Maharaja Surajmal Brij University
Bharatpur

Syllabus

M.Sc. Microbiology

Session: 2024-26

(I & II Semester)

Dr. Farbat Singh
Asstt. Registrar
Acad.I

(Dr. Ramesh Chand Swami)

M.Sc. Microbiology

First Semester with laboratory work Session 2024-2025 onwards

S. No.	Subject code	Course Title	Credit	Contact hours per week			Weightage (%)		
				L	T	P	CWS	MTE	ETE
Discipline Specific Core (DSC):									
1.	MBC 701	General Microbiology	4	4	0	0	10	20	70
2.	MBC 702	Techniques in Microbiology	4	4	0	0	10	20	70
3.	MBC 703	Microbial Biochemistry	4	4	0	0	10	20	70
4.	MBC 711	Lab. (Based on MBC 701, MBC 702 & MBC 703)	6	6	0	12	45	-	105
Discipline Specific Elective (DSE):									
5.	DSE 701	Food Microbiology	4	4	0	0	10	20	70
		Or							
6..	DSE 702	Molecular Biology	4	4	0	0	10	20	70
7.	DSE 712	Lab. (Based on DSE)	2	0	0	4	15	-	35
Value Added Course (VAC):									
8.		VAC	2	0	0	2	05	10	35

Summary: I Semester		
S. No.	**Particulars**	**Credits**
1.	Discipline Specific Core (DSC)	18
2.	Discipline Specific Elective (DSE)	06
3.	Value Added Course (VAC)	02
4.	Seminar/Internship/Dissertation (**SEM/INT/DIS**)	--
	Total	26
CWS (Class work): It would include attendance, assignments, class test/quiz test, ppt, play, learn by fun activities etc.		

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Second Semester with laboratory work **Session 2024-2025**

S. No.	Subject code	Course Title	Credit	Contact hours per week			Weightage (%)		
				L	T	P	CWS	MTE	ETE
Discipline Specific Core (DSC):									
1.	MBC 801	Bacteriology	4	4	0	0	10	20	70
2.	MBC 802	Biostatistics	4	4	0	0	10	20	70
3.	MBC 803	Research Methodology	4	4	0	0	10	20	70
4.	MBC 811	Lab. (Based on MBC 801, MBC 802 & MBC 803)	6	6	0	12	45	-	105
Discipline Specific Elective (DSE):									
5.	DSE 801	Immunology	4	4	0	0	10	20	70
Or									
6..	DSE 802	Computational Biology	4	4	0	0	10	20	70
7.	DSE 812	Lab. (Based on DSE)	2	0	0	4	15	-	35
Value Added Course (VAC):									
8.		VAC	2	0	0	2	05	10	35

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1. SCHEME OF EXAMINATION MICROBIOLOGY (2024-2025, 2025-2026)

1. Each theory paper shall carry 100 (70 for End term exam + 30 for Internal/midterm exam) marks. The Paper will be of 3 hours duration. Part "A" of theory paper shall contain 10 Short Answer Questions of 10 marks based on knowledge, understanding and applications of the topics/texts covered in the syllabus. Each question will carry one mark for correct answer.
2. Part "B" of paper will consist four questions with internal choice selecting one question from each unit (except in case where a different scheme is specified in the syllabus) of 15 marks each.

2. Course Structure:

The details of the courses with code, title and the credits assigned are as given below.

Abbreviations Used

Course Category

DSC: Discipline Specific Core

DSE: Discipline Specific Elective

VAC: Value added course

SEM/INT/DIS: Seminar/ Internship/Dissertation

CWS: Class work (It would include attendance, assignments, class test/quiz test, ppt, play, learn by fun activities etc.)

MTE: Mid Term Exam

ETE: End Term Exam

Contact Hours

L: Lecture

T: Tutorial

P: Practical

S: Self Study

The medium of instruction and examination shall be English only.

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Syllabus M.Sc. Microbiology

Semester I

MBC 701: General Microbiology

Course objectives:

- To impart knowledge of historical discoveries in domain of Microbiology
- To make students familiar with organization of cellular components and their functions

Course Learning outcomes:

- Demonstrate the practical skills in basic microbiological techniques
- Designate the role of microorganisms in different ecosystems
- Retrieve and use contemporary information on different microbial groups

Unit I **Max. Marks -100**

Discovery of microbial world : History of Microbiology and contributions of Anton Von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Martinus Beijerinck, Sergei Winogradsky, Alexander Fleming, Selman Waksman; Spontaneous generation controversy; Current thoughts on microbial evolution including the origin of life; Scope and relevance of microbiology.

Unit-II

System of Classification- Binomial classification, Whittaker's five kingdom scheme, Three domain system of classification and eight kingdom system of classification, Bergey's system of bacterial classification, Characteristics & Classification of Archaebacteria & Cynobacteria, Difference between prokaryotic and eukaryotic microorganisms.

Unit-III

General characteristics: Acellular microorganisms (Viruses, viroids & Prions), Nomenclature and classification of viruses.

Unit-IV

Cellular microorganisms with emphasis on distribution, occurrence, morphology, mode of reproduction and economic importance.

