal agents - testing methods.

Unit-III
CLASSIFICATION AND ECOLOGY OF ALGAE

History, classification, and ecology of algae: Definition, General characteristics, phases of development of phycology, scope of modern phycology, Classification of algae: Types of classification, Fritsch's classification.
Habitat, diversity, Phytoplankton, marine epilithic, freshwater and soil algae. Algal ecology at extreme temperatures, ecology of algae in symbiotic associations.
Algal Genetics: Chlamydomonas- unordered tetrad analysis - Recombination and Mapping, Nucleocytoplasmic interactions and gene expression in Acetabularia. Extra nuclear (cytoplasmic) inheritance.

UNIT-IV
TYPE STUDY AND ECONOMIC IMPORTANCE

Type study and Culturing of algae: General thallus organization, reproduction types and life cycles in algae, type study of Chlorophyceae (Chlamydomonas), Xanthophyceae (Vaucheria), Bacillariophyceae (Diatoms), Pheophyceae (Sargassum), Rhodophyceae (Gracilaria), Myxophyceae (Anabaena).
Laboratory and commercial cultivation of algae: Different kinds of algal cultures, isolation of algal cultures, Culture media for algae, laboratory culturing of algae, importance of laboratory culture.
Economic importance: Harmful and beneficial aspects of algae, Algae as primary source of food and energy (single cell protein and biofuels). Applications in the field of agriculture, bioremediation, pharmaceutics, cosmetics, sewage and research.

Recommended Textbooks and References:

1. OP Sharma. (2017). Algae. McGraw Hill Education (0070681945, 978-0070681941)
2. BR Vashishta, AK Sinha, VP Singh. Botany for Degree Students Algae. S Chand &Company, 2 edition (8121935210, 978-8121935210)
3. GR South, A Whittick (2009). An Introduction to Phycology, Wiley publications (1444314203, 9781444314205)
4. Robert Edward Lee. (2018). Phycology, 5th Revised edition,Cambridge University Press, ISBN10: 1107555655, ISBN13: 9781107555655
5. Helga Meyer and Dagmar Krueger. (2012). Algae : Ecology, Economic Uses & Environmental Impact, 1st edition, Nova Science Publishers Inc, ISBN10: 1620812800, ISBN13: 9781620812808
6. Yusuf Chisti and FaizalBux. (2016). Algae Biotechnology : Products and Processes, 1st edition, Springer International Publishing AG, ISBN10: 3319123335, ISBN13: 9783319123332.
7. Alexopoulas C J and Mims C W and M Blackwell. (2007). Introductory Mycology 3rd edn, Wiley Eastern., NewDelhi.
8. Mehrotra, RS &Aneja, K R, (2015). An Introduction to Mycology. New Age International Pvt. Ltd. New Delhi.
9. Mercedes S. Foster& Gerald F. Bills. 2011. Biodiversity of Fungi: Inventory and Monitoring Methods. Academic Press
10. Michael John Carlile, Sarah C. Watkinson, G. W. Gooday. 2007. The fungi. Academic Press. London, U. K
11. Kevin Kavanagh. 2011. Fungi: Biology and Applications. John Wiley & Sons, Sussex, U.K.
12. David Moore, Geoffrey D. Robson, Anthony P. J. Trinci. 2011. 21st Century Guidebook to Fungi. Cambridge University Press.

SEMESTER ONE

No. of hours/week	Credits
2	2

AECC: PRINCIPLES OF STATISTICS

Course Objectives: The Course

- Provides knowledge about both theoretical and practical aspects of statistics, to bring them in contact with basic concepts and methods in Statistics.
- Emphasizes on a problem-solving attitude with the aid of statistical methodology.

Course Outcomes: At the end of the course, learners will be able to

- Explain and construct the frequency distribution and graphical methods.
- Describe the types of probability and apply it in statistical methods.
- Analyze sampling methods and understand the concept of population.
- Perform Test of Hypothesis and understand the concept of p-values

UNIT-I

Descriptive statistics

Importance and Scope of Statistics, Data Types, Variables, Frequency Distribution, Graphical Representation Methods (Histogram, Bar Charts, Pie Charts), Measures of Center Tendency (Mean, Median, Mode,) and Dispersion (Standard Deviation, Variance) Advantages and Disadvantages.

UNIT-II

Probability

Basic Terminology: Trial, Events, Sample Space and Sample Points, Basic Laws of Probability, Types of Probability, Normal probability curve, Standard Normal Distribution, Bayes theorem - simple problems.

UNIT-III

Sampling Methods

Concept of Population, Sample, Sampling, Sample Size, Sampling Error, Advantages and Disadvantages of Sampling Method, Types of Random Sampling Methods – SRS, Stratified Random Sampling, Systematic Random Sampling and Cluster Sampling.

UNIT-IV

Testing of Hypotheses

Statistical Hypotheses-Null and Alternative, Level of Significance, Type I and Type II Error, P Value, Degrees of Freedom, Chi-Square Test, Student's t Test: One Sample t Test and Paired and unpaired t Test, Analysis of Variance. Correlation-Karl Pearson's and Spearman's rank correlation. Regression Analysis.

Recommended Textbooks and References:

1. Fundamentals of Biostatistics. Veer Bala Rastogi. Publisher: ANE Books. 2nd Edition, 2009.
2. Fundamentals of Mathematical Statistics, S.C. Gupta and V. K. Kapoor, Publisher: Sultan Chand & Sons (2014).
3. Fundamentals of Statistics. S.C. Gupta. Publisher: Himalaya Publishing House Pvt. Ltd.Edition.7th Edition, 2012
4. Introductory Statistics for Biology. R. E. Parker. Publisher: Cambridge University Press 2nd Edition, 1991.
5. Statistics for behavioral science. Chintamani Kar. Publisher**:** Dominant Publishers & Distributors (P) Ltd. (2015).

SEMESTER ONE

No. of hours/week	Credits
2	2

SEC 01: RESEARCH METHODOLOGY

Course Objectives: The Course

- Provides knowledge on research methodology, types of research and formulation and designing of research problem.
- Emphasizes on ethical issues in research and provides knowledge on scientific writing.

Course Outcomes: At the end of the course, learners will be able to

- Explain the types of research and formulate a research problem.
- Describe the basic principles of experimental design types and tools for data collection.
- Understand the overview and research misconduct and ethical issues in research.
- Discuss and understand the significance of scientific writing and concept of interpretation.

UNIT I
RESEARCH FORMULATION

Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research.
Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.

UNIT II
RESEARCH DESIGN

Meaning, Need, Features of Good Design, Concepts, Types. Basic principles of Experimental Design, various methods of Research. Survey, Philosophical, Historical, Experimental, Causal Comparative, Genetic, Case Studies.
Tools for Data Collection: Collections of Primary Data, Collection of Data through questionnaire and Schedules, other Observation Interview Methods, Collection of Secondary Data, Selection of appropriate method for data collection, Case Study, Focus Group Discussion, Techniques of developing research tools, viz. Questionnaire and rating scales etc. Reliability and validity of Research tools.

Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically package (Sigma STAT, SPSS for student t-test, ANOVA, etc.), hypothesis testing.

UNIT III
ETHICAL ISSUES IN RESEARCH

Introduction, overview and research misconduct, rules and regulations in India, data management, mentoring, mentor - mentee responsibilities, authorship guidelines, publication and peer review, intellectual property, plagiarism, patents, collaboration, reporting and representation research, representing images.
Bias, conflicts of interest, ethical use of animal subjects, protection of human subjects, stem cell ethics, Eco sourcing code of practice, radioactive, chemical and biohazard safety, waste management and disposal, social responsibility.

UNIT IV
SCIENTIFIC WRITING

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation.
Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

Recommended Textbooks and References:

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
7. Satarkar, S.V., 2000. Intellectual property rights and Copy right. Ess Ess Publications.

SEMESTER ONE

No. of hours/week	Credits
4	2

Practical 01- Virology, Parasitology, Bacteria & Archaea

1. Isolation of coliphages from sewage (Plaque assay for bacteriophage)
2. Enumeration of bacteriophage in a sample by plaque forming unit (PFU method)
3. Isolation and identification of protozoa from sewage
4. Preparation of smear and identification of blood parasites (preparation of stains andready slides (Leishmania, Trypanosome and Plasmodium)
5. Isolation of bacteria from soil and water.
6. Identification of bacteria- Colony morphology, staining and biochemical characteristics.
7. Study of bacterial growth curve and determination of growth rate of E. coli.
8. Endospore formation and staining in Bacillus spp.
9. Capsule staining in bacteria.
10. Antimicrobial sensitivity test and demonstration of drug resistance.
11. Determination of minimum inhibitory concentrations (MICs) of antimicrobial agents.

