MANGALORE UNIVERSITY

DEPARTMENT OF BIOSCIENCES

SYLLABUS AND SCHEME OF EXAMINATIONS FOR TWO YEAR (FOUR SEMESTERS) M.Sc. DEGREE PROGRAMME IN BIOSCIENCES UNDER CHOICE BASED CREDIT SYSTEM (CBCS – 2016)

Preamble:

The University Grants Commission, New Delhi has directed all Universities in the Country to implement the Choice Based Credit System (CBCS Semester Scheme) in both the Undergraduate and Post-Graduate Programmes. The Higher Education Council, Government of Karnataka also considered the implementation of CBCS. Mangalore University has directed all the P.G. Board of Studies to frame the new syllabus for the P.G. Programmes as per the new regulations governing the Choice Based Credit System for the Two Year (Four Semester) Post –Graduate Programmes. Accordingly the internal members of P.G. Board of Studies in Biosciences prepared draft syllabus. The syllabus is placed before the P.G. Board of Studies. The P.G. Board of Studies in Biosciences thoroughly discussed, modified and finalised the draft syllabus.

The present M.Sc. Programme (Biosciences) under CBCS – PG Scheme has total credits 88 (Hard Core credits: 52 (59.09%), Soft Core credits: 30 (34.09%) and Open Elective credits: 06 (6.97%).

Programme Outcomes (PO)

PO1. Knowledge Enhancement: Upgrade the knowledge to develop general competence and analytical skills on an advanced level required in teaching, research, industry, entrepreneurship and public administration in the field of biological sciences.

PO2. Usage of Modern Tools: Independently operate various modern tools and apply appropriate techniques to assess samples helping to carry out innovative studies on basic or applied aspects of biology.

PO3. Social Responsibility: Apply the contextual knowledge of life sciences to address certain issues in the society with special reference to health and environment for well-being and sustainable development.

PO4. Effective Communication: Communicate effectively about diversified aspects of biology through oral presentation, writing proposal, dissertation, reports, data analysis, interpretation and documentation.

Programme Specific Outcomes (PSO)

PSO1. Gain the knowledge from basics to advanced levels in various branches of life sciences enabling to build the confidence to go for academics, industries or entrepreneurships in India and abroad.

PSO2. Empower with skill-based expertise and technical know-how in the field of bio-medical sciences.

PSO3. Develop a good communication skill with sound technical background in biological sciences; thus providing a strong foundation for both academic and industrial placements as well as setting up entrepreneurial ventures.

PSO4. Be acquainted with a deep scientific knowledge in various branches of biology, including Biochemistry, Cell Biology, Genetics, Microbiology, Aquatic Biology, Biodiversity, Cancer Biology, Physiology, Immunology, Ecotoxicology, Biotechnology, Developmental Biology, Molecular Biology, Bio-Analytical Techniques, Biostatistics and Bioinformatics.

PSO4. Explore, analyse and interpret lab and field based data using state-of-the-art techniques and modern tools in planning and executing innovative projects in life sciences.

M.Sc. BIOSCIENCES PROGRAMME
CONTENTS

	Hrs/week	Credits
I SEMESTER		
HARD CORE COURSES - THEORY		
BSH401 Biochemistry	4	4
BSH402 Cell Biology and Genetics	4	4
BSH403 Basic Microbiology	4	4
SOFT CORE COURSES - THEORY (Out of 2 Courses ONE to be offered)		
BSS404 Advanced Cell Biology	3	3
BSS405 Bio-analytical Techniques	3	3
PRACTICAL COURSES		
BSP406 Biochemistry Lab	4	2
BSP407 Cell Biology and Genetics Lab	4	2
BSP408 Basic Microbiology Lab	4	2
BSP409 Advanced Cell Biology Lab	4	2
BSP410 Bio-analytical Techniques Lab		
II SEMESTER		
HARD CORE COURSES - THEORY		
BSH451 Molecular Biology	4	4
BSH452 Biostatistics and Bioinformatics	4	4
SOFT CORE COURSES - THEORY (Out of 3 Courses TWO to be offered)		
BSS453 Applied Microbiology	3	3
BSS454 Aquatic Biology	3	3
BSS455 Metabolism and Bioenergetics	3	3
PRACTICAL COURSES		
BSP456 Molecular Biology Lab	4	2
BSP457 Biostatistics and Bioinformatics Lab	4	2
BSP458 Applied Microbiology Lab	4	2
BSP459 Aquatic Biology Lab	4	2
BSP460 Metabolism and Bioenergetics Lab	4	2
OPEN ELECTIVE COURSES (Out of 2 Courses ONE to be offered)		
BSE461 Biodiversity	3	3
BSE462 Cancer Biology	3	3

III SEMESTER **HARD CORE COURSES - THEORY**		
BSH501 Animal Physiology	4	4
BSH502 Plant Physiology	4	4

SOFT CORE COURSES - THEORY (Out of 3 Courses TWO to be offered)

BSS503	Applied Ecology	3	3
BSS504	Immunology	3	3
BSS505	Ecotoxicology	3	3
PRACTICAL COURSES			
BSP506 Animal Physiology Lab		4	2
BSP507 Plant Physiology Lab		4	2
BSP508 Applied Ecology Lab		4	2
BSP509 Immunology Lab		4	2
BSP510 Ecotoxicology Lab		4	2
OPEN ELECTIVE COURSES (Out of 2 Courses ONE to be offered)			
BSE511 Pollution and Bioremediation		3	3
BSE512 Stem cell Biology and Regenerative Medicine		3	3
IV SEMESTER			
HARD CORE COURSES - THEORY			
BSH551 Biotechnology		4	2

SOFT CORE COURSES - THEORY (Out of 2 Courses ONE to be offered)

BSS552 Ecotoxicology	3	2
BSS553 Developmental Biology	3	2
PRACTICAL COURSES BSP554 Biotechnology Lab	4	2
BSP555 Ecotoxicology Lab	4	2
BSP556 Developmental Biology Lab	4	2
PROJECT WORK BSP557 Project Work (Report/Dissertation)	4	4

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M.Sc. BIOSCIENCES PROGRAMME

(CBCS Semester Scheme)