Bacteria: General Characteristics, *Cyanobacteria, Spirochaetes, Rhizobium, Nitrosomanas, Clostridium, Lactobacillus, Streptococcus & Staphyococcus.*

Fungi: General Characteristics, *Sacchromyces cerevisae, Dictyostelium discodium, Penicillum, Aspergillus & Candida albicans.*

Algae: General Characteristics, *Diatoms & Dinoflagellates.*

Protozoa: General Characteristics, *Entamoeba, Toxoplasma, Plasmodium, Trypanosoma,* Leishmania & Giardia.

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Practicals:

1. Bacterial smear preparation.

2. Identification of various bacteria: Simple staining.

3. Identification of various bacteria: Gram staining.

4. Identification of various algae.

5. Identification of various fungi: Lactophenol -cotton blue & Acid Fuschin.

6. Identification of various protozoans- Free living.

7. Identification of various protozoans: Parasitic.

8. Identification of Cyanobacteria.

9. Culture and Identification of yeast.

10. Permanent Slides: From bacteria, fungi, algae and protozoans.

Note:

(a) Photographs may be supplemented if slides are not available.

Suggested Books:

1. Aneja K.R., Jain P. and Aneja R., 2008, A text book of basic and applied microbiology. New Age. Int. Publications. New Delhi.

2. Atlas R.M., 1995, Principles of Microbiology Mosby publishers, St. Louis.

3. Balows A., Truper, H. G., Dworkin M., Harder, W. and Schleifer, K. H., 1992, The Prokaryotes. A handbook on the biology of bacteria: ecophysiology, isolation, identification, applications. Volumes I-IV, Springer-Verlag, New York.

4. Berg J.M., Tymoczko J.L. and Stryer L., 2007, Biochemistry Edition W.H. Freeman and Company, New York.

5. Holt J.G, and Krieg N.R., 1984-1989, Rergey's Manual of Systematic Bacteriology 151 Edition (Volumes 1-4) Williams and Wilkins Co Baltimore, Springer.

6. Holt J.G., and Krieg N.R., Sneath P.H.A., Staley J.T. and Williams J.T., 1994, Bergey's Manual Determinative Bacteriology 9 thEdition, Williams and Wilkins Co Baltimore, Springer.

7. Logan, A. and Logan N.A., 1994, Bacterial Systematics, Wiley- Blackwell.

8. Nelson 0. and Cox M.M., 2009, Principles of Biochemistry Edition and W.H. Freeman Company, New York.

9. Prescott L.M., Harley J.P. and Klein 0.A., 2007, Microbiology 7'hEdition, Mc Graw Hill.

10. Talaro K.P. and Talaro A., 2006, Foundations in Microbiology, McGraw Hill Publications.

11. Tortora G.J., Funke B.R. and Benjamin C.L.C., 2008, Microbiology: An Introduction, Cummings Publishing Company.

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12. Wilson K. and Walker J., 2008, Principles and Technique of Biochemistry and Molecular Biology. 6thEditionCambridge University Press.

13. Woese C. R., 1981, Archaebacteria, Sci. Am., 244: 98-122.

15. Woese C.R., Kandler 0. and Wheelis M.L., 1990, Towards a Natural System of Organisms: Proposal for the Domains Archea, Bacteria and Eucarya. Proc. Natl, Acad, sci., 87:4576-4570.

16. Woese C. R. 1987, Bacterial evolution, Microbiological Reviews, 51: 221-271.

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MBC 702: Techniques in Microbiology

Course objectives:

- To introduce the students to different methods of isolation, enumeration, maintenance and preservation of microorganisms
- To make students familiar with methods of identification of different groups of microorganisms

Course Learning outcomes:

- Know-how of the basic microbiological tools and techniques
- Understanding of applications of techniques for exploitation of microbes Ability to grow and identify specific microorganisms

Max. Marks - 100

Unit –I

Basic principles and methods of sterilization& disinfection: Control of microorganisms by physical methods: heat, filtration and radiation; Chemical methods:Phenolics, alcohols, halogens, heavy metals, quaternary ammonium compounds, aldehydes and sterilizing gases; evaluation of antimicrobial agent effectiveness; Principle and function of Laminar air flow hood (LAF).

Unit-II

Basic principles for preparing microbes for light, dark field, phase contrast, confocal, fluorescent and electron (transmission and scanning) microscopy; Micrometry; Specimen collection, preparation and basic principles of simple, Gram, negative, capsule, endospore, flagella, acid- fast and fluorochrome staining.

Unit-III

Culture characteristics: Types of culture media, preparation of medium, Minimal requirements, Nutritional types; Methods of isolation and maintenance of pure cultures (Pour plate method, streak plate method &spread plate method); Cultivation of bacteria: aerobic& anaerobic; Growth curve of bacteria; Cultivation and morphology of molds; Yeast morphology; Cultivation and isolation of viruses; Preservation of culture: Short term &long term; Disposal of cultures.

Unit-IV

Principle and theory of biochemical activities of the microorganisms:Triple sugar –Iron agar test,ImVic test, Urease test, Catalase test, Oxidase test, Coagulase test, Sugar fermentation test, Hydrogen sulphide test and Nitrogen reductase test.