Practical 02 - Mycology & Phycology

1. Isolation of fungi from rhizosphere.
2. Isolation of aquatic fungi by baiting technique.
3. Direct examination of infected tissues (skin/nail/hair) for dermatophytes.
4. Isolation of yeast from different sources
5. Enumeration of fungal spores/ cells by Haemocytometer
6. Study of the following representative genera: Aspergillus, Penicillium, Fusarium, Neurospora, Saccharomyces, Polyporus, Agaricus, Puccinia, Ustilago, Alternaria, Drechslera, Saprolegnia, Rhizopus, Trichoderma and symbiotic fungi- Lichens.
7. Isolation and identification of cyanobacteria from soil
8. Isolation and identification of cyanobacteria from freshwater
9. Study of the following representative genera: Chalmydomonas, Vaucheria, Sargassum, Diatoms, Gracilaria, Anabaena.
10. Biodegradation of agricultural waste by fungi

Semester Two

SEMESTER TWO

No. of hours/week	Credits
4	4

DSC 04: MICROBIAL ENZYMOLOGY & PHYSIOLOGY

Course Objectives: The course

- Provides the knowledge about enzymes and their basic working principles, concepts of immobilization technologies, biosensors and their applications and apply the knowledge of enzyme purification and characterization in research and industry.
- Enables to understand the importance of metabolism & Physiology in Microbial Growth

Course Outcomes: At the end of the course, the learners will be able to

- Understand and apply the concepts and principles of enzymology
- Explain the structure and function of enzymes, kinetics, and regulation mechanisms
- Analyze and apply concepts of enzyme applications and technologies in various fields including industry, medicine etc.
- Understand the importance of enzyme immobilization and biosensors

UNIT-I
BASIC CONCEPTS AND ENZYME KINETICS

Principles of catalysis – collision theory, transition state theory. Definition, Structure, Classification and Properties of enzymes; Mechanism of Enzyme actions: Lock and Key model, induced fit Theory; concept of active site; energetics of enzyme substrate complex formation; Factors affecting rates of enzyme mediated reactions.
Kinetics of single substrate reactions: Michelis – Menten equation, Km and Vmax, turnover number. Enzyme inhibition - competitive, non-competitive, uncompetitive, mixed inhibition; double reciprocal plot; Enzyme regulation.

UNIT-II
PURIFICATION, CHARACTERIZATION AND APPLICATION OF ENZYMES

Production and purification of crude enzyme extracts from plant, animal and microbial sources: ammonium sulphate precipitation, dialysis and chromatographic techniques (gel filtration, ion exchange, affinity, hydrophobic interaction chromatography, HPLC); polyacrylamide gel electrophoresis (SDS-PAGE).
Methods of characterization of enzymes (temperature, pH, kinetic constants, substrate specificity, determination of molecular weight, effect of metal ions, chelating and denaturing

agents, and isoelectric point). Enzymatic assays – Enzyme activity and specific activity concept, Continuous and discontinuous assays.
Enzyme Immobilization and Biosensors: Physical and chemical techniques for enzyme immobilization- examples, advantages and disadvantages, design of enzyme electrodes (biosensors) and their applications. Industrial applications of enzymes.

UNIT-III
MICROBIAL PHYSIOLOGY

Microbial Energetics, Basic aspects of bioenergitics, entropy, enthalpy, electron carriers, artificial electron donors, inhibitors, uncouplers, energy bond, phosphorylation.
Microbial Photosynthesis: Photosynthetic Pigments and apparatus in bacteria. Oxygenic and AnoxygenicPhotosynthesis. Autotropic CO_2 fixation and mechanism of Photosythesis. Utilization of light energy by Halobacteria.
Autotrophic Mechanisms in bacteria: Hydrogen bacteria, Nitrifying bacteria, Purple sulfur bacteria, Non-sulfur bacteria, Green sulfur bacteria, Iron bacteria, Methylotrophs; Microbial Stress Responses: Oxidative stress, Thermal stress, Starvation stress, Aerobic to anaerobic transitions. Biofilm and quorum sensing.

UNIT-IV
MICROBIAL METABOLISM

Nucleic acid metabolism: Biosynthesis and degradation of purines and pyrimidines.
Carbohydrate metabolism Glycolysis, Citric acid Cycle and different types of Phosphorylation, Fates of pyruvate, Fermentation. Utilization of sugars other than glucose: Lactose, Galactose, Maltose, Mannitol. Degradation of cellulose, Starch and Glycogen.

Recommended Textbooks and References

1. Cook Paul F and Cleland WW. (2007). Enzyme Kinetics and Mechanism. Garland Science, New York
2. Hsiu-Chiung Yang, Wu-Kuang Yeh, JR, McCarthy. (2015). Enzyme Technologies: Pluri potent Players in Discovering Therapeutic Agent, Wiley-Blackwell, ISBN-10: 0470286261, ISBN-13: 978- 0470286265
3. Nelson DL and Cox MM (2005). Lehninger's Principles of Biochemistry, Fourth New York.
4. Nooralabettu KP (2011). Enzyme Technology Pacemakar of Biotechnology, PHI Learning Pvt. Ltd., New Dehli
5. Palmer T. (2004). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Affiliated East West Press Pvt. Ltd., New Delhi
6. Pandey A, Webb C, Soccol CR, Larroche C. (2005). Enzyme Technology, Asiatech
7. RA Crowther. (2016). Methods in Enzymology, 1st Edition, Academic Press Publisher, ISBN- 13: 978-0128053829, ISBN-10: 0128053828
8. Shanmugam S and Sathishkumar T. (2009). Enzyme Technology, I K International, New Delhi.

9. Stryer L. (2004). Biochemistry, 5th Edn., W. H. Freeman & Co., New York.
10. Trevor Palmer and Philip Bonner (2014). Enzymes: Biochemistry, Biotechnology, Clinical Chemistry,2nd Edition, AbeBooks Seller,ISBN 10: 1904275273 ISBN 13: 9781904275275
11. Albert G. Moat, Michael P. Spector John W. Foster (2009) Microbial Physiology,BWSTM
12. Daniel R.Caldwell (1999) Microbial Physiology and metabolism,; Star Pub Co
13. Albert G. Moat,Michael P. Spector John W. Foster (2009) Microbial Physiology; BWSTM
14. Daniel R.Caldwell (1999) Microbial Physiology and metabolism ; Star Pub Co
15. Robert K. Poole (2014) Advances in Microbial Systems Biology, Volume 64 (Advances in Microbial Physiology); Academic Press.

SEMESTER TWO

No. of hours/week	Credits
4	4

DSC 05: SOIL MICROBIOLOGY & PLANT HEALTH

Course Objectives: The course

- Introduces the fundamental concepts of plant disease, differences between symptom, sign, infectious and non-infectious diseases.
- Enables to understand the importance of plant disease control for economic and environmental sustainability and to obtain healthy crops; to reduce infectious disease in plants and about the concept of integrated disease management.

Course Outcome: At the end of the course, learners will be able to,

- Explain the structure of soil and interactions among microorganisms
- Describe host pathogen interaction and defense mechanism
- Identify disease symptoms, major infective crop diseases and their economic impact
- Interpret the principle of disease control and integrated disease management.

UNIT-I
SOIL MICROBIOLOGY

Characteristics and classification of soil: physical, chemical and biological, soil profile and soil formation. Interaction of microbes with plants (positive and negative interactions): Rhizosphere, phyllosphere, mycorrhizae.
Nitrogen cycle, Symbiotic and Asymbiotic Nitrogen Fixation – mechanism and genetics of Nitrogen Fixation.

UNIT-II
PLANT PATHOLOGY

Plant pathogens and classification of plant diseases. Host-pathogen recognition and specificity. Principles of plant infection and defense mechanisms - entry of pathogen in to host, colonization of host, role of enzymes, toxins and growth regulatory substances.
Defense mechanisms in plants – Structural, biochemical, and molecular aspects of host defense reactions.

UNIT-III
PLANT DISEASES

Plant pathogens type study - Study of the following diseases (Epidemiology, life cycle, pathogenicity, diagnosis, prevention and management of): Tobacco mosaic, Bacterial blight of paddy, Blast of Paddy, Red rot of sugarcane, Citrus canker, Leaf spot of mulberry, Sandal Spike, Root knot of mulberry, Tikka disease of Groundnut, Downey mildew and powdery mildew of grapes, Bunchy top of Banana, Fusarium wilt of Banana.

UNIT-IV
EPIDEMIOLOGY AND MANAGEMENT OF PLANT DISEASES

Methods used in plant-disease forecasting (weather-based predictions, inoculum-based predictions and host physiology based predictions).
Cultural and chemical methods for exclusion, eradication of pests and pathogens for protection of plants (Crop rotation, tillage, fertilization, irrigation, selection of the cultivar(s) and site ofcultivation, plant and soil management, pruning, phytosanitation, seed treatment). Breeding for disease resistance and application of integrated methods of plant disease control.