Scheme of Teaching and Examination (As per the University Guidelines) 2016-17

I SEMESTER							
Code	Title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARD CORE COURSES - THEORY							
BSH401	Biochemistry	4	3	70	30	100	4
BSH402	Cell Biology and Genetics	4	3	70	30	100	4
BSH403	Basic Microbiology	4	3	70	30	100	4
SOFT CORE COURSES – THEORY (Out of 2 Courses ONE to be offered)							
BSS404	Advanced Cell Biology	3	3	70	30	100	3
BSS405	Bio-analytical Techniques	3	3	70	30		
PRACTICAL COURSES							
BSP406	Biochemistry Lab	4	3	70	30	100	2
BSP407	Cell Biology and Genetics Lab	4	3	70	30	100	2
BSP408	Basic Microbiology Lab	4	3	70	30	100	2
BSP409	Advanced Cell Biology Lab	4	3	70	30	100	2
BSP410	Bio-analytical Techniques Lab	4	3	70	30		
Total						**800**	**23**

II SEMESTER

Code	Title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARD CORE COURSES - THEORY							
BSH451	Molecular Biology	4	3	70	30	100	4
BSH452	Biostatistics and Bioinformatics	4	3	70	30	100	4
SOFT CORE COURSES – THEORY (Out of 3 Courses TWO to be offered)							
BSS453	Applied Microbiology	3	3	70	30	100	3
BSS454	Aquatic Biology	3	3	70	30	100	3
BSS455	Metabolism and Bioenergetics	3	3	70	30		
PRACTICAL COURSES							
BSP456	Molecular Biology Lab	4	3	70	30	100	2
BSP457	Biostatistics and Bioinformatics Lab	4	3	70	30	100	2
BSP458	Applied Microbiology Lab	4	3	70	30	100	2
BSP459	Aquatic Biology Lab	4	3	70	30	100	2
BSP460	Metabolism and Bioenergetics Lab	4	3	70	30		
OPEN ELECTIVE COURSES (Out of 2 Courses ONE to be offered)							
BSE461	Biodiversity	3	3	70	30	100	3
BSE462	Cancer Biology	3	3	70	30		
Total						**900**	**25**

III SEMESTER

Code	Title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARD CORE COURSES - THEORY							
BSH501	Animal Physiology	4	3	70	30	100	4
BSH502	Plant Physiology	4	3	70	30	100	4
SOFT CORE COURSES – THEORY (Out of 3 Courses TWO to be offered)							
BSS503	Applied Ecology	3	3	70	30	100	3
BSS504	Immunology	3	3	70	30	100	3
BSS505	Ecotoxicology	3	3	70	30		
PRACTICAL COURSES							
BSP506	Animal Physiology Lab	4	3	70	30	100	2
BSP507	Plant Physiology Lab	4	3	70	30	100	2
BSP508	Applied Ecology Lab	4	3	70	30	100	2
BSP509	Immunology Lab	4	3	70	30		
BSP 510	Eco-toxicologyy Lab	4	3	70	30	100	2
OPEN ELECTIVE COURSES (Out of 2 Courses ONE to be offered)							
BSE511	Pollution and Bioremediation	3	3	70	30	100	3
BSE512	Stem cell Biology and Regenerative Medicine	3	3	70	30		
Total						**900**	**25**

IV SEMESTER

Code	Title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARD CORE COURSES - THEORY							
BSH551	Biotechnology	4	3	70	30	100	4
SOFT CORE COURSES - THEORY(Out of 2 Courses ONE to be offered)							
BSS552	Environmental Physiology	3	3	70	30	100	3
BSS553	Developmental Biology	3	3	70	30		
PRACTICAL COURSES							
BSP554	Biotechnology Lab	4	3	70	30	100	2
BSP555	Environmental Physiology Lab	4	3	70	30	100	2
BSP556	Developmental Biology Lab	4	3	70	30		
PROJECT WORK							
BSP557	Project Work (Report/Dissertation)	-	-	70	30	100	4
Total						**500**	**15**
Grand Total						**3100**	**82+6***

IA = Internal Assessment
***** Not included for CGPA

Total Credits: 88 (82+6*)
Hard Core credit: 18 + 12 +12+06+04 (Project) = 52 (59.09%)
Soft Core credit: 05 + 10 + 10 +05 = 30 (34.09%)
Open Elective credit: 0 + 03 + 03 + 0 = 06 (6.97%)

NOTE:

BASIS FOR INTERNAL ASSESSMENT: Internal Assessment marks in theory papers shall be awarded on the basis of theory test (70 Marks), Objective Test (MCQs)(15 Marks), Seminars and Assignments (15 Marks). The marks obtained shall be reduced to 30. The tests may be conducted 14 weeks after the start of a Semester. Practical Internal Assessment marks shall be based on practical test and records. 60 marks for Practical test and 10 marks for Class record. The marks obtained shall be reduced to 30. The test may be conducted 14 weeks after the start of a Semester. 30 marks for project work (Report/Dissertation and Presentation/Viva).

THEORY QUESTION PAPER PATTERN: Question Papers in all the four semesters consists of three sections (Model question paper enclosed). Section I: Write short notes on any four out of six: (4x4=16 Marks) Section II: Write explanatory notes on any five out of seven: (5x6=30 Marks). Section III: Answer any two out of three: (2x12=24 Marks). Questions are to be drawn from all the units of the syllabus by giving equal weightage to all the units.

PRACTICAL QUESTION PAPER PATTERN: 60 marks for practical exam proper (Major experiment-20 marks, Minor experiments- 10+10 marks, Identify and Comment on-5x4=20marks) and 10 marks for Class record. The Project work may be conducted either in the department or any other Institution or in an Industry. Project Report/Dissertation carries 70 marks and evaluated as per regulations.

Model Question Paper

First Semester M.Sc. Degree Theory Examination, December 2016

(CBCS)

BIOSCIENCES

BS

Time: 3 Hours Max. Marks: 70

Write short notes on **any four** of the following (not exceeding **2** pages **each**): **(4x4=16)**

1. a)
   b)
   c)
   d)
   e)
   f)

Write explanatory notes on **any five** of the following (not exceeding **3** pages **each**): (**5x6=30)**

2.
3.
4.
5.
6.
7.
8.

Answer **any two** of the following (not exceeding **8** pages **each**): **(2x12=24)**

9.
10.
11.