Practicals:

1. Laboratory rules and requirement, Bio safety equipments.
2. Microscopy (a) Dissecting
   (b) Compound
3. Microscopy:Phase contrast.
4. Media: (a) Liquid &solid media preparation.
   (b) Sterilization of glass wares and media.
5. Streak plate technique.
6. Pour plate technique and Spread plate technique.
7. Use of selective and differential medium; Use of indicator media.
8. Cultivation of microorganisms- nutritional & physical requirements; anaerobic cultivation.
9. Cultural characteristics of microorganisms.

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10. Isolation and maintenance of pure cultures &Preservation of cultures.
11. Biochemical tests- Iron agar test,ImVic test, Urease test, Catalase test, Oxidase test,Hydrogen sulphide test, Nitrogen reductase test etc.

Suggested Books:

1. Atlas R.M., 1997, Principles of Microbiology. 2nd Edition, McGraw Hill Publications.
2. BalowsA.A.G., Thuper M., Dworker W., Harder K. and Schleifer, 1991, The Prokaryotes, Springer.
3. Berg J.M., Tymoczko J.L. and Stryer L., 2007, Biochemistry Edition W.H. Freeman and Company, New York.
4. Davis R.Y. Adeberg E.A. and IngramJ.L., 1991, General Microbiology.
5. Nelson D. and Cox M.M., 2009, Principles of Biochemistry Edition W.H. Freeman and Company, New York.
6. Potter G.W.H and Potter G.W., 1995, Analysis of Biological Molecule: An Introduction to Principles, Instrumentation and techniques, Kluwer Academic Publishers.
7. Prescott, L.M., HarleyJ.P. and KleinD. A., 2007, Microbiology, 7th Edition, Mc Grow Hill.
8. Stainer, General Microbiology, 5thEdition, Printice Hall of India, Pvt. Ltd.New Delhi.
9. Talaro K.P. and Talaro A., 2006, Foundations in Microbiology, McGraw HillPublications.
10. Verlog,Gunsales and Stainer, The Bacteria,Volumes I-V, Academic Press.
11. Wilson K. & Walker J., 2008, Principles and Techniques of Biochemistry and Molecular Biology. 6th Edition, Cambridge University Press.

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MBC 703: Microbial Biochemistry

Course Objectives

- To provide students with an understanding of biomolecules, the basic building blocks of living organisms
- To impart knowledge on metabolic and synthetic pathways of major biomolecules.

Course Learning Outcomes:

- Acquainted with chemical and molecular structures of biomolecules
- Able to determine the significance, role of biomolecules
- Able to determine the metabolic pathways in synthesis of biomolecules

Max. Marks -100

Unit-I

Chemical properties of water: ionization and acid base chemistry; Carbohydrates-classification; configuration and conformation of mono-saccharides, disaccharides polysaccharides,(structural–cellulose,peptidogycan,storage-glycogen) and glycoproteins; Lipids : General characters and classification, biosynthesis of saturated and unsaturated fatty acids; Structure and functions of triglycerides, phospholipids, glycolipids and steroids.

Unit –II

Structure of amino acids; Classification of essential amino acids based on polarity; Proteins: structure –secondary tertiary, quaternary& protein folding and stability; Levanthal paradox, Chaperones associated with folding; Properties of proteins: acid - base & solubility; Ramchandran plot; Methods of purification: General approach; Protein solubility chromatography, electrophoresis & ultracentrifugation; Sequencing of proteins: Preliminary steps, polypeptide cleavage, Edman degradation & reconstruction of protein sequence.

Unit –III

Laws of thermodynamics: First and second law, concept of free energy, oxidation reduction reactions; Enzymes: Classification and nomenclature, mechanism of enzyme action, enzyme inhibition, allostery, cofactors, coenzymes and prosthetic groups; Enzyme kinetics: Derivation of Michaelis - Menton equation and its significance, Lineweaver-Burke plot & Haldane-Briggs relationship.

Unit-IV

Chemical analysis of microbial cells for- carbohydrates, amino acids, proteins, lipids and nucleic acids; Structure and classification of secondary metabolites: Antibiotics (penicillin, streptomycin etc), alkaloids (Ergot toxins), flavanoids, vitamins and bacterial toxins.

Practicals:

1. Calibration of standard curve – Glycogen.
2. Calibration of standard curve - Protein.
3. Calibration of standard curve – Cholesterol.
4. Quantitative estimation of microbial total proteins (Lowry *et al*., method).
5. Quantitative estimation of microbial / blood glucose & glycogen.
6. Quantitative estimation of microbial/eukaryotic lipids & total cholesterol.
7. Quantitative estimation of microbial DNA.
8. Quantitative estimation of microbial RNA.
9. Quantitative estimation of any one microbial enzyme.
10. Quantitative estimation of polyphenol / carotenoids/flavonoids.