Recommended Textbooks and References

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego.
2. Vidhyasekaran P. (2004). Concise encyclopedia of plant pathology, Food Products, Crop science.
3. Mehrotra RS. Plant pathology. Tata Mc Graw Hill Publication, New Delhi.
4. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Lucas JA. (2002). Plant Pathology and Plant Pathogens. 4th edition. Blackwell Science, Oxford.
6. Singh RS. (2001). Plant Diseases Management. 8th edition. Oxford & IBH, New Delhi.
7. Vidhyasekaran P. (2008). Fungal pathogenesis in plants and crops: molecular biology and host defence mechanisms. 2nd edition. CRC Press.
8. Subbarao NS. (1994). Soil Microorganisms and Plant Growth. Oxford & IBH Pvt. Ltd. New Delhi.
9. Singh RS. (1998). Plant diseases 7th edition. Oxford and IBH Publish.Co. New Delhi.
10. Sharma PD. (2004). Plant pathology. Rastogi Publ. Meerut, India.

SEMESTER TWO

No. of hours/week	Credits
4	4

DSC 06: FOOD & DAIRY TECHNOLOGY

Course Objectives: The Course

- Introduces students about occurrence and interactions of microorganisms with foods and provides information on different techniques of detecting the presence of microbes in foods.
- Provides the knowledge on food sanitation and microbiological food quality control and biological hazards in food.

Course Outcomes: At the end of the course the learners will be able to

- Explain the occurrence and interactions of microorganisms with food and demonstrate the different techniques of preserving the food through physical and chemical methods.
- Describe the types of food borne infections and intoxications and explain detection of food borne pathogens.
- Explain the role of microorganisms in fermented dairy products and in vinegar fermentation.
- Demonstrate the various techniques of detection of food borne microorganisms.

UNIT-I
MICROBIOLOGY OF FOODS & PRESERVATION METHODS

Microorganisms important in food microbiology- Molds, yeasts and bacteria, general characteristics, classification, and importance. Sources of contamination of food. Factors influencing microbial growth in food- Extrinsic and Intrinsic factors.
Food Preservation Methods- Physical: Radiations – UV, Gamma, and microwave. Temperature-High and Low temperatures, Canning. Chemical and naturally occurring antimicrobials, genetically modified foods. Biosensors in food, Applications of microbial enzymes in dairy industry (Protease, Lipases)

UNIT-II
FOOD-BORNE INFECTIONS, DETECTION OF FOOD BORNE PATHOGENS AND QUALITY ASSURANCE

Foodborne infections and intoxications; bacterial with examples of infective and toxic types – Clostridium, Salmonella, Staphylococcus, Campylobacter. Mycotoxins in food with reference to Aspergillus species.
Role of microorganisms in beverages – tea, coffee, vinegar, sauerkraut, tempe fermentations, Sausages : Fish & meat.
Detection of Food-borne Microorganisms: Culture, Microscopic and Sampling methods: SPC, DEFT, MPN. Chemical method: Thermostable nuclease Limulus Lysate for Endotoxins, Adenosine Triphosphate Measurement, Radiometry; Molecular Genetic methods: Nucleic Acid (DNA) probes, DNA Amplification (PCR); Immunologic Methods: Fluorescent Antibody, Salmonella 1-2 Test, Radioimmunoassay.
Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI. National and International microbiological standards for dairy products (BIS, ICMSF, Codex Alimentarius Standards).

UNIT-III
MICROBIOLOGY OF DAIRY PRODUCTS

Microbiology of milk and fermented milk products (cheese, ice cream, whole and skimmed milk powder, acidophilus milk, yoghurt). Factors influencing microbiological quality of dairy products during production, processing, handling, storage and distribution. Microbial defects of dairy products & their control. Utilization and disposal of dairy by-product – whey. Dairy products as functional / health foods : LAB as probiotics in development of health foods; Selection criteria, colonization and functional properties; Antibacterial and therapeutic properties of probiotic cultures; Survival and stability of probiotics in health foods, gut and their tracking; Concept of probiotics and synbiotics.

UNIT-IV
STARTER CULTURES IN DAIRY INDUSTRIES

Lactic Acid Bacteria (LAB) as starters : Types of starter cultures and their classification; Microbiology of starter cultures; Single and multiple strain cultures, and custom cultures. Associative growth of starter cultures; Concepts of starter growth and metabolism of lactose and citrate.
Modem trends in propagation, production and preservation of starter cultures; Production of starter concentrates; Starter defects; Starter failure; Intrinsic and extrinsic factors associated with starter failure; Bacteriophages of dairy starters and their impact on dairy industry; Prevention and control of starter failures. Role of starters in the preparation of fermented products (Yoghurt, Kefir, Cultured buttermilk, Cottage cheese, Pickles, Idli).

Recommended Textbooks and References

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology.1st edition. CBS Publishers and

Distributors, Delhi, India.

3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology.3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA.(2005). Modern Food Microbiology.7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

SEMESTER TWO

No. of hours/week	Credits
4	4

DSE 01a: INTELLECTUAL PROPERTY RIGHTS, BIOSAFETY & BIOETHICS

Course Objectives: The course

- Provides with sound theoretical knowledge on intellectual property rights, biosafety and bioethics.
- Imparts the knowledge on patent filing and types of patents.

Course Outcomes: At the end of the course, the learners will be able to,

- Explain about patents, patent laws, agreements, concepts of patents.
- Understand the treaties, agreements, and amendments in IPR.
- Critically analyze the patent applications for novelty and utility.
- Describe various biosafety levels, regulations of biosafety and bioethics.

UNIT-I
INTRODUCTION TO INTELLECTUAL PROPERTY IPR

Definition and types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications.
IP as a factor in R & amp; D; IPs of relevance to Microbiology / Biotechnology and few Case Studies.
WTO - Definition and Functions; Forms of IPR Protection.

UNIT-II
AGREEMENTS AND TREATIES

History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement. WIPO Treaties; Budapest Treaty.
PCT; Indian Patent Act 1970 & recent amendments.

UNIT-III
PATENT, FILING AND INFRINGEMENT

Types of patents, Patent application- types (Provisional and complete specifications), forms and guidelines, fee structure, time frames; Precautions before patenting- disclosure/non-disclosure,
Databases- Country-wise patent searches [USPTO, esp@cenet (EPO), PATENT Scope (WIPO), IPO, etc.].

UNIT-IV
BIOSAFETY AND BIOETHICS

Introduction to Biological Safety Cabinets; Primary Containment for Biohazards. Biosafety Levels; Biosafety Levels of Specific Microorganisms; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO pplications in food and agriculture. Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk Management and communication; Biosafety in relation to transgenic research and applications.
Bioethics: Definition, Animal ethics; Norms in India, Licensing of animal house, Ethical clearance norms for conducting studies on human subjects.

Recommended Textbooks and References

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information
3. Solution Pvt. Ltd., 2007
4. Gurumani, N. Research Methodology, For Biological Sciences . MJP Publishers,
5. Chennai 2006
6. http://www.w3.org/IPR/
7. http://www.wipo.int/portal/index.html.en
8. http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
9. www.patentoffice.nic.in
10. www.iprlawindia.org/
11. http://www.cbd.int/biosafety/background.shtml
12. http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
13. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html

SEMESTER TWO

No. of hours/week	Credits
4	4

DSE 01b: BIOFERTILIZERS, BIOMANURE & BIOPESTICIDES

Course Objectives: The course

- Highlights the use of microorganisms as fertilizers in enrichment of soil fertility.
- Elucidates the knowledge on mass production of biofertilizers, biomanure, organic farming and biopesticides.

Course Outcomes: At the end of the course, the learners will be able to

- Explain different microbes to be utilized as biofertilizer.
- Discuss host plant and microbe association.
- Describe the mass production of Biofertilizers and importance of organic farming.
- Understand the types and applications of biopesticides.

UNIT-I
INTRODUCTION TO BIOFERTILIZERS

History, importance and present status of different types of biofertilizers and their application to crop plants (symbiotic, non-symbiotic, phosphate solubilisers, silicate-zinc solubilisers,
Plant Growth Promoting Rhizobacteria (PGPR). Biological fixation of nitrogen; Natural cycles associated with microorganisms - carbon, nitrogen, phosphorous and sulphur.

UNIT-II
MASS PRODUCTION AND APPLICATIONS OF BIOFERTILIZERS

Mass Production of Cyanobacterial Biofertilizers - Nostoc, Anabaena, Gloeocapsa and Scytonema as biofertilizers; Symbiotic association with Azolla; Multiplication of blue green algae and its effect on agricultural (rice) yields, Mass multiplication.
Mass Production of Bacterial Biofertilizers - Free living forms: Azotobacter, Azospirillum; Symbiotic forms : Rhizobium - Legume Association; Psuedomanas, Nonlegume association; Actimomycetes as Biofertilizers - Actinomycetes associations - Frankia sp
Mass Production of Fungal Biofertilizers - Ectomycorrhizal association with pines; Vesicular arbuscular mycorrizal association (VAM) - Glomus sp.
Methods of applying biofertilizers: Seedling root dip, seed treatment, soil treatment, foliar spray.