M.Sc. BIOSCIENCES PROGRAMME
(CBCS Semester Scheme) 2016-17
SYLLABUS

I SEMESTER

HARD CORE COURSES

BSH401 BIOCHEMISTRY

Course Outcomes:
Upon successful completion of the course, students will be able to:

- Refresh the knowledge of biochemistry with the updated information.
- Demonstrate an understanding the basic biochemical principles with reference to structure and functions of proteins, carbohydrates and lipids, and their metabolic pathways.
- Understand the mechanisms of transport and excretion of cholesterol and sterols
- Know the clinical relevance of studying biomolecules and metabolic disorders.
- Appreciate the knowledge of biochemistry in the day-to-day life

Unit I (13 hours)

Carbohydrates: Classification, chemistry and properties of monosaccharides, disaccharides, polysaccharides, glycoproteins, peptidoglycans.

Lipids. Classification, chemistry and properties of lipids.

Unit II (13 hours)

Proteins and amino acids. Classification, chemistry and properties of proteins and amino acids. Primary, secondary, tertiary and domain structure of proteins. Reverse turn and Ramachandran plot. Helix - coil, transition. Energy terms in biopolymers. Conformational calculations, hydrogen bonding, hydrophobic, electrostatic and Vander Waal's interactions.

Lipoprotein metabolism and asssociated disorders. Triacylglycerol biosynthesis and role of adipose tissues. Biosynthesis, transport and excretion of cholesterol and sterols.

Unit III (13 hours)

Metabolism of carbohydrates: Pathways and regulation. Glycogenogenesis and Glycogenolysis. Anaerobic glycolysis, Citric acid cycle, Hexose monophosphate shunt. Gluconeogeneis. Coordinated control of metabolism.

Metabolism of lipids. Biosynthesis of fatty acids, oxidation of fat and fatty acids - beta, alpha and Omega oxidation. Ketogenesis and ketolysis. Biosynthesis of phospholipids.

Unit IV (13 hours)

Protein and amino acid metabolism. Nitrogen balance, transamination and deamination. Catabolism of phenylalanine, tyrosine, tryptophan, sulphur containing amino acids, creatine and creatinine. Urea cycle and disorders.

References:

1. Lehninger Principles of Biochemistry - D. L. Nelson and M. M. Cox, 2008, 5th Ed., W.H. Freeman.
2. Biochemistry - J. M. Berg J. L. Tymoczko L. Stryer, 2010, 6th Ed., W.H. Freeman, New York.
3. Biochemistry - Geoffrey Zubay, 1998, 4th Ed., WBC/McGraw Hill.
4. Text Book Biochemistry - E. S. West, W. R. Todd, H. S. Mason, J.T. V. Bruggen, 1974, 4th Ed., Oxford & IBH Publishing.
5. Harper's Biochemistry - R. K. Murray, D. K. Granner, P. A. Mayer, V. W. Rodwell, 2009, 28th Ed., Appleton & Lange.
6. Principlesof Biochemistry - White, A., Handler, P., Smith, E. L., 2004, 6th Ed.,Tata McGraw Hill, New Delhi.
7. Outlines of Biochemistry - E.E. Conn, P.K. Stumpf, G Bruening, R.H. Doi, 2005, Wiley
8. Principles and Techniques of Biochemistry & Molecular biology - K. Wilson & J. Walker (Eds.), 6th Ed, Cambridge University Press.
9. Biochemistry and Molecular Biology of Plants - B. B. Buchanan, W. Gruissem & R. L. Jones, 2005, 2002, Courier companies Inc
10. Principles of Instrumental Analysis - D. A. Skooge, F. J. Holler & T. A. Nieman, 2006, 6th Ed., Brooks/Cole
11. Fundamentals of Biochemistry - Life at the Molecular Level - 2nd Ed., D. Voet, J. G. Voet, C. W. Pratt, 2006, Wiley.
12. Principles of Bioinorganic Chemistry - S. J. Lippard, J. M. Berg, 1997, Panama Publishing.
13. Molecular & Cellular Biophysics - M. B. Jackson, 2006, Cambridge University press.
14. Principles of Physical Biochemistry - K. E. van Holde, W. C. Johnson, P. S. Ho, 1998, Prentice Hall.
15. Biochemistry – R.A. Harvey, D. R. Ferrier and P.C. Champe,2007, 4th edition,, Lippincott Williams and Wilkins
16. Biochemistry – U. Satyanarayana and U. Chakrapani, 2008 3rd edition, Elsevier Publishers
17. Textbook of Medical Biochemisty – Dinesh Puri, 2011, 3rd edition, Elsevier Publishers

BSH402 CELL BIOLOGY AND GENETICS

Course Outcomes:

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

- Understand the molecular basis of life.
- Know the structure, organization and functions of organelles of prokaryote and eukaryotes.
- Comprehend the general structure and molecular organization of chromosomes.
- Gain theoretical knowledge how to use basic tools and techniques such as microscope, centrifugation, autoradiography and centrifugation for cytogenetics experiments .
- Update the knowledge in Genetics along with historical perspectives and scope of the subject.
- Understand the principles governing the inheritance and variations (Menedelian and non-Mendelian Genetics).
- Know how recombination occurs in bacteria and led to the development of rDNA technology.
- Get the idea about mutation and how to detect mutations.
- Apprehend the clinical relevance of studying Genetics.
- Integrate the core elements of cell biology and Genetics.

Unit I (13 hours)

Structure of prokaryotic and eukaryotic cells; Structure, organization and functions of cell organelles: Endoplasmic reticulum, liposomes, Golgi complex and protein sorting, ribosomes and nucleus; Structure of mitochondrion, cytoskeleton, chloroplast - their genetic organization and their semiautonomous nature. Cell division (mitosis and meiosis).

Unit II (13 hours)

Secretory and endocytotic pathway. Cytoskeleton-microtubules, microfilaments, intermediary filaments. Centriole, cilia, flagella and cell motility.

Eukaryotic chromosome - General structure and molecular organization. Nucleosome model of chromatin structure, Giant chromosomes, Structure and function of centromere and telomere.

Principles and applications of light, Phasecontrast, fluorescence, scanning and transmission electron microscopy. Autoradiography, cytophotometry and flowcytometry and centrifugation. Cytochemical and histochemical staining techniques.

Unit III (13 hours)

Historical perspectives and scope of Genetics; Principles of Mendelian inheritance; Modifications of Mendelian monohybrid and dihybrid ratios-Incomplete dominance, Codominance, Lethal genes and Multiple alleles.

Cytological basis of inheritance: Linkage and crossing over; Genetic mapping of chromosomes. Sex determination, Sex linked inheritance (*Drosophila* and Man). Sex related traits, genetic disorders.