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Suggested Books:

1. Alexander R.R. and Griffith J.M., 1993, Basic Biochemistry Methods, 2nd Edition, Wiley.
2. Atlas R.M., 1997, Principles of Microbiology, 11th Edition, McGraw Hills.
3. Berg J.M., Tymoczko J.L. and Stryer L., 2007, Biochemistry, W.H. Freeman and Company.
4. Cohen, 2011, Microbial Biochemistry, 2nd Edition, Springer.
5. Conn E.E. and Stumpf P.K., 2006, Outlines of Biochemistry, 5th Edition, John Wiley & Sons.
6. Moat A.G. and Foster J.W., 2002, Microbial Physiology, 3rd Edition, John Wiley and Sons.
7. Nelson D.L.and Cox M.M., 2009, Lehninger Principles of Biochemistry, 5th Edition, W.H. Freeman and Company.
8. Plummer D., 1988, An Introduction to Practical Biochemistry, 3rd Edition, Tata McGraw Hills.
9. Potter G.H.W. and Potter G.W., 1995, Analysis of Biochemical Molecules: An Introduction to Principles, Instrumentation and Techniques, Kluwer Academics Publisher.
10. Stryer, 2001, Biochemistry, Fifth Edition, WH Freeman.
11. Talaro K.P. and Talaro A., 2006, Foundation in Biochemistry, 6th Edition, Tata McGraw Hills.
12. Voet D. and Voet J.G., 1995, Biochemistry, 4th Edition, John Willey and Sons Inc.
13. Willey J., Sherwood L. and Woolverton C., 2007, Prescott Harley/Klein's Micriobiology, McGraw Hills.
14. Wilson E.K. and Walker J., Principles and techniques of practical biochemistry, 5th Edition, Cambridge.
15. White D., 2000, The Physiology and Biochemistry of Prokaryotes, 2nd Edition, Oxford University Press.
12. Zubzy G.L., 2008, Biochemistry, 4th Edition, Addison-Welsey Educational Publishers Inc.

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DSE 701 Food Microbiology

Course Objectives:

- To provide the knowledge about food associated microorganisms and microbial spoilage and preservation of foods
- To provide insights on producing dairy and non-dairy fermented foods, and role of probiotics and prebiotics in improving human health

Course Learning outcomes:

- Understanding about the interactions between microorganisms and the food environment
- Knowledge of the various food fermentations, and methods for preservation of foods
- Understanding about the detection, preventive measures and sources of food infections and intoxications caused by various microorganisms

Max. Marks -100

Unit:1

Important microbes involved in spoilage of food: Meat, poultry,vegetables & dairy products; Microbial deterioration of cereals, pulses, fish & sea foods during storage; Feed for cattle: Use of microbes and microbial enzymes in the improvement of nutritive quality of feed.

Unit: II

Toxins: Bacterial and mycotoxins, important microbes secreting toxins, chemical nature of important toxins, their role in food poisoning; Physiology and mechanism of action, modification and detoxification, prevention and control of toxin contamination. Starter cultures- their biochemical activities, Production and preservation of fermented foods- Soya sauce, sauerkraut, meat – sausages & baker's yeast.

Unit III

Microbial biomass and single cell proteins; Uses of microbes in meats and poultry products vegetables etc.;Low calorie sweeteners, flavour modifiers&food additives; Food quality monitoring Indian fermented food.

Unit IV

Microbial enzymes in food industry, Tea and coffee fermentations, Vinegar, Wine & Beer production; Food preservation methods, Use of low & high temperature, radiations – UV, Gamma and Microwave, chemicals and naturally occurring anti microbials.

Practicals:

1. Statutory tests for microbiological analysis of canned foods.
2. Determination of bacteria in spoiled canned foods.
3. Single cell Protein (SCP) cultivation.
4. Preparation of fermented food & beverages: Sauer Kraut, Koji & Soya sauce.

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5. Bacterial count in any of the two food products (fermented & non fermented).
6. Sampling & analysis of microbial load on food contact surfaces.
7. Isolation and identification of common microorganisms spoiling food: Bacteria & fungi.
8. Aflatoxin production from fungi.

Suggested Books:

1.Banwart GJ, Basic Food Microbiology. CBS Publishers &Distributers.

2.Frazier WC and WesthoffDC,Food Microbiology.TataMcGraw-Hill Publishing Company Limited,New Delhi.

3. Adams MR and Moss MO, Food Microbiology. New Age International Ltd.

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DSE 702 Molecular Microbiology

Course objectives:

- Detailed knowledge on fine structure and function of the cell.
- Familiarity with molecular biology pathways as cellular processes

Course Learning outcomes

- Understanding the organization of cell.
- Understanding the mechanisms of cell-to-cell communication.
- Knowledge on structure and function of DNA as genetic material.
- Molecular basis of genetic information and function

Unit –I

Nucleic acids: DNA structure; Chargaff's rule; Types of DNA; Reannealing and hybridization; DNA replication in prokaryotes and eukaryotes: Polymerases, replication origin, initiation, elongation and termination; Synthesis of telomeric DNA; topological properties: linking number, super helicity, mechanism of topoisomerases; Drugs & inhibitors of DNA synthesis.