UNIT-III

MASS PRODUCTION AND APPLICATIONS OF BIOMANURES

A general account of manures – Agro-industrial wastes - Poultry manure and saw-dust; Farm Yard Manure - Oil seed cakes - Castor and neem; Green leaf manures - Gyricidia, Sesbania and Crotalaria.

Composts, Vermicompost; Microbial compost - pure culture techniques, consortium - types of compost pits. Biodegradation of organic components

Biomanure applications with reference to soil, seed and leaf sprays. Laboratory and field application.

UNIT-IV

MASS PRODUCTION AND APPLICATION OF BIOPESTICIDES

Definition and types. Characteristics, physiology, Mechanism of action, Mass production and applications: Virus- Baculovirus; NPV, CPV& GV; Bacteria- Bacillus thuringiensis & Bacillus sublitis; Fungi- Beauveria bassiana, Metarhizium anisopliae. A brief account on nematodes as biopesticides; Integrated use of biofertilizers and biopesticides in crop production.

Formulation and applications of biopesticides. Biopesticides for integrated crop management; Nanobiopesticides; biopesticides of microbial consortium. Quality standards and constraints in biopesticide production.

Recommended Textbooks and References

- Subba Rao, N.S. 2000 Soil Microbiology. Oxford and IBH Publishing Co.Ltd.
- Verma A and Hock B. 1995. Mycorrhiza.
- Yaacovokan, 1994 - Axospirillum, CBC press.
- Wicklow, D.T. and B.E. Soderstrom. 1997, Environmental and microbial relationships. Springer.
- Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
- Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. NewYork.
- Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
- Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt.Ltd. NewDelhi.
- Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
- Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.
- Subba Rao, N.S., 1995. Biofertilizer in agriculture and forestry. Oxford and IBH, New york.
- Totawat, K.L., Somani, L.L., Sharma, R.A. and Maloo, S.R., 2004. Biofertilizer Technology. Agrotech Publishing Academy. Udaipur, Rajasthan.

SEMESTER TWO

No. of hours/week	Credits
4	4

DSE 02a: MICROBIAL NANOTECHNOLOGY

Course Objectives: The Course

- Provides the knowledge on the concept of nanoscience in the field of Microbiology
- Enables to understand the application of nanomaterials as antimicrobials, in diagnostics, and therapeutics.

Course Outcomes: At the end of the course, the learners will be able to

- Describe properties, characteristics, and types of nanoparticles.
- Demonstrate techniques used for synthesis of nanoparticles.
- Discuss the types, preparation methods and application of bionanomaterials.
- Explain the applications of nanotechnology in the field of biology and medicine

UNIT-I
INTRODUCTION TO NANOTECHNOLOGY

Physical and chemical properties of nanoparticles, nanoclusters, nanocomposite, nanotubes and nanowires.
Characterization of nanoparticles – UV- Vis spectroscopy, XRD, EDAX, Electron Microscopy – HRTEM, SEM, AFM.
Application of Scanning probe microscopy in biology and medicine.

UNIT-II
SYNTHESIS OF NANOPARTICLES

Biological synthesis of nanoparticles and nano biomaterials - microbial synthesis of nanoparticles, S Layers-Engineered nanopores; Magnetosomes-Nanoscale magnetic iron minerals in bacteria.
Synthesis of nanodrugs – metal nanoparticles, nano shells, dendrimers, and nanoparticle drug systems; Self assembled and biologically directed molecules.

UNIT-III
PREPARATION OF NANO-BIOMATERIALS

Nanoparticles – types, functions and application of metal and metal oxide nanoparticles (Silver, Gold, Copper, Iron oxide, Zinc oxide and Titanium).

Preparation of polymeric scaffolds for biomaterial applications (mucopolysaccharides, proteoglycans, cellulose and derivates, dextrans, alginates, pectins and chitin).

UNIT-IV
BIOLOGICAL APPLICATIONS OF NANOPARTICLES

Antimicrobial activity of nanoparticles – mechanism of action and applications.
Use of micro-/nano- fluidics and Point-of-Care diagnostics for diagnosis of infectious diseases; nanobiosensors for detection of pathogens.
Nanoparticles for drug delivery – protein and DNA mediated, Hybrid-conjugates of gold nanoparticles and DNA origami.

Recommended Textbooks and References

1. Boisseau P, Houdy P and Lahmani M. (2010). Nanoscience: Nanobiotechnology and Nanobiology, Springer, New York.
2. Nalwa HS. (2005).Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology. American Scientific Publishers.
3. Niemeyer CM and Mirkin CA. (2004). Nanobiotechnology. Wiley.
4. Ajayan, Schadler and Braun. (2006) .Nanocomposite Science & Technology .Wiley.
5. Boisseau P, Houdy P and Lahmani M. (2010).Nanoscience: Nanobiotechnology and Nanobiology. Springer .New York.
6. Ramsden J and Ramsden J. (2011). Nanotechnology: An Introduction, 1st Edition, and William Andrew.

SEMESTER TWO

No. of hours/week	Credits
4	4

DSE 02b: PHARMACEUTICAL MICROBIOLOGY

Course Objectives: The Course

- Is designed to understand the basics of pharmaceutical microbiology and importance of microorganisms in pharmaceutical industry
- Will emphasize on products of microbial origin with pharmaceutical applications and understand good microbiological practices and regulations in pharma industry

Course Outcomes: At the end of the course, learners will be able to:

- Describe the pharmaceutical importance of microorganisms and methods for standardization of pharmaceuticals.
- Discuss sources of microbial contamination and sterilization practices in pharmaceutical industries.
- Explain principles of preservation; and types, properties and application of antimicrobial preservative
- Understand processes involved in microbial production of pharmaceuticals; and good laboratory practices and regulations used for quality control.

UNIT I
MICROORGANISMS IN PHARMACY

Pharmaceutical importance of the major categories of microorganisms - Benefits and problems; Classification and mode of action of disinfectants, Factors influencing disinfection, antiseptics and their evaluation. Evaluation of bactericidal & Bacteriostatic; Designing of aseptic area, laminar flow equipments; study of different sources of contamination in an aseptic area and methods of prevention, clean area classification.
Principles and methods of different microbiological assay. Methods for standardization of antibiotics, vitamins, and amino acids. Assessment of a new antibiotic. Growth of animal cells in culture, general procedure for cell culture, Primary, established and transformed cell cultures. Application of cell cultures in pharmaceutical industry and research.

UNIT-II
STERILIZATION AND MICROBIAL SPOILAGE OF PHARMA PRODUCTS

Microbial contamination, spoilage, and hazard: Sources of contamination, factors affecting survival and growth, breakdown of active ingredient and general formulations.
Principles of sterilizations with respect to pharmaceutical industries. Methods of sterilizations: Steam, dry heat, Radiation, Gaseous and Filtration. Sterility testing of products (solids, liquids, ophthalmic and other sterile products) according to IP, BP and USP.

UNIT-III
PRESERVATION OF PHARMA PRODUCTS

Principles of preservation: objectives of preservation, the ideal preservative, rational development of a product preservative system etc. Antimicrobial preservatives and their properties: antimicrobial activity, factors affecting antimicrobial activity, preservative monographs.
Preservative stability and efficacy. Methods of Preservative evaluation and testing.

UNIT-IV
MICROBIAL PRODUCTION OF PHARMACEUTICALS AND QUALITY MANAGEMENT

Production of pharmaceuticals of microbial origin: Primary metabolic products, Secondary metabolic products; basics of fermentation process; History and discovery of microbial natural products; Screening and development approaches for new microbial natural products; Good laboratory/manufacturing practices for pharmaceuticals production, validation and regulation; Government regulatory practices and policies for pharmaceutical industry: Food and Drug Administration (FDA), The Central Drugs Standard Control Organisation (CDSCO), the Drug Controller General of India (DCGI); patenting of pharmaceutical products.
Production Management and Documentation: ICH, ISO 9000 series, total quality management, validation for tablets and parenterals, practice of WHO GMP. Industrial Safety: Industrial hazards and their prevention, fire, accidents, mechanical and electrical equipments, industrial effluent testing.