Unit IV (13 hours)

Genetics of Bacteria: Transformation, transduction, Conjugation - Plasmids. Extra chromosomal inheritance with examples; Genomic organization in prokaryotes and eukaryotes; Laws of DNA constancy and C - value paradox.

Mutations: Classification, Biochemical basis for mutations; Detection of mutations - mutagenicity testing.

References:

1. C.J. Avers (1986). Molecular Cell Biology. Addison - Wesley Publishing Company, England.
2. J. Brachet (1985). Molecular Cytology. Vol.I &II. The cell cycles. Academic Press, Inc.
3. C.F.A. Culling (1974). Handbook of Histopathological and histochemical Techniques. 3rd Edition. Butterworths.
4. J.H. Darnell, Lodish and D. Baltimore (1995). Molecular Cell Biology. Scientific American Books, New York.
5. C.P. Swanson and P.L. Webster (1989). The Cell. 5th edition. Prentice Hall of India Pvt. Ltd., New Delhi.
6. Sadova, E., 1993. Cell Biology. Jones and Bartlett Publishers, London.
7. Kleinsmith, L.J. and Kish, V.M., 1995. Principles of Cell and Molecular Biology. 2nd Edition. Harper Collins Collge Publishers,
8. Thorpe, N.O., 1984. Cell Biology. John Wiley and Sons, New York.
9. Ladish, H., Baltimore, D., Berk, A., Zipursky, S.W., Matsudaira, P. & Darnell, S., 1995. Moelcular Cell Biology. Scientific American Books. Freeman & Company, New York.
10. Lowey, A.G., Siekevitz, P., Mesninger, J.R. and Gallant, J.A.N., 1987. Princples of Cell structure and function.
11. Thorpe, N.O., 1984. Cell Biology. John Wiley and Sons, New York.
12. Fraser, F.C. and James J. Nora, 1986. Genetics of Man. Lea and Febiger, Philadelphia.
13. Friefelder, D. 1987. Molecular Biology II Edn. Jones and Bartlett Pub. Inc., Boston.
14. Gardner, E.J., M.J. Simmons & D.P. Snustad, 1991. Principles of Genetics. 8th Ed. John Wiley and Sons, Inc., New York.
15. Hartl, D. L., D. Freifelder and L.A. Snyder, 1988. Basic Genetics. Jones and Bartlett Publishers, Boston.
16. Hollaender A. (Ed). 1971-76. Chemical Mutagens. Priniples and Methods for their Detection. Vols. 1, 2 & 3. Plenum Press, New York.
17. Jha, A.P. 1993. Genes and Evolution. MacMillan India Ltd., New Delhi.
18. Lewin, B. 1997. Genes VI, Oxford University Press, New York
19. Marther, K. and J. L. Jinks, 1977. Introduction to Biometrical Genetics. Chapman and Hall.
20. Peter J. Russell, 1998. Genetics. The Benjamin/Cummings Publishing Company, Inc.
21. Essential Cell Biology, Alberts *et al.*, 2010, 3rd edition, Garland Publishing, Inc., New York.
22. Lewin's Cells 2 nd edition, Editors Lynne Cassimeris, V.R. Lingappa, George Plopper, 2011, Jones and Bartlett publishers Sudbury Massachusetts, USA,.
23. Becker'sWorld Of The Cell 8th Edition by Wayne M Becker, Lewis J Kleinsmith, Jeff HardinDorling 2012, Kindersley (India) Pvt Ltd.

BSH403 BASIC MICROBIOLOGY

Course Outcomes:
Upon successful completion of the course, students will be able to:

- Understand the basic concepts, historical perspectives and scientists' contributions in Microbiology.
- Know how the evolution of prokaryotic and eukaryotic metabolism took place.
- Appreciate the microbial nutrition and how to culture the microbes in laboratory.
- Discern various factors affecting the growth and death of microorganisms.
- Explain the microbial metabolic pathways with their applications.

UNIT I (13 hrs)

Introduction to microbiology, historical perspectives, contributions of early microbiologists, Koch Postulates. Branches and scope of microbiology. Origin and evolution of microorganisms, discovery of anaerobic life, evolutionary chronology, trends in evolution of archaebacteria, eubacteria and eukaryotes. Evolution of prokaryotic and eukaryotic metabolism. Modern methods of tracing and analysis of evolution.

UNIT II (13 hrs)
Microbial diversity, habitats, life cycles, structure and classification of bacteria, cyanobacteria, actinomycetes, fungi and viruses. Pathogenic microorganisms: bacteria, mycoplasmas, rickettsias, chlamydias and protozoa.
Microbial nutrition and cultivation: Nutritional categories of microorganisms, role of microbial nutrients; cultivation of aerobes, anaerobes and facultatives, obligate pathogens and viruses. Selective media, selective isolation and methods of preservation of microbes.

UNIT III (13 hrs)
Microbial growth, population and growth curves, generation time, batch and continuous cultures (e.g. chemostat, turbidostat), measurement of growth, microbiological assays (e.g. antibiotics, amino acids and vitamins).
Factors affecting growth and death of microorganisms: temperature, pH, water activity, O-R potential, salinity, hydrostatic pressure, disinfectants, antiseptics and chemotherapeutic agents. Methods of sterilization.

UNIT IV (13 hrs)
Microbial metabolism: Energy sources and classification; metabolism in autotrophs, heterotrophs; hexose and pentose phosphate pathways; synthesis of peptidoclycan, intermediary metabolism and secondary metabolites. Aerobic and anaerobic respiration, fermentation, electron transport system and substrate phosphorylation.

References:

1. Brock Biology of microorganisms. TB Brock and Madigan (2003). Prentice Hall, 10th Ed.
2. Elements of microbiology. J. Pelczar and ECS Chan (1988). Mac Graw Hill New York.
3. Microbial biology E Rosenberg and IR Cohen (1983). Saunders Coll. Pub.
4. The microbial world. RY Stanier (1990). Prentice Hall New Delhi, 5th ed.
5. Microbiology. Prescott, Harley & Klein (2002), 5th, 6th, 7th Ed, Mc Graw Hill Pub.
6. Microbiology, Principles & Exploration. J. G.Black (2004) 6th Ed, John Wiley & sons, Inc.
7. Soil Microbiology N.S. S. Rao (1999), 4th Ed, Oxford IBH Pub.