Unit –II

Transcription: Prokaryotes - polymerase, promoter, initiation, elongation and termination; Eukaryotes- promoters, initiation, elongation, termination and post translational modification of mRNA [capping &polyadenylation, Splicing: L & Y splicing (Group I and II introns) hRNA using spliceosome/snurposome]; Ribozymes; Inhibitors of transcription.

Unit –III

Types of RNA: Structural features (mRNA, rRNA, tRNA); Genetjc code: Degeneracy of the code, three rules governing the code; Protein synthesis in prokaryotes and eukaryotes: initiation, elongation and termination; Protein synthesis on membrane bound ribosomes: signal hypothesis, post translation modification in ER and Golgi complex; Drugs & inhibitors of protein synthesis.

Unit –IV

Regulation of gene expression: Operon concept, negative & positive regulation, inducers, co-repressors and catabolite repression; Negative regulation-*Lac* operon; Positive regulation-*Ara*operon; Regulation by attenuation –*trp* operon; Anti termination –N protein and *nut* sites in lambda.

Practicals:

1. Preparation of buffers and solutions (Normality & Molarity).
2. DNA isolation from different cell types: Microbes and eukaryotic cell (Yeast).
3. Check for purity of isolated DNA sample: Microbes and eukaryotic cell (Yeast).
4. Quantification of DNA (microbes & eukaryotic cell) using spectrophotometer.
5. Microbial DNA denaturation and determination of Tm and G+C content.
6. Agarose gel electrophoresis of bacterial DNA.
7. Total RNA isolation from bacterial cells.

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Suggested Books:

1. Bale J.W., 1994, Molecular Genetics of Bacteria, John Wiley & Sons.
2. Biology of the Gene, 6th Edition, CSHL Press.
3. Clarke D.P., 2005, Molecular Biology. 1st Edition, Elsevier Academic Press.
4. Friedberg C., Walker G.C. and Wolfman S., 1995, DNA repair and mutagenesis. ASM Publications.
5. Friefelder D., 1995, Molecular Biology. 2nd Edition. Narosa Publishing House.
6. Gardner E.J., Simmons M.J. and Snustad D.P., 1991, Principles of Genetics. 8th Edition. John Wiley & Sons Inc.
7. Larry S. and Wendy, 1997, Molecular Genetics of Bacteria. ASM Publications.
8. Lewin, 2000, Gene VII. Oxford University Press.
9. Maloy, 1994, Microbial Genetics. Jones & Bartlett Publishers.
10. Pierce B.A., Genetics- A Conceptual Approach, 2nd Edition, W. H. Freeman & Co.
11. Sambrook J. and Russell D. 2001 Molecular Cloning: A laboratory manual. 3rd Edition, CSHL Press.

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Syllabus M.Sc. Microbiology
Semester II
MBC 801: Bacteriology

Course objectives:

- To impart knowledge of historical discoveries in domain of Microbiology
- To make students familiar with organization of cellular components and their functions

Course Learning outcomes:

- Demonstrate the practical skills in basic microbiological techniques
- Designate the role of microorganisms in different ecosystems
- Retrieve and use contemporary information on different microbial groups

Max. Marks -100

Unit I

Microbial evolution and diversity ,Taxonomic ranks, Phenetic classification, Numerical taxonomy,16s rRNA, Major characteristics used in taxonomy, Microbial phylogeny-Molecular characteristics, Phylogenetic trees, rRNA, DNA & proteins as indicators of phylogeny, Polyphasic taxonomy.

Unit II

Morphology and ultrastructure of bacteria: Size , shape and arrangement of bacteria, structure and chemical composition of cell wall of Gram positive and Gram negative bacteria and Archaea; Structure , composition and function of cell membrane, capsule, flagella, pili, gas vesicles, cytoplasmic matrix reserve food materials, nucleoid, plasmids.

Unit III

Bacterial life cycles, nutrition, respiration & reproduction; Economic importance of bacteria. Endospore : structure, formation and stages of sporulation; Chemoautotrophs, chemoheterotrops, Nutritional categories among microorganisms, Nutritional requirements in bacteria and nutritional categories, the requirement of carbon, nitrogen and sulphur, growth factors, the role of oxygen, continuous culture, their applications, chemostats and turbidostats.

Unit IV

Antibacterial agents: General consideration and classification; Bacterial resistance to antibacterial agents-Acquisition of bacterial resistance, Mechanism of bacterial resistance, Bacterial resistance to drug classes & antibiotic susceptibility testing.

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Practicals:

1. Quantitation of viable cells in bacterial culture.
2. Micrometry of bacterial cells.
3. Study of microorganism morphology: Hanging drop method and wet mount.
4. Bacterial motility.
5. Preparation of bacterial smears and Negative staining.
6. Differential staining : Gram staining.
7. Differential Staining: Acid – Fast staining.
8. Differential Staining: Endospore staining.
9. Differential Staining: Capsule staining.
10. Differential Staining: Flagella staining.
11. Cytoplasmic inclusion staining: (a) Poly –β- hydroxybutyrate (PHB) granules.
    (b) Metachromatic granules.