Recommended Textbooks and References

- Quality control in the Pharmaceutical Industry - Edt. by Murray S.Cooper Vol.2. Academic Press New York.
- Sidney H Willing, Murray M, Tuckerman. Williams Hitchings IV, Good manufacturing pharmaceuticals (A Plan for total quality control) 3rd Edition. Bhalani publishing house Mumbai.
- Quality Assurance of Pharmaceuticals- A compedium of Guide lines and Related materials Vol I & II, 2nd edition, WHO Publications, 1999.
- Good laboratory Practice Regulations – Allen F. Hirsch, Volume 38, Marcel Dekker Series, 1989.
- The International Pharmacopoeia – vol I, II, III, IV & V - General Methods of Analysis and Quality specification for Pharmaceutical Substances, Expedients and Dosage forms, 3rd edition, WHO, Geneva, 2005
- Geoff Hanlon & Norman A (2013). HodgesEssential Microbiology for Pharmacy and Pharmaceutical Science, Wiley-Blackwell
- Madhu Raju Saghee , Tim Sandle , Edward C. Tidswell (2011). Microbiology and Sterility Assurance in Pharmaceuticals and Medical Devices,Business Horizons.
- Geoff Hanlon, Norman A. Hodges (2013). Essential Microbiology for Pharmacy and Pharmaceutical Science,Wiley-Blackwell.
- Stephen P. Denyer , Norman A. Hodges, Sean P. Gorman , Brendan F. Gilmore (2011).
- Hugo and Russell's Pharmaceutical Microbiology,Wiley-Blackwell.
- Prahlad Singh Mehra (2011). A Textbook of Pharmaceutical Microbiology,I K International Publishing House

SEMESTER TWO

No. of hours/week	Credits
2	2

SEC 02: BIOINSTRUMENTATION & BIOANALYTICAL TECHNIQUES

Course Objectives: The Course

- Provides the knowledge on construction and working principle of various instruments.
- Imparts skills in handling and operations of various instruments.

Course learning outcomes: At the end of the course, the learners will be able to

- Describe the working principle of colorimeter and spectrophotometer.
- Explain the types of rotors and centrifugation techniques.
- Understand the principles and applications of chromatography.
- Demonstrate the techniques of electrophoresis.

UNIT-I
COLORIMETRY AND SPECTROPHOTOMETRY

Colorimetry and Spectrophotometry: description and working principle, Beer lambert's law, absorption co-efficient, absorbance, transmittance; turbidometry and fluorimetry

UNIT-II
CENTRIFUGATION

Preparative and analytical centrifugation, Types of rotors: fixed angle and swinging bucket. RPM, RCF and sedimentation coefficient; differential centrifugation, density gradient centrifugation, batch centrifugation, and ultracentrifugation.

UNIT-III
CHROMATOGRAPHY

Principles and applications of paper chromatography – circular, ascending, descending, thin layer, and 2-D.
Column chromatography, Gel filtration chromatography, ion-exchange chromatography and affinity chromatography, Gas Chromatography, Liquid -HPLC.

UNIT-IV
ELECTROPHORESIS

Electrophoresis: Principle and applications of native polyacrylamide gel electrophoresis. SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram; Agarose gel electrophoresis.

Recommended Textbooks and References

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology.7thEd., Cambridge University Press.
2. Nelson D L and Cox MM. (2008). Lehninger Principles of Biochemistry,5thEd., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM& Woolverton CJ. (2013). Prescott, Harley, and Klein's Microbiology. 9thEd., Mc Graw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6thedition. John Wiley &Sons. Inc.
5. De Robertis EDP and DeRobertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5thEdition. ASM Press& Sunderland, Washington D. C., Sinauer Associates, MA.
7. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata Mc Graw Hill.

SEMESTER TWO

No. of hours/week	Credits
4	2

Practical 03- Microbial Enzymology & Physiology

1. Preparations of solutions and buffers, pH adjustment using pH meter
2. Qualitative screening of microorganisms for Invertase production
3. Qualitative screening of microorganisms for Amylase production
4. Qualitative screening of microorganisms for Lipase production
5. Determination of enzyme activity: Catalase, invertase and amylase.
6. Demonstration of protein purification by ammonium sulphate
7. Demonstration of SDS PAGE
8. Isolation of Photosynthetic Bacteria
9. Demonstration of microbial respiration / fermentation.
10. Demonstration of Thermal death time (TDT) and Thermal death point (TDP)

No. of hours/week	Credits
4	2

Practical 04- Soil Microbiology, PlantHealth & Food and Dairy techniques

1. Study of associated soil microbes with plants: Actinorhiza and Mycorrhiza
2. Isolation of phosphate solubilizing microbes from soil
3. Isolation of Fusarium from wilt diseases.
4. Fungicide evaluation by spore germination inhibition assay.
5. Demonstration of antagonism by dual culture plate technique.
6. Isolation and identification of microorganisms in utensils and canned foods.
7. Preparation of Yoghurt.
8. Seed quality testing by Blotter's method.
9. Breeds count and Standard plate count methods.
10. Milk quality analysis: MBRT, turbidity test, alkaline phosphatase. Litmus milk test.

Semester Three

SEMESTER THREE

No. of hours/week	Credits
4	4

DSC 07: MEDICAL MICROBIOLOGY AND IMMUNOLOGY

Course Objectives: The Course

- Introduces to the principles of infection and epidemiology of selected infections, know some viral, bacterial, protozoans and fungal diseases of man
- Provides an insight to the basic concept of immunology, expose the students to the major determinants that confer immunity in a host to infections and acquire practical skills for immunodiagnosis of infectious diseases

Course Outcomes: At the end of the course, the learners will be able to

- Understand the principles of infection, explain the epidemiology of some selected infections and their control/preventive measures, collect, and analyse samples for laboratory diagnosis
- Discuss the basic principle underlining body response to foreign agents, purpose and function of antibodies and other molecules involved in resistance to infection, mechanism of antibody formation, various diseases associated with immunodeficiency disorders and autoimmunity.
- Understand the concept of immune system, cells and organs of immune systems and explain complement system and Major Histocompatibility System
- Explain types, features and mechanisms of immediate and delayed hypersensitivity reactions and understand the concept of monoclonal antibodies.

UNIT-I
MICROBIAL INFECTIONS

History and development of medical microbiology; Concept of epidemic, endemic and pandemic, acute, chronic, morbidity, mortality, prevalence, incidence; Microbial infections: Types of infections, modes of transmission, portal of entry; Urinary tract infection, Veneral infection, Infection of the central nervous system, Infections of circulatory system, Respiratory tract infection, Gastrointestinal infection.

Nosocomial infections: Types of nosocomical infections, emergence of antibiotic resistant microorganisms, hospital infection control programmes, preventing nosomical infections; General concepts for specimen collection and handing of specimen, specimen processing and biosafety.

Normal microflora of human body and their advantage, Opportunistic infections.

UNIT-II
MOLECULAR BASIS OF MICROBIAL PATHOGENESIS

Molecular Koch's postulates, Process of infection-Types, stages of infection, Establishment of pathogenic microorganisms: Entry, spread and tissue damage. Mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Biofilms and quorum sensing, modulation of apoptotic processes, aggressins and toxins.

Clinical Pathogens: Pathogen –morphology, cultural and biochemical characteristics, classification, resistance, pathogenesis, clinical symptoms, laboratory diagnosis, epidemiology, prophylaxis and treatment of the following:

i. Bacterial diseases – Tuberculosis, Cholera, Typhoid, Syphilis.
ii. Viral diseases – Hepatitis, Poliomyelitis, AIDS.
iii. Fungal diseases- Candidiasis, Dermatomycosis (Tinea – ringworm infection).
iv. Protozoan diseases – Malaria, Trichomoniasis.

Antibacterial agents: Mode of action of antibiotics and chemotherapeutic drugs; antibiograms. Antibiotic sensitivity assays- disc method; replica plating technique; Ames test; Antibiotic resistance in bacteria-various factors that contribute to the development of resistance, MDR Biofilms.

UNIT-III
IMMUNE SYSTEM

Overview of immune system; cells and organs of immune systems; innate and acquired immunity, Recognition of self and non-self, Humoral immunity-immunoglobulins, basic structure, classes and subclasses, structural and functional relationships, nature of antigen, antigen-antibody reaction, estimation of affinity constants. Molecular Mechanisms of Antibody Diversity and Cellular Immunity: Organization of genes coding for constant and variable regions of heavy chains and light chains, antibody diversity & class switching. Lymphocytes, cytokines, interferons, interleukins, antigen recognition-membrane receptors for antigens

Complement System and Major Histocompatibility System: Complement components, their structure and functions and mechanisms of complement activation by classical, alternative and lectin pathway. Structure and functions of Major Histocompatibility Complex (MHC) and Human Leukocyte Antigen (HLA) system, polymorphism, distribution variation and function. Association of MHC with disease and superantigen, recognition of antigens by T and B-cells, antigen processing, role of MHC molecules in antigen presentation and co-stimulatory signals, & tumor immunology.

UNIT-IV
HYPERSENSITIVITY

Hypersensitivity: Types, features and mechanisms of immediate and delayed hypersensitivity reactions, immunity to microbes, immunity to tumors, AIDS and immune-

deficiencies, hybridoma technology and vaccine, natural, synthetic and genetic, development of vaccine for diseases like AIDS, cancer and malaria.

Monoclonal Antibodies and Diagnostic Immunology: Production, characterization and applications in diagnosis, therapy and basic research, immunotoxins, concept of making immunotoxins. Methods for immunoglobulin determination-quantitative and qualitative antigen and antibody reactions, agglutination-precipitation, immunoflourescence and immunoblotting and assessment of human allergic diseases.