8. Principles of Virology, S. J. Flint (2006), Molecular Biology, Pathogenesis & control ASM press.
9. Alcamo's Fundamentals of Microbiology. Pommerville. 9th edition. Jones and Bartlett.
10. Microbiology: a Human Perspective. E W Nester,D G Anderson,C. Evans Roberts (2004).4th edition.
11. Foundations in Microbiology. K. P Talaro and A. Talaro. 8th Edition. McGraw Hill.
12. Medical Microbiology. R. Ananthanarayan and CK Jayaram Paniker, (2009) 8th edition. Universities Press.
13. Microbiology: An Introduction Gerard J Tortora; Berdell R Funke, Christine L Case,; (2010) 10th Edition. Benjamin Cummings.
14. Biopesticides: Use and Delivery. Methods in Biotechnology, Vol. 5. (1998)FR Hall & JJ Menn, Humana Press
15. Medical Microbiology, (Jawetz, Melnick, & Adelberg's Medical Microbiology) (2008) 24th edition.. McGraw Hill
16. Foodborne and Waterborne Bacterial Pathogens: Epidemiology, Evolution and Molecular Biology Caister Edited by Shah M. Faruque. (2012) Academic Press
17. Medical Microbiology (2005). Kayser, Bienz, Eckert and Zinkernagel. Thieme.
18. Microbiology with Diseases by Body System (2012). Robert W. Bauman. Third Edition. Benjamin Cummings
19. Sherris Medical Microbiology – An Introduction to Infectious Diseases. (2004). Kenneth Ryan and George Ray.. Fourth edition. McGraw Hill
20. Principles and Practice of Clinical Bacteriology. (2006). Stephen Gillespie and Peter Hawkey. Wiley, Second edition.
21. Microbenet: the Microbiology od the Built Environment network (http://microbe.net/microbenet-social-media/microbiology-blogs/)
22. http://www.microbiologymaven.com/
23. http://twistedbacteria.blogspot.in/2011/09/microbiology-blogs-list-of-20-great.html

SOFT CORE COURSES

BSS404 ADVANCED CELL BIOLOGY

Course Outcomes:

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

- Gain a deep knowledge in Cell Biology and its biomedical relevance.
- Know how scientists develop hypothesis by learning various models for membrane structure.
- Explain the physiochemical properties of biological membranes with structural and functional insights.
- Understand the components of cell cycle control, mechanisms of cell division and cellular senescence.
- Know factors affecting the programmed cell death (apoptosis).
- Understand how cells communicate one another and role of various messenger molecules in signal transduction.

Unit I (13 hours)

Introduction to Cell Biology. Various models for membrane structure; Singer and Nicolson's model. Physicochemical properties of biological membranes – compositions, molecular organization, Membrane asymmetry – lipids, proteins and carbohydrates, lateral diffusion, membrane domains – caveolae, rafts. RBC as a Model membrane. Transport across biomembranes- Energetics of membrane transport, Donnan membrane equilibrium, simple diffusion, osmosis, facilitated diffusion and active transport. Carrier proteins, Ion channels (voltage gated and transmitter gated) Bacterial -K^+ leak channel, & aquaporin channel, Electrical properties of membranes- Membrane potential, Mechanisms of nerve conduction. Transmission across electrical and chemical synapse. Mechanisms of endocytosis and exocytosis.

Unit II (13 hours)

Components in cell cycle control - Cyclins, CDKs in yeast and mammalian cells. Check points in cell cycle. Mechanics of Cell Division- Different stages of mitosis. Cohesins and Condensins in chromosome segregation, Microtubules in spindle assembly, Structure of kinetochore, centrosome and its functions, Sister Chromatid separation. Cytokinensis role of actin & myosin in the generation of contractile ring. Meiosis – Significance. Chiasma formation - Synaptonemal complex. Recombination during meiosis - recombination nodules. Programmed cell death (Apoptosis): Mechanisms by internal signals and external signals, factors affecting apoptosis. Cell senescence.

Unit III (13 hours)

Various types of cell signaling-endocrine, paracrine, juxtacrine and autocrine; Signalling molecules – hormones, neurotransmitters, gases, lipids, peptides. Overview of classes of extra cellular (G-protein coupled receptors, Ion channel receptors, Tyrosine kinase linked receptors & Receptors with intrinsic enzyme activity (RTK) and Intracellular receptors (cytosolic and nuclear receptors). General mechanisms of signal transduction by G protein coupled receptors and receptor tyrosine kinase, Second messengers- Ca^{2+}, IP_3, DAG, cAMP & cGMP – cellular effects. Signalling pathways in development and differentiation (overview). Cell–cell adhesion, cell junctions; Extracellular matrix, extracellular matrix receptors. Cell – cell and Cell – matrix interaction (Integrins and selectins and their interaction).

References:

1. Molecular cell biology, 6th ed. 2007, Harvey Lodish, Arnold Berk, S. Lawence Zipursky, Paul Matsudaira & David Baltimore. WH. Freeman and company, New york.
2. Cell and Molecular Biology-Concepts and experiments. 6th (ed), John Harris, D(ed) Karp, G. 2010 . Wiley & sons, New york.
3. Principles of Cell and Molecular Biology. 2nd edn, Kleinsmith, L. J. & Kish, V.M. 1995. Mc Laughlin, S., Trost, K., Mac Elree, E. (eds.)., Harper Collins Publishers, New York.
4. Molecular Biology of the cell. 5th edn.,Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K, Watson, J. D. (eds.) 2007. Garland Publishing, Inc., New York.
5. The Cell-A Molecular Approach. 5th ed. Cooper, Geoffrey M. Sunderland (MA): 2009, Sinauer Associates, Inc.;
6. Cell and Molecular Biology. 8th edn, De Robertis, E.D.P. and De Robertis, E.M.F. 2001. B. I. Waverly pvt. Ltd., New Delhi.
7. Developmental Biology. 6th ed Gilbert, Scott F.. Sunderland (MA): 2006, Sinauer Associates, Inc.;
8. Principles of Technique of biochemistry & Molecular biology, 2010, Edited by Keith Wilson & John Walker, 6th Ed. Cambridge University press.
9. Essential Cell Biology, Alberts *et al.*, 2010, 3rd edition, Garland Publishing, Inc., New York.
10. Lewin's Cells 2 nd edition, Editors Lynne Cassimeris, V.R. Lingappa, George Plopper, 2011, Jones and Bartlett publishers Sudbury Massachusetts, USA,.
11. Becker'sWorld Of The Cell 8th Edition by Wayne M Becker, Lewis J Kleinsmith, Jeff HardinDorling 2012, Kindersley (India) Pvt Ltd

BSS405 BIO-ANALYTICAL TECHNIQUES

Course Outcomes:

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

- Know the basics and terminologies of various analytical techniques used in Biological sciences.
- Understand the principles and utilities of advanced chromatographic techniques, electrophoresis and ultracentrifugation.
- Explain the principles and applications of tracer techniques, including the handling of radionuclides.
- Address the principles of biophysical methods for analysis of biopolymer structure.
- Appreciate the usefulness of various advanced technologies such as UV, ORD, CD, NMR, ESR spectroscopy and atomic absorption spectroscopy.
- Connect biology and nanotechnology deriving various applications.
- Gain the knowledge of biophotonics, biosensors and electrophysiology and their biomedical applications.