SuggestedBooks:

1. Baron S. Medical Microbiology. 4th edition, Galveston (TX).
2. Brown A, 1996, Benson's Microbiological Applications Complete Version. (Kindle edition).
3. Lehmann KB. Atlas and Principles of Bacteriology and Text-Book of Special Bacteriologic Diagnosis. (Karl Berhard) Andesite Press.
4. Morrey CB. The Fundamentals of Bacteriology.
5. Snyder L, Joseph E. Peters, Tina M. Henkin ,Wendy Champness , 2007.Molecular Genetics of Bacteria. 4th edition . ASM Press.

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MBC 802: Biostatistics

Course objectives:

- To introduce the students in the field of biostatistics
- To enables them to understand the concepts of statistics in biology.

Course Learning outcomes:

- Handling commonly used bioinformatics tools and understand their pros and cons
- Statistically analyse the data in a biologically relevant manner
- Understanding the role of computer science in predicting structure and function of biomolecules
- Understanding basic computer skills necessary for the conduct of research
-

Max. Marks -100

Unit-I

1. Introduction to Biostatistics
   1.1 Definitions of biostatistics
   1.2 Scope and applications of biostatistics
   1.3 Collection, organization and representation of data (graphical & diagrammatic)

2. Measures of Central tendency & Dispersion (Direct, Short cut and Step deviation methods where ever applicable)
   2.1 Mean, median & mode
   2.2 Mean deviation
   2.3 Standard deviation & standard error

   Measures of central tendency, Mean deviation, standarddeviation andstandard error (Individual, discrete and continuous series – Direct, short cut and step deviation).
3. Plotting of scatter diagram and regression lines. Calculation of correlation coefficient, regression equation and regression analysis.
4. Test of significance by student'st- test, F-test & chi-square test.
5. Statistical calculations using MS Excel.
5. Preparation of graphs using MS Excel.

Suggested Books:

1. Bailey N.T.J., 2000, Statistical Methods in Biology, English Univ Press.
2. Bansi L., 1968, Mathematics of Probability of Statistics, S.Chand & Co., Delhi.
3. Baxevanis A.D. and Ouellette, 2005, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition, John Wiley and Son Inc.
4. Campbell R.C., 1974, Statistics for Biologist, Cambridge University Press.
5. Gralla P., 2000, How the Internet Work, Tech Media.

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6. Kenny J.F. and Keeping E.S., 1964, Mathematics of Statistics Part I & II, Affiliated East-West Press Ltd, New Delhi.
7. MountD.W., 2004, Bioinformatics Sequence and Genome Analysis, CSHL Press.
8. Shina P.K., 2002, Fundamentals of Computers, BPa Publications, New Delhi.
9. Snedecor G.W. and Cochram W.G., 1968, Statistical Methods, Oxford & IBH, Delhi.
10. Tramontano A., 2007, Introduction to Bioinformatics, Chapman &Hall/CRC.
11. White R., 2000, How Computer Works, Tech Media.
12. Zvelebil M. and Baum, 2008, Understanding Bioinformatics, Chapman & Hall/CRC.

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MBC 803: Research Methodology

(Credit: Theory 4; Practical 2)

Objectives of the Course

- A basic understanding of how to pursue research.
- A basic understanding of how to learn mathematics.
- A basic understanding of set theory.
- A basic understanding of the software that supports the mathematical research.

Course Learning Outcomes

- After completion of this course, students will be able to
- Understand mathematics more efficiently and clearly.
- Understand how to write a basic mathematics article.
- Make students analyze a given fact or concept and how to reach a concept.
- Make students curious enough to read the most recent trends in mathematics.
- Understand the basic ideas of how to write an algorithm and related ideas.
  Understandthe effective use of open-source software to write mathematical articles.

Unit -I

Nature of Scientific Inquiry- Scientific Methods- Induction, Deduction Hypothesis and Theory and their Interpretation-Nature and Scope of Social Research for Multi-Disciplinary Inter-Disciplinary Approach in Commerce. Planning of Research-Selection of a Problem for Research-Sample design Census and Sample Surveys- Sampling Techniques- Sample size.

Unit -II

Research Design- Important Aspects of Research Design. Methods of Data Collection-Sources of data Use of secondary data- Methods of collecting primary data- Observation- Interviews- Questionnaires and Schedules.

Unit -III

Processing and Analysis of Data: Processing Operations- Types of Analysis- Presentation and Interpretation of Data-Editing, Classification and Tabulation, Interpretation.
Preparation of a Report- Types of Report- Research Report- Format- Principles of Writing Reports- Documentation- Footnotes and Bibliography

Unit -IV

Quantitative Tools- Measures of Central Tendency- Dispersion- Measures of Correlation- Simple and Multiple Correlation-testing of Hypothesis-Tests based on t-P, Z, and Chi square, Time Series Analysis, Trend Measurement, Moving Averages.

Suggested Laboratory Exercises:

- Experiments based on chemical calculations.
- Hands on training in Computer application
- The art of imaging of samples through microphotography and field photography.
- Poster presentation on defined topics.
- Technical writing on topics assigned.