Recommended Textbooks and References

1. Roitt IM & Delves PJ (2001) Roitt's essential Immunology. Blackwell Science, Oxford. 10th edition
2. Kindt TJ, Goldsby RA, Osborne BA, &Kuby J (2006) Kuby Immunology. W.H. Freeman, New York. 6th edition
3. Murphy K, Travers P, Walport M, &Janeway C (2008) Janeway's Immunobiology. Garland Science, New York. 7th edition
4. Chapel H (2006) Essentials of clinical Immunology .Blackwell, Malden, Mass. ; Oxford. 5 th edition
5. Paniker CKJ (2006) Ananthanarayan & Paniker's Textbook of microbiology. Orient Longaman 7th edition.
6. Greenwood, D., Slack, R.B. and Peutherer, J.F.(2002) Medical Microbiology, 16th Edn. Churchill Livingstone, London.
7. Finegold, S.M. (2000) Diagnostic Microbiology, 10th Edn. C.V. Mosby Company, St. Louis.
8. Ananthanarayanan, R. and JayaramPanicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
9. Jenni Punt , Sharon Stranford, Patricia Jones, Judy Owen, 2018, Kuby Immunology, 8th Edition, WH Freeman, 978-1464189784
10. Andrew H. Lichtman, Abul K. Abbas, Shiv Pillai,2015. Basic Immunology, 5th Edition, Elsevier, 9780323390828
11. Kenneth Murphy, Casey Weaver, 2016. Janeway's Immunobiology, 9th Edition, Norton, W. W. & Company, Inc, 9780815345053
12. Patrick R. Murray, 2017. Basic Medical Microbiology, 1st edition, Elsevier - Health Sciences Division, ISBN10: 0323476767, ISBN13: 978032347676

SEMESTER THREE

No. of hours/week	Credits
4	4

DSC 08: MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Course Objectives: The Course

- Enables the students to understand the organization of DNA into genes give students deeper insight into the core aspects of the central dogma of molecular biology.
- Introduces the students to the importance of elements of genetic engineering and biotechnology and provide students with the basic theoretical knowledge in the field of gene engineering.
-

Course Outcomes: At the end of the course, the learners will be able to

- Explain the prokaryotic and eukaryotic genome organization, and understand the mechanism of DNA replication, damage and repair process.
- Describe the structure and types of RNA and mechanism of protein synthesis and post translational events.
- Explain the concepts and scope of genetic engineering and understand the concepts in r-DNA technology & tools in genetic engineering.
- Discuss the microbial genome sequencing and applications of gene cloning in biotechnology.

UNIT-I
FUNDAMENTALS OF MOLECULAR BIOLOGY

Microbes in molecular biology, Physical and genetic organization of prokaryotic and eukaryotic genome.
DNA structure and Replication: DNA as Genetic material, Chemistry of DNA, Modes of DNA Replication, Enzymes and molecular mechanism of DNA replication, Differences in prokaryotic and eukaryotic DNA replication.
DNA Damage and Recombination: Types of DNA damage - deamination, oxidative damage, alkylation and pyrimidine dimers; DNA repair – mismatch, short patch repair, nucleotide/base excision repair, recombination repair and SOS repair. Molecular basis of mutation, Recombination (Site specific recombination, Homologous recombination, transposition).

UNIT-II
GENE EXPRESSION AND PROTEIN SYNTHESIS

Structure of RNA- Classes of RNA, Chemistry of RNA. Transcription in prokaryotes and eukaryotes, Eukaryotic transcription factors. RNA processing, Ribozymes, Antisense RNA, Inhibitors of transcription and their mechanism of action.
Translation: Role of ribosome and different types on RNA in protein synthesis, basic feature of genetic code, mechanism of initiation, elongation and termination, Translational control and post-translational events.
Regulation of Gene expression: Regulation of gene expression in prokaryotes and Eukaryotes. Regulation of gene expression in bacteriophages, gene silencing – gene regulation after transcription.

UNIT-III
FUNDAMENTALS AND TOOLS OF GENETIC ENGINEERING

Introduction to Genetic Engineering: Definition, concepts and scope of genetic engineering. Historical perspectives and milestones in Recombinant DNA Technology. Importance of gene cloning and future perspectives.
Tools in Genetic Engineering: Enzymes in genetic engineering. Cloning vectors: Ti Plasmid, pBR322, pUC –series. Phage vectors-M13 phage vectors, Cosmids-Types, Phasmids or Phagemids, Shuttle vectors. YAC and BAC vectors, Adenoviruses, Retroviruses, Synthetic construction of vectors, Ti cloning vector
rDNA Technology: The basic principles of gene cloning strategies: Preparation, Manipulation and Insertion of desired DNA into vector. Introduction of DNA into host cells – Transformation, Transduction, Transfection, Microinjection, Biolistics, Electroporation, Liposome fusion. Shotgun cloning. Genomic and c-DNA Libraries. Cloning and expression in bacteria, yeasts, Identification and Selection of recombinants.

UNIT-IV
TECHNIQUES IN GENETIC ENGINEERING

Analysis of gene and gene products: Isolation and purification of nucleic acids, staining, Molecular markers in genome analysis: RFLP, RAPD, AFLP and ISSR analysis, DNA sequencing. Blotting techniques- Southern, Northern and Western blotting techniques. PCR –principles, types, and applications.
Microbial genome sequencing projects: DOE microbial genome programme, TIGR microbial database. Analysis of genome sequences, DNA chips: studying gene expression using DNA microarrays. Nest Generation sequence.
Applications of gene cloning in Biotechnology, Medicine, Agriculture, Forensic Science, Antisense technology; Restriction and regulation for the release of GMOs into Environment. Ethical, Legal, Social and Environmental Issues related to rDNA technology.

Recommended Textbooks and References

1. Flint, S.J., Enquist, L.W., Drug, R.M., Racaniello, V.R. and Skalka, A.M. 2000. Principles of Virology- Molecular Biology, Pathogenesis and Control. ASM Press, Washington, D.C.
2. Alexander N. Glazer, Hiroshi Nikaido(2007) Microbial Biotechnology Fundamentals of
3. Applied Microbiology 2nd Ed. Cambridge University Press
4. H.-J. Rehm, G. Reed. (2008) Biotechnology: Genetic Fundamentals and Genetic Engineering, Volume 2, Second Edition. Wiley.
5. Maheshwari, D.K., Dubey, R.C. and Kang, S.C.(2006) Biotechnological Applications of
6. Microorganisms. I.K. International Publishing House. New Delhi.
7. Harvey Lodish, 2016, Molecular Biology, 8th Edition, W.H.Freeman, 1464183392
8. Gerald Karp, Janet Iwasa, Wallace Marshall, 2015. Cell and Molecular Biology: Concepts and Experiments, 8th Edition, Wiley, 978-1-118-88614-4
9. John Kammermeyer, Genetic Engineering Fundamentals: An Introduction to Principles and Applications, 1st Edition, CRC Press, Taylor &Francis Group, 9780824780692
10. Sandy B. Primrose, Richard Twyman, 2016. Principles of Gene Manipulation and Genomics, 8th Edition, Wiley-Blackwell, 978-1-405-15666-0
11. David Calrk, Nanette Pazdernik, Michelle McGehee, 2018, Molecular Biology, 3rd Edition Elsevier, 9780128132883

SEMESTER THREE

No. of hours/week	Credits
4	4

DSC 09: INDUSTRIAL MICROBIOLOGY AND FERMENTATION TECHNOLOGY

Course Objectives: The course

- Highlights the importance of microorganisms in the production of useful human products.
- Introduces the various concepts of fermentation, role microorganisms in fermentation process.

Course Outcomes: At the end of the course, learners will be able to:

- Describe the importance of microorganisms in fermentation process and the production of industrial products
- Discuss the design of the fermenter and components in the fermentation process.
- Explain types of fermentation processes and techniques used in recovery of microbial biomass and products.
- Understand the processes involved in microbial production of enzymes, vitamins, antibiotics, SCPs and fermented foods.

UNIT I:

INDUSTRIALLY IMPORTANT MICROORGANISMS AND FERMENTATION PROCESS

Isolation, preservation and improvement of strains - handling - development of inoculum for various fermentation processed upstream processing - media for industrial fermentation - formulation - sterilization.
An Introduction to fermentation process - The range of fermentation process, chronological development - component parts of fermentation process - fermentation economics

UNIT II:

FERMENTOR DESIGN AND TYPES OF FERMENTATION

Fermenter design - Body construction, individual parts, heat production - gas liquid exchange - mass transfer - heat transfer - oxygen transfer - stirring and mixing - Newtonian, non-Newtonian fluids - effect of viscosity - scale up - control of temperature, pH, form pressure, computer applications.
Fermentation types - submerged and solid-state fermentation

UNIT III:

INDUSTRIAL PRODUCTION AND DOWN STREAM PROCESSING

Microbial production of organic acids - Amino acids, antibiotics - enzymes - vitamins - alcoholic beverages - wine and beer. Fermented foods - bread, cheese, soy sauce. Microbial transformations - steroids and sterols and antibiotics. Mushroom: Types, Cultivation, and its nutritional value

Downstream processing - Recovery of intracellular and extra cellular products - Biomass separation by centrifugation, filtration, flocculation and other recent developments, Cell disintegration - physical, chemical and enzymatic methods. Extraction - solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods, Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization.