Unit I (13 hours)

Principles and applications of Thin Layer Chromatography, Gel filtration, ion exchange and affinity chromatography, HPLC, Electrophoresis, electro focusing and ultra-centrifugation (Velocity and buoyant density), Principle and applications of tracer technique in biology, Radiation dosimetry. Radioactive isotopes and half life of an isotope, Effects of radiation on biological system, Cerenkov radiation, Liquid scintillation counter and radiation measurement

Unit II (13 hours)

Principles of biophysical methods for analysis of biopolymer structure. X-ray diffraction, fluorescence UV, ORD, CD, visible NMR and ESR spectroscopy, Atomic absorption spectroscopy and plasma emission spectroscopy, Principles and applications of Bionanotechnology

Unit III (13 hours)

Biophotonics, Biosensors-principles, design, working, types and applications, Electrophysiology, single neuron recording, patch-clamp recording, medical biophysics, neuroimaging techniques, PET, MRI, fMRI, CAT, Calcium imaging techniques

References:

1. Biophysics - V. Pattabhi & N. Gautham, 2003, Narosa Publishing house,
2. Basic Concepts of Analytical Chemistry - S. M. Khopkar, 2008, 3rd Ed., New Age Publications.
3. Biophysical Chemistry-Principles and Techniques - A. Upadhyay, K. Upadhyay, N. Nath, 2005, Himalaya publishing house
4. Nuclear and Radiochemistry - Gerhart Friedlander, 1981, 3rd Ed., Wiley.
5. Biophysical Chemistry Part II. Techniques for the study of biological structure and function - C. R. Cantor, P. R. Schimmel. 1980, W.H. Freeman
6. Principles of Bioinorganic Chemistry - S. J. Lippard, J. M. Berg, 1997, Panama Publishing.
7. Molecular & Cellular Biophysics - M. B. Jackson, 2006, Cambridge University press.
8. Principles of Physical Biochemistry - K. E. van Holde, W. C. Johnson, P. S. Ho, 1998, Prentice Hall.
9. Physical Biochemistry by D. Freifelder IInd Edition(1982)

10. Biochemical calculation by I.H. Segal IInd Edition (1976)
12. Wilson, K. and Walker, J.(1996). Practical biochemistry.Principles and Techniques. Cambridge Low Price Editions
13. Shrikant, L. P. (2013) Understanding Biophysics. 4th edition, Sumana Publications.
14. Krishna A. P (2014) Text book of Medical Physiology, 2nd edition. Suman Publications.
15. Biophysical chemistry (principles and techniques) Upadhyay Mumbai: Himalaya Pub. House, 2009.

PRACTICAL COURSES

BSP406 BIOCHEMISTRY LAB

Course Outcomes:

After undergoing the course, students will be able to :

- Enhance the theoretical knowledge in biochemistry with laboratory experiments.
- Perform qualitative tests for identification of proteins, carbohydrates, lipids and NPN substances.
- Know how to prepare laboratory reagents in different concentration modes.
- Operate instruments such as Micro-Kjeldahl distillation unit, pH meter and spectrophotometer.
- Gain the skill to estimate the concentrations of certain biomolecules.
- Know how to conduct biochemical tests to diagnose some metabolic diseases.

1. Qualitative analysis of carbohydrates: monosaccharides, disaccharides and polysaccharides
2. Qualitative tests for the proteins,
3. Qualitative tests for lipids and NPN substances.
4. Preparation of buffers and its pH determination
5. Preparation of normal, molar and percent solutions
6. Estimation of amino acids and nitrogen analysis by Micro-Kjeldahl method
7. Enzyme activity: Effect of temperature, pH, Km determination
8. Spectrophotometric estimation of metabolites: serum protein, sugar, creatinine, urea, uric acid
9. Colorimetric analysis of vitamins, ascorbic acid etc.,
10. Estimation of plant phenolics
11. Tests to measure glycosuria, proteinuria etc

BSP407 CELL BIOLOGY AND GENETICS LAB

Course Outcomes:

After undergoing the course, students will be able to:

- Acquire the knowledge and skills to perform experiments in Cell Biology and Genetics-
- Learn how to measure the cells using micrometry and technique of camera lucida drawing.
- Know how to diagnose some diseases through haematological parameters
- Gain the skill how to use microtome as a tool to cut extremely thin sections of material for histology.
- Know how to do histochemical localization of carbohydrates, proteins and nucleic acids through staining techniques
- Understand and appreciate the importance of *Drosophila melanogaster* as an excellent modelin Genetics.
- Become familiar with the methods of maintenance and techniques of handling *D. melanogaster*.
- Enhancetheoretical knowledge of gene expression with the aid of cytogenetic experiments.
- Conduct crossing experiments to learn Mendelian and non-Mendelian Genetics to understand the governing principles of inheritance and variations.
- Solve genetic problems, including for legal issues like paternity and maternity disputes.

Cell Biology

1. Micrometry and camera lucida drawings
2. Cell (RBC) counting using haemocytometer
3. 4. Study of plasmolysis in cells of *Rheo* leaves.
4. Determination of mitotic index in onion root tips
5. Preparation of tissues for histology, Sectioning & Staining
6. Histochemistry-localization of a) Carbohydrates b) Proteins c) Nucleic acids
7. Hematoxylin staining and study on histology of liver, intestine, stomach, ovary, etc.,

Genetics

1. Salient features and method of maintainance of *Drosophila melanogaster* culture.
2. Techniques for handling and examining the flies.
3. Preparation of salivary gland chromosomes of *D. melanogaster* and identification of different arms.
4. Preparation of salivary gland chromosomes in *D. nasuta*
5. Identification of blood types in man.
6. Experiments to demonstrate patterns of inheritance of a few characters (Crossing).
7. Study of (i) mating behaviour in *Drosophila* (ii) somatic mitosis in *Drosophila*.
8. Biochemical separation of eye pigments in *Drosophila*
9. Genetic problems.