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Suggested Reading:

1. Srivastava, S.C. (1990) Foundation of Social Research and Economics Techniques, Himalaya Publishing House.
2. Sharma H.D. and Mukherji S.P. (1992) Research Methods in Economics and Business, New York: The Macmillan Company.
3. Gerber R. and Verdoom, P.J. (1992) Research Methods in Economics and Business, New York, The Macmillan Company.
4. Krishna swami O.R. (1993) Methodology of Research in Social Sciences, Himalaya Publishing House.
5. Menden HYall and Varacity: Reinmuth J.E. (1982) Statistics for Management and Economics (2nd Edition).
6. Courtis J.K.(ed.) (1980) Research and Methodology in Accounting & Financial Management.

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DSE 801: Immunology

Course Objectives:

- To understand the various components of the host immune system, their structure and organization, and functions to serve as the defense system of the body.
- To understand the operational mechanisms which underlie the host defense system, allergy and organ transplantation.

Course Learning Outcomes:

- Able to describe normal human microflora, and role of microbes in causing diseases
- Able to understand the fundamental bases of immune system and immune response
- Will gather information about the structure and organization of various components of the immune system
- Able to understand the genetic organization of the genes meant for expression of immune cell receptors and the bases of the generation of their diversity
- Able to understand the operation and the mechanisms which underlie the immune response

Max.Marks : 100

Unit I

1. Historical background; Innate immunity, Adaptive immunity (cell mediated and humoral), Natural and artificial immunity;Active and Passive immunity,Barriers to infection; Phases of Immune responses; Clonal selection hypothesis.
2. Hematopoiesis; Cells of immune system; Lymphoid organs-Primary and Secondary.
3. Immunoglobulin-General structure, Igisotypes, structure and function.

Unit II

1. Antigens-Properties, Types(Isotypes, Allotypes, Idiotypes), Antigen specificity, superantigen, Determinants-linear, conformational and neo-antigenic, Haptens, Adjuvants
2. Characteristics of primary antigen- antibody interactions; antigen-antibody interactions (Precipitations, Agglutinations, RIA, ELISA, Immunoelectrophoresis, Crossed antigen-antibody electrophoresis, Western blotting etc).
3. Complement pathways (Classical, alternative and lectin), Biological significance and deficiencies.
4. Hybridoma technology-monoclonal antibodies and its applications; Production of polyclonal antibody and its application.

Unit III

1. Mechanism of cell mediated and humoral immunity.
2. MHC types and structure, Exogenous and endogenous antigen capture and presentation to the lymphocytes, Cross presentation of exogenous antigens.
3. Vaccine-Route of immunization, Natural immunization schedule, Types: attenuated and inactivated vaccine, synthetic peptide, DNA vaccine, Recombinant vaccine, subunit vaccine, idiotype based vaccine, glycoconjugate vaccine, ISCOM's and plantibodies, vaccine delivery system.
4. Immunity to microbes: Bacteria, Fungi, Virus and Helminthes, Pathogen recognition receptor (PRR) and Pathogen Associated Molecular Pattern (PAMP).

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Unit IV

1. Cytokine (Properties, receptors, cytokine related disease and cytokine -based therapy), Hypersensitivity (Classification, types and disease).
2. Autoimmune diseases- Addison's disease, Graves' disease, Hasimoto'sthyroidites, autoimmune haemolytic anemia; rheumatoid arthritis, Goodpasture's syndrome, Sjögren's syndrome.
3. Immune deficiencies-B cell deficiencies (X-linked agammaglobulinemia, X-linked hyper-IgM syndrome); T cell deficiencies (22q11 deletion syndrome, CD8 deficiency); B and T cell deficiencies (Common γ chain deficiency, ADA deficiency).

Practicals:

1. Dissect, localize and study the structure of lymphoid organs (Demonstration and detailed study).
2. Preparation of antigen and routes of immunization.
3. Generation of antibody in mice/rat/rabbit/guinea pig and sample collection (retro-orbital and heart).
4. Blood smear preparation & Identification of different WBC.
5. Differential Blood Counts- WBC & RBC.
6. Agglutination: Widal test.
7. Precipitation.
8. Ouchterlony's double diffusion.
9. Radial Immunodiffusion.
10. Immunoelectrophoresis: RIE.
11. ELISA.
12. Viability and cell counting of peritoneal macrophages using trypan blue.
13. Slides: Spleen, thymus, lymph node, ileum- Peyers patch, Blood cell type's identification.

Note : (a) Photographs to be supplemented on unavailability of slides.
(b) Slides from experiments.

Suggested Books:

1. Abbas A.K., Lichtman A.H., Pillai, S. and Saunders, 2007, Cellular and Molecular Immunology. Elsevier.
2. Benjamin, 2004, Immunology- A short course.
3. Claus C., 1996, Immunology- Understanding of Immune System. Wiley, New York.
4. Delves P.J., Martin S.J., Burton D.R. andRoitt I.M., 2006, Roitt's Essential Immunology. 11th edition, Blackwell Publishing/Oxford University Press.
5. Kindt T.J., Goldsby R.A., Osborne B.A. and Kuby J., 2006, Kuby Immunology. 6th Edition, WH Freeman, New York.
6. Levinson W. andJawetz E., 2001, Medical Microbiology and Immunology. Lange Publications.
7. Paul W.E., 2000, Fundamental Immunology.4th edition, New York. Raven Press.