UNIT IV:

IMMOBILISED CELLS AND ENZYMES IN BIOPROCESS

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking and covalent binding; advantages, limitations and applications. Design of enzyme electrodes and their application as biosensors in industry, healthcare and environment; Modified and Artificial Enzymes (Ribozymes, Abzymes, Isoenzymes).

Industrially important enzymes (Amylases, Lipases, proteases, invertase, cellulases, pectinases, laccases); Diagnostic enzymes (ALT, AST, ALP); Extremozymes - biotechnological significance of extremozymes of thermophiles, psychrophiles, acidophiles, alkalophiles, halophiles.

Recommended Textbooks and References

1. Stanbury, P.F., Whittaker, A. and Hall, S.J., 1995. Principles of fermentation technology, 2nd edition, Pergamon press.
2. Crueger and Crueger, A., Biotechnology: A text book of Industrial Microbiology, 2nd edition, Sinavos association, InoSundeland.
3. Cassida, J.E., 1968. Industrial Microbiology, Willy Eastern.
4. Presscott and Dunn, S., Industrial Microbiology.
5. Peppler, H. J. and Pearlman, D. 1979. Microbial Technology, Vol 1 ans 2, Academic press.
6. Belter, P.A., Cussler, E.L. and Hu, W.S., Bioseparation: Downstream processing for Biotechnology, John Wiley and Sons, N.Y.
7. Peter StanburyAllan Whitaker Stephen Hall, 2016. Principles of Fermentation Technology, 3rd Edition, Butterworth-Heineman.
8. E.M.T.El-Mansi, C.F.A.Bryce, Arnold L.Demain,2012. Fermentation Microbiology and Biotechnology, 3rd Edition, CRC Press Taylor &Francis Group, 9781439855799
9. Michael J. Waites, Neil L. Morgan, John S. Rockey, Gary Higton, 2010. Industrial Microbiology: An Introduction, 1st Edition, Blackwell Science, 0-632-05307-0
10. L E Casida, J R, 2016, Industrial Microbiology, 2nd Edition, John Wiley & Sons Inc

SEMESTER THREE

No. of hours/week	Credits
4	4

DSE 03a: ADVANCES IN BIOREMEDIATION & MICROBIAL TECHNOLOGY

Course Objectives: The Course

- Provides the knowledge on the types of bioremediations, bioleaching and extraction of metals from ores using microbes.
- Introduces students to the application of microorganisms in several biotechnological techniques in pharma industries and in SCP production.

Course Outcomes: At the end of the course, the learners will be able to

- Identify the microorganisms useful in the field of bioremediation.
- Understand and explain the principles of various techniques used in studying mechanism of microorganisms involved in degradation of environmental pollutants.
- Discuss the potential application of microorganisms in various pharmaceutical industries and demonstrate the algal cultivation for SCP production.
- Describe the applications of microbial enzymes in the field of therapeutics and diagnostics.

UNIT – I

APPLICATION OF MICROBIAL BIOREMEDIATION AND BIODEGRADATION TECHNOLOGIES

Bioremediation techniques for treatment of Pulp and Paper Industry Wastewater; Microbial Remediation of radioactive wastes, Heavy Metals, Dyes in contaminated soils, hydrocarbons. Biotransformation of Hexavalent Chromium [Cr(VI)] in Tannery Wastewater and Pesticides. Biodegradation of biopharmaceuticals and cosmetics from Wastewater; Use of biodegradation technologies for Agro-Industrial effluent Management. Biodegradation of natural and synthetic rubber.

UNIT – II

ADVANCES IN BIOREMEDIATION

Extremophiles in bioremediation of toxic compounds (oxyanions); Use of enzymes from White Rot Fungi and lignolytic microorganisms in biodegradation; Application of cyanobacteria for heavy metal biosorption; Bioprospecting of novel metabolites in marine bacteria for biodegradation; Bioremediation and energy synthesis using bioelectrochemical system.
Energy efficient ammonia removal techniques, metagenomic approach for the assessment of microbial communities in contaminated sites. Microbial indicators for monitoring pollution and bioremediation. Microbial fuel cell technology for bioremediation.

UNIT – III

BIOTECHNOLOGICAL POTENTIALS OF MICROALGAE

Introduction to microalgae; Food – feed – fuel and pharmaceutically valuable compounds. Cultivation methods of algae with reference to Dunaliella. Single cell protein – Chlorella, Spirulina, Yeasts, Mushrooms, SCP from wastes. Economic implications of SCP.
Production of Ethanol, butanol etc. by microorganisms using plant biomass. Saccharification of pretreated plant biomass using enzymes from fungi and bacteria- Separate hydrolysis and fermentation process (SHF), Simultaneous saccharification and fermentation process (SSF), Consolidated Bioprocess (CBP, simultaneous hexose and Pentose fermentation by yeast and bacteria; Anaerobic digestion of plant biomass for biogas production; hydrogen production by microorganism.

UNIT – IV

MICROBIAL PRODUCTION OF BIOMATERIALS

Use of Microorganisms in Producing Biomaterials, bioplastics;; restriction enzymes etc, Cyanobacterial cultures for Polyhydroxyalkanoates (PHAs); Microbial synthesis of nanoparticles and their applications, Biomineralisation by microorganisms.

Recommended Textbooks and References

1. Bioremediation by Baker K.H. And Herson D.S. 1994. MacGraw Hill Inc. N.Y.
2. Biodegradation and Bioremediation, Academic Press, San Diego.
3. Genetics and Biotechnology of Industrial Microorgansims by C.l. Hershnergey, S.W. Queener and Q.Hegeman. Publisher. ASM. Ewesis ET. Al. 1998. Bioremediation Principles. Mac Graw Hill.
4. Balasubramaniam D, Bryce CFA, Dharmalingam K, Green J, Jayaraman K. (1996). Concepts in Biotechnology, University Press, India. Borowitzka MA,
5. Borowitzka LJ (1989) Microalgal technology, Cambridge University Press
6. https://www.elsevier.com/books/microbial-biodegradation-and-bioremediation/das/978-0-323-85455-9
7. https://link.springer.com/book/10.1007/978-981-15-1812-6

SEMESTER THREE

No. of hours/week	Credits
4	4

DSE 03b: DISEASE DIAGNOSTIC TECHNOLOGY

Course Objectives: The Course

- Introduces to the role of clinical microbiologist and laboratory safety.
- Provides knowledge on the concepts of serology and antigen antibody reactions, types of vaccines and types of antimicrobial chemotherapy.
-

Course Outcomes: At the end of the course, the learners will be able to

- Explain the role of microbiologist in diagnostic laboratory and understand the concept of biohazardous waste.
- Demonstrate the skills of specimen collection, handling, and transport.
- Understand and perform precipitation and agglutination reactions.
- Explain the working principle and applications of diagnostic tools and describe the types of vaccines and mechanism of drug resistance.

UNIT -I
INTRODUCTION TO CLINICAL MICROBIOLOGY

Role of Microbiologist in Diagnostic laboratory, General concepts for specimen collection, handling, transportation, processing, specimen workup. Laboratory safety and infection control

A brief note on biohazardous waste.

UNIT- II
SPECIMEN COLLECTION AND PROCESS

Specimen collection and processing of blood, urine, sputum, CSF, pus & feces; separation of serum and plasma, deproteinization of sample, Handling of specimens for testing, preservation of specimen, transport of specimen factors affecting the clinical results, effect of storage on sample, specimen workup.

Microscopic examination of specimens: Bacteria – simple, differential staining and motility, fungi – wet mount; Biochemical reaction – Sugar fermentation test.

UNIT- III
ANTIGEN ANTIBODY INTERACTIONS

Principles of antigen antibody reactions; Precipitation reactions and its mechanism (VDRL); Immunodiffusion (Precipitation in gel – Single and double diffusion in one dimension and two dimensions), Immuno electrophoresis (Counter immune electrophoresis and rocket electrophoresis); Electro immunodiffusion

Agglutination reaction (Hemagglutination, WIDAL), Radioimmunoassay (RIA), Enzyme Linked Immunosorbent Assay (ELISA- Indirect, Sandwich and competitive),

Chemiluminescence; Elispot assay; Western Blotting; Immunoprecipitation; Immunofluorescence.

UNIT- IV
DIAGNOSTIC TOOLS AND VACCINES

Working principle and applications of autoanalyzer, biosensor glucometer; Enzymes in Disease diagnosis and therapy: Lactate dehydrogenase, Aspartate aminotransferase, Alkaline phosphatase, Creatine kinase, Acid phosphatase, Cholinesterase.
Vaccines – definition, adjuvants. Active and passive immunization, Types of Vaccines. Antigens used as Vaccines, effectiveness of vaccines, Vaccine safety, Current vaccines.
Antimicrobial Chemotherapy: Development of chemotherapy and chemoprophylaxis General characteristics of drugs and their testing; Mechanism of Drug resistance– MDR, XDR;

Recommended Textbooks and References

1. Brooks, G.F., Butel, J.S., and Ornston, L.N.1995. Jawetz, Melnick&Adelberg's Medical Microbiology, 20th ed, Stamford, Conn, Appleton & Lange.
2. Fernandes, P.B. 1996, Pharmaceutical perspective on the development of drugs to treat infectious diseases. ASM Press.
3. Gootz.T.D. 1990. Discovery and development of new antimicrobial agents, Clinical Microbiology. f
4. Isenberg, H.D.,editor, 1992, Clinical microbiology procedures handbook, Washington, D.C. American Society for Microbiology.
5. Miller, M.J. 1996. A Guide to specimen management in clinical microbiology, Washington, D.C. ASM press.
6. Murray, P.R., editor-in-chief, 1995, Manual of clinical microbiology, 6th ed. Washington, D.C., ASM Press.
7. Rose, N.R., Macario, E., Fahey, J., Friedman, H., and Penn, G., edigtors. 1997, Manual of clinical laboratory immunology, 5th ed, Washington, D.C., American society for Microbiology. 8. Stites, D.P., Terr, A. I., and Parslow, T.G. 1994, Basic and clinical immunology, 8th ed, Norwalk, Conn, Appleton and Lange.
8. Turgeon, M.L., 1990. Immunology and serology in laboratory medicine, St.Louis, C.V. Mosby Co.

SEMESTER THREE

No. of hours/week	Credits
2	2

SEC 03: INTRODUCTION TO BIOINFORMATICS

Course Objectives: The Course

- Introduces the basic concepts of Bioinformatics and its significance in biological data analysis.
- Discusses the overview about biological macromolecular structures and structure prediction methods.

Course Outcome: At the end of the course, the learners will be able to

- Describe the scope, importance, and application of bioinformatic tools.
- Explain about the methods to characterize and manage the different types of Biological
- data.
- Classify different types of Biological Databases.
- Analyze the nucleotide and protein sequence data.

UNIT – I INTRODUCTION TO BIOINFORMATICS

Biological databases and data retrieval - Nucleotide databases (Genbank, EMBL, DDBJ), Sequence submission Methods and tools (Sequin, Sakura, Bankit), Sequence retrieval systems (Entrez & SRS), Sequence File Formats and Conversion tools, Protein (Swiss-Prot, TrEMBL, PIR_PSD, Expasy), Genome (NCBI, EBI, TIGR, SANGER), Derived Databases (Prosite, PRODOM, Pfam, PRINTS), Metabolic Pathway DB (KEGG, EMP, EcoCyc, BioCyc and MetaCyc).

UNIT – II BIOLOGICAL DATABASE

Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources.
Biological Databases: General introduction of databases, Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum)

UNIT – III DATA ANALYSIS TOOLS

Data storage and retrieval and Interoperability Flat files, relational, object-oriented databases and controlled vocabularies. File Format (GenBank, DDBJ, FASTA, PDB, SwissProt).
Structural databases: Protein Data Bank (PDB), Nucleic Acid Data Bank (NDB), Molecular Modelling Data Bank (MMDB).

UNIT – IV SEQUENCE ALIGNMENTS AND VISUALIZATION

Introduction to Sequences, alignments, and Dynamic Programming; Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm).
Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), Anatomical visualization.

Recommended Textbooks and References

1. Becker, W. M., Kleinsmith, L. J., Hardin, J., & Raasch, J. (2003). The world of the cell (Vol. 6). San Francisco: Benjamin Cummings.
2. Claverie,J.,M., Notredame,C.(2003).Bioinformatics: A Beginner's Guide. Wiley India Pvt. Limited.
3. Fall, C.P., Marland, E.S., Wagner, J.M., Tyson, J.J.(2002). Computational Cell Biology. Springer.
4. Hausman, R. E., & Cooper, G. M. (2004). The cell: a molecular approach.ASM, Washington, DC.
5. Karp, G. (2009). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons.
6. Misener, S., Krawetz, S.A.(1999). Bioinformatics Methods and Protocols. Humana Press.
7. Moody, G. (2004). Digital code of life: how bioinformatics is revolutionizing science, medicine, and business. John Wiley & Sons.
8. Old, R. W., & Primrose, S. B. (1981). Principles of gene manipulation: an introduction to genetic engineering (Vol. 2). Univ of California Press.
9. Reece, J. B., Taylor, M. R., Simon, E. J., & Dickey, J. (2009). Biology: concepts & connections (Vol. 3, p. 2). Pearson/Benjamin Cummings.
10. Wünschiers, R. (2004). Computational Biology: Unix/Linux, data processing and programming. Springer.
11. Zvelebil, M. J., & Baum, J. O. (2008). Understanding bioinformatics. Garland Science.

SEMESTER THREE

No. of hours/week	Credits
4	2

Practical 05-Medical Microbiology, Immunology & Molecular Biology techniques

1. Study of normal micro-biota of mouth; isolation, identification, and preservation of microorganisms
2. Study of normal micro-biota of skin; isolation identification and preservation of microorganisms
3. Type Study:
   a. Viral: Influenza, Herpes, Ebola, HPV
   b. Bacterial: Whooping cough, Leprosy, Tetanus,
   c. Fungal: Tenia, Fungal Meningitis, Aspergillosis
   d. Protozoan: Leishmaniasis, Giardiasis, Trypanosomiasis
4. Demonstration of bleeding time and clotting of blood
5. Double immunodiffusion test using specific antibody and antigen, Dot Immuno blot assay (DIBA), ELISA, VDRL.
6. Isolation of DNA from bacteria
7. Amplification of known DNA sequences by Polymerase Chain Reaction (PCR).
8. Digestion of DNA using restriction enzymes (RE) and agarose gel electrophoresis
9. Separation of proteins by SDS-PAGE.

No. of hours/week	Credits
4	2

Practical 06- Industrial Microbiology & Fermentation Technology

1. Grape wine preparation.
2. Estimation of alcohol by specific gravity method.
3. Screening and isolation of amylase producing fungi from different sources.
4. Biomass production (Baker's yeast and Spirulina).
5. Isolation of Bacteria / Actinomycectes and their screening for antibiotic production.
6. Biochemical test for vinegar during fermentation
7. Submerged fermentation for the production of citric acid
8. Precipitation of protein from a crude extract by Ammonium sulphate precipitation Method
9. Type Study: Down stream processing, Fermenter design & Microbial fermented products (Mentioned in theory syllabus)

Semester Four

Accepts of method validation: observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with static package (Sigma STAT, SPSS for student t-test, ANOVA, etc.), hypothesis testing.

DISSERTATION

Course Type	Marks	Credits	L	T	P	C
Project	300					12

The student shall carryout, a semester long project work under the supervision/mentorship of identified guide (internal or external or both). The project work shall be compiled and submitted in the form of dissertation as per the format. The project work shall be original research work related to the programme or case studies that provide an analysis of specific research questions/socio-economic issues, etc. leading to a dissertation as partial fulfilment of the degree.

Question Paper Pattern

MODEL QUESTION PAPER **QP CODE:**

JSS Academy of Higher Education & Research, Mysuru
(Deemed to be University)
First Semester M.Sc., (Program) (RS-1) Examination - Year
Subject:

Note: *Draw neat, labeled diagrams wherever necessary.*
Your answers should be specific to the questions asked.

Time: 03 Hours **Max Marks: 70**

I. LONG ESSAYS (Answer any TWO of the following) **2x15=30 Marks**

1.
2.
3.

II. SHORT ESSAYS (Answer any FIVE of the following) **5x6=30 Marks**

4.
5.
6.
7.
8.
9.
10.

III. SHORT ANSWERS (Answer all the following) **5x2=10 Marks**

11.
12.
13.
14.
15.

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MODEL QUESTION PAPER **QP CODE:**

JSS Academy of Higher Education & Research, Mysuru

(Deemed to be University)

First Semester M.Sc., (Program) (RS-1) Examination - Year

Subject:

Note: *Draw neat, labeled diagrams wherever necessary.*

Your answers should be specific to the questions asked.

Time: 02 Hours **Max Marks: 50**

I LONG ESSAYS (Answer any TWO of the following) **2x10=20 Marks**

1.
2.
3.

II SHORT ESSAYS (Answer any FIVE of the following) **5x4=20 Marks**

4.
5.
6.
7.
8.
9.
10.

III SHORT ANSWERS (Answer all the following) **5x2=10 Marks**

11.
12.
13.
14.
15.

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