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DSE 802: Computational Biology

Course objectives:

- To introduce the students in the field of bioinformatics
- To enables them to understand the concepts of bioinformatics in biology.

Course Learning outcomes:

- Handling commonly used bioinformatics tools and understand their pros and cons
- Understanding the role of computer science in predicting structure and function of biomolecules
- Understanding basic computer skills necessary for the conduct of research

Max. Marks: 100

Unit I

Introduction to computers and bioinformatics: Types of computer operating systems; Servers and algorithms in Bioinformatics; objectives, Scope, application, advancements and limitations of bioinformatics; Database: Concept , Biological data and Biological Database-Primary, secondary and structural; Classification of databases based on the types of data and mode of data storage; Examples of biological database (GenBank, PIR, Swiss-Prot, PDB,DDBJ, NCBI, EMBL etc.); Biological data management and retrieval systems;Perspectives &Limitations of biological databases; System modelling & metabolomics -Concept & principle.

Unit-II:

Biological sequences: DNA, RNA and Protein sequences, Formats of biomolecular sequence files (Fasta, genbank, gcg, etc.); Sequence alignment: Concept of Local and Global sequence alignment; Single sequence alignment ; Multiple sequence alignment(MSA)-Progressive &Iterative method; Concept of sequence Identity, Similarity and Homology; Methods used in alignment algorithms: Dot plot and Dynamic programming methods; Dot matrix- Scoring matrices: PAM and BLOSUM; Database searching: Heuristic method of similarity search; Sequence similarity search tools: BLAST, variants of BLAST (BLASTn, BLASTp, PSI-BLAST,PHI-BLAST etc) and FASTA; Domain and Motif search in sequence.

Unit-III:

Phylogenetic trees: Basic concept and types of phylogenetic trees-Rooted, Unrooted, Bifurcating Multi-furcating etc ; Molecular evolution and Molecular phylogeny -; Gene phylogeny vs Species phylogeny; Methods for construction of phylogenetic trees: Distance based, Character based, Parsimony method; Bioinformatics tools for Phylogenetic analysis and phylogenetic tree construction: ClustalΩ/ClustalW, Mega, iTOL.

Unit-IV

(a) Structural Bioinformatics: Basics of protein structure determination (X-ray crystallography) and structure prediction - Secondary structure prediction – Chou-Fasman, GOR methods(SOPMA), Neural network concept, transmembrane structure prediction and Tertiary structure prediction/Homology modeling, Protein structure database (PDB); Structural alignment, comparison, protein – protein interaction database-STRINGS,DIP ; classification of proteins. Bioinformatic basis of protein structural classification: CATH and SCOP.

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(b) DNA sequence analysis: ORF prediction, Gene and promotor prediction in prokaryotes and eukaryotes; Categories of gene prediction programs; Genome mapping, assembly and comparison; Functional genomics: Microarray and SAGE; Next generation sequencing. Molecular visualisation software for architecture & topologies of proteins and DNA – RasMol, Cn3D, SPDBV etc.

Practicals:

1. Study of database.
2. Single Sequence and Multiple Sequence alignment by BLAST and FASTA.
3. Sequence retrieval from database.
4. Phylogenetic tree construction using ClustalW and Mega-4.
5. Analysis of molecular variance (AMOVA)
6. NTSYS-pc analysis of DNA bands.
7. Analysis of protein and nucleotide sequence
   (a) ORF and Gene finding
   (b) Motif finding
   (c) Conserved domain finding
8. Classification of protein using CATH and SCOP.
9. Visualization of proteins using various visualization tools.
10. Study of relationships among various biochemical molecules using STRING.

Suggested Books:

1. Baxevanis A. D. and OuelletteB. F.F., 2001, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 2nd edition, John Wiley & Sons, Inc., Publication.
2. LeskA. M., 2005, Introduction to Bioinformatics, 2nd edition Oxford University Press.
3. Mount D., 2004, Bioinformatics: Sequence and Genome Analysis. 2nd edition, Cold Spring Harbor Laboratory Press, New York.
4. Gottfried, B.S., 1996,Schaum's Outline of Theory and Problems of Programming with C, McGraw-Hill ISBN 10 0070240353.
5. XiongJin., 2006, Essential Bioinformatics, 1st edition, Cambridge University Press.
6. Pevsner J., 2009, Bioinformatics and Functional Genotnics. 2nd edition, John Wiley and Sons, New Jersey.
7. Attwood T. K and Smith D. J. P., 1999, Introduction to Bioinformatics. Pearson Education Limited, England.
8. Waterman M.S., 1995, Introduction to Computational Biology: Maps, Sequences and Genomes. Waterman Chapman and Hall/ CRC Press ISBN -10: 0412993910.
9. Wayne W. D., 1999, Biostatistics: A Foundation for Analysis in Health Sciences, John Wiley and Sons.

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