BSP408 BASIC MICROBIOLOGY LAB.

Course Outcomes:

After undergoing the course, students will be able to :

- Understand the basic techniques and instrumentations in microbiology.
- Enjoy the subject with microscopic observation and culturing of microorganisms.
- Gain the skill of different staining techniques with application point of view.
- Know how to perform microbial motility tests.
- Apply the techniques of sterilization of media and glassware.
- Execute the filter sterilization and microbial isolation.

1. Introduction to basic techniques and instrumentation in microbiology
2. Microscopic observations of microorganisms and micrometry
3. Staining techniques: Properties of stains, microbial smear preparation, simple and differential staining for morphological studies, Gram's staining, endospore staining, intracellular lipids, acid-fast staining, flagella, viability tests and relief (negative) staining;
4. Microbial motility tests.
5. Microbial culture media, microbial growth
6. sterilization of media and glassware, filter sterilization
7. stock culture, subculture, maintenance of culture.
8. Techniques of microbial isolation.

BSP409 ADVANCED CELL BIOLOGY LAB

Course Outcomes:

After undergoing the course, students will be able to :

- successful completion of the course, students will be able to:Enhance the theoretical knowledge of cell division and cell cycle through visualization of stages of mitosis and meiosis.
- Develop the skill of cytogenetic staining techniques.
- Understand the impact of toxic agents on chromosomes and cell division through cytogenetic experiments.
- Conduct the cell viability tests for screening agents for anticancer activity.
- Know how to isolate the sub-cellular organelles.
- Gain the skill to measure Na-K ATPase in membrane fractions and determine osmotic fragility.

1. Study of mitotic stages in onion root tip
2. Study of meiosis in Onion inflorescence/grasshopper testis
3. Study of chromosomal aberration in *Allium cepa* after chemical induction
4. Differential staining of tissue sections
5. Cell viability assays
6. Isolation of Sub cellular organelles
7. Measurement of Na-K ATPase in membrane fractions
8. Determination of osmotic fragility of erythrocyte membranes

BSP410 BIO-ANALYTICAL TECHNIQUES LAB

Course Outcomes:

After successful completion of the course, students are able to:

- Develop the technical skill handling and operation of various advanced instruments in Biology.
- Know how to separate the mixtures by planar and column chromatographic techniques.
- Undertake quality analyses required in food industry by identifying additives, vitamins, preservatives, proteins, sugars and amino acids.
- Understand the Beer Lambert's law and how to operate UV-Visible Spectrophotometry for estimation.
- Operate of flame photometry, amino acid analyser and HPLC.
- Perform different electrophoresis techniques for separation and determination of molecular weight.
- Gain the skill to perform ELISA for quantification of antigens.
- Perform immune-diffusion as a diagnostic tool for detection of antibodies and antigens.
- Carry out experiments using centrifuge for separation of molecules.
- Demonstrate the biophysical methods for structure elucidation.

1. Ascending, descending and circular paper chromatography for separation of amino acids/carbohydrates
2. TLC of amino acids (1D and 2D)/carbohydrates
3. UV-Visible Spectrophotometry-verification of Beer Lambert's law
4. Flame photometry and its application in the estimation of serum, calcium, potassium and lithium and sodium.
5. HPLC (Demonstration)
6. Gel electrophoresis- native and SDS-PAGE and estimation of molecular weight of Proteins
7. ELISA for quantification of an antigen.
8. Immunodiffusion
9. Amino acid analyser
10. Western blotting
11. Isoeletric focussing
12. Centrifuge use and application of centrifugations techniques for separation
13. Demonstration of biophysical methods for structure elucidation

II SEMESTER

HARD CORE COURSES

BSH451 MOLECULAR BIOLOGY

Course Outcomes:
After successful completion of the course, students will be able to :

- Understand the molecular basis of life.
- Explain the structure and functions of nucleic acids.Know the role of various enzymes involved in DNA replications.
- Comprehend how gene transcription occurs in prokaryotes and eukaryotes.
- Understand the mechanism of transcriptional, post-transcriptional and post- translational regulations.
- Appreciate the role of ribosomes in protein synthesis.
- Know the clinical relevance of inhibitors of RNA and protein synthesis.
- Recognize how cells communicate one another in prokaryotes and eukaryotes.
- Realize the significance of non-coding RNAs and miRNAs.
- Explain how genome can be edited with advanced technologies.

Unit I (13 hours)

Structure of nucleic acids; structure of DNA, topology, forms of DNA, repetitive DNA, DNA polymerases, DNA ligases, topoisomerases, gyrases, methylases, nucleases and restriction endonucleases, Ribonucleoproteins, Structure of m-RNA, Three dimensional structure of t-RNA, Genetic code, Heterochromatization, transposition, regulatory sequences and transacting factors, homologous recombination

Unit II (13 hours)

Organization of transcriptional units, Mechanism of DNA transcription in prokaryotes and eukaryotes, RNA processing (capping, polyadenylation, splicing, introns and exons), RNA polymerase, types, promoter initiation and transcription, DNA replication (Eukaryotes and prokaryotes), inhibitors of RNA synthesis and their mechanism of action, polycistronic and monocistronic RNAs, post transcriptional modification

Unit III (13 hours)

Protein synthesis in prokaryotes and eukaryotes, role of ribosomes and different types of RNA in protein synthesis, basic feature of genetic code, Amino acid activation, mechanism of initiation, elongation and termination, post translational modifications, inhibitors of protein synthesis

Unit IV (13 hours)

Molecular basis of signal transduction in bacteria, plant and animals, Regulation of gene expression in bacteria and eukaryotes, non-coding RNAs, microRNAs, Genome editing technologies

References:

1. Molecular Biology of the cell. 5th edn.,Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K, Watson, J. D. (eds.) 2007. Garland Publishing, Inc., New York.2.
2. The Cell-A Molecular Approach. 5th ed. Cooper, Geoffrey M. Sunderland (MA): 2009, Sinauer Associates, Inc.;
3. Developmental Biology. 6th ed Gilbert, Scott F.. Sunderland (MA): 2006,Sinauer Associates, Inc.;
4. Molecular cell biology, 6th ed. Harvey Lodish, Arnold Berk, S. Lawence Zipursky, Paul Matsudaira & David Baltimore. 2007, WH. Freeman and company, New york.
5. Cell and Molecular Biology-Concepts and experiments. 6th (ed), Karp, G. 2010 . John Harris, D(ed) Wiley & sons, New york.
6. Lewin's Genes X Jocelyn E. Krebs, Elliott S. Goldstein Stephen T. 5th ed. 2011, .Jones & Bartlett Publisher
7. Molecular Biology: Genes To ProteinsBurton E. Tropp, David Freifelder2007, Jones & Bartlett Learning,
8. Molecular Biology of the Gene, 5th ed. 2004, Cold Spring Harbor Laboratory Press, ,
9. Fundamentals of Biochemistry: Life at the Molecular Level Donald VoetCharlotte W. Pratt , Judith G. Voet 3rd edn, 2008 John Wiley & Sons

BSH452 BIOSTATISTICS AND BIOINFORMATICS

Course Outcomes:

After successful completion of the course, students will be able to :

- Appreciate the relevance of statistics in solving biological problems.
- Become expert how to apply the statistical methods to analyse and interpret the biological data.
- Know how to represent the data of experimental and field studies, in terms of graphs and diagrams.
- Understand the concept of central tendency and how to apply mean, mode and median.
- Comprehend the measure of dispersion, coefficient of variation and diversity Index.
- Gain the practical knowledge of sampling techniques
- Know how to apply the Binomial, Poisson and Normal distributions for Genetics.
- Understand how to perform the simple linear and multiple regressions and correlation analysis.
- Calculate the level of significance by applying normal, Chi-square, `t' and F tests.
- Solve the biological data through ANOVA and Two-way analysis of variance.
- Know about various statistical packages and how to use them for analysis of biological data.
- Understand the basics of bioinformatics, structural and functional features of computers.
- Know how to retrieve the databases and make use of search engines, internet tools and World Wide Web (WWW).
- Understand the concept of parsimony and bootstrapping.
- Know how to use bioinformatics tools for DNA and protein sequence analysis through FASTA, BLAST and GCG Wisconsin/Emboss packages.
- Explain the genomics and proteomics.
- Know the microarray techniques and gene expression analysis.
- Understand the concept of protein folding and various models.
- Apply distributed computing approach, genome@home, folding@home,
- Know protein structure based targeted drug designing.

Unit I (13 hours)

Biological data-frequency distribution, graphical and diagrammatic representations; Measures of Central tendency - Mean, Median and Mode; Measure of Dispersion - Range, Variance, Standard deviation, Coefficient of variation, Diversity Index.
Populations versus sample - sampling techniques; Standard error, Confidence limits.
Random experiment-probability. Binomial, poisson and Normal distributions and their applications in genetics.

Unit II (13 hours)

Simple linear Regression and Correlation analysis. Analysis of variance, principles of experimental design. Multiple regression.
Tests of significance- Normal, X^2, (Chi-square), `t' and F tests; Testing for goodness of fit.
One-way analysis of variance (ANOVA) and Two-way analysis of variance. Statistical packages.

Unit III (13 hours)

Introduction to Bioinformatics, Structural and functional features of computers. Databases, search engines, internet tools and World Wide Web (WWW). Molecular Modeling Database at NCBI, major web resources for bioinformatics. Phylogeny - Tree definitions, distance matrix methods and parsimony and bootstrapping. DNA and protein sequence Analysis, FASTA, BLAST and GCG Wisconsin/Emboss packages. Genomics and proteomics.

Unit IV (13 hours)

Microarray techniques, Gene Expression analysis, Protein Folding, Lattice models, Comparative modeling, threading, folds and function, Distributed Computing approach, genome@home, folding@home, proteomics, protein structure based targeted drug design – small molecular interactions and docking

References:

1. Norman, T. J. and Bailey. II Edn. Statistical methods in Biology. Hodder and Stonghton Ltd.
2. Arnold, E. 1979. II Edn. Introductory statistics for Biology, London.
3. Campbell, R.C. 1983. Statistics for Biologists II Edn., Cambridge Press.
4. Higgans, D. and Taylor, W. 2000. Bioinformatics, Sequence and Structure. Oxford University Press, USA.
5. Sillince, J.A. and Sillince, M. 1991. Molecular databases for protein sequence and structure studies. Springer-Verlag
6. Stephen, M. and Stephen, K. 2001. Bioinformatics – Methods and Protocols. Humana Press, USA.
7. Beginning Perl for Bioinformatics. James D. Tisdall
8. Bioinformatics: Sequence and Genome Analysis. David W. Mount
9. Bioinformtics: Methods and protocols. Stephen A. Krawetz, Humana Press
10. Fundamental Concepts of Bioinformatics. Krane & Raymer, Pearson Ed.
11. Introduction to Protein Structure. C.I. Branden and J. Tooze, Garland Pub.
12. Introduction to Bioinformatics. Attwood & Parrysmith, Pearson Ed.

SOFT CORE COURSES

BSS453 APPLIED MICROBIOLOGY

Course Outcomes:

After successful completion of the course, students will be able to :

- Understand and appreciate the applications of Microbiology in biomedical and industrial fields.
- Comprehend the interactions of microbes with plants and animals, including humans.
- Realize the beneficial and harmful effects of microbes.
- Know how to do the fermentation for production of ethanol, lactic acid and other industrial products.
- Gain a good theoretical knowledge of food microbiology from basics to advanced.
- Know how to prevent milk-borne, air-borne and food-borne diseases, and food poisoning.
- Gain the basics of soil microbiology and its allied applications in agriculture.
- Know the importance of aquatic microbiology.
- Know how to do water purification and assessment of drinking water quality.

UNIT I (13 hrs)

Microbial Ecology: Microbial symbiosis, mutualism, plant-microbe interactions (e.g. mycorrhizas), animal-microbe interactions (human, ruminants and non-ruminants). Microbes in hydrothermal vents and coral reefs.
Fermentation: Ethanol, lactic acid, mixed acids, 2-3 butanidiol, costridial and propionic acid fermentation with emphasis on their ecological niches, merits and demerits.

UNIT II (13 hrs)

Food Microbiology: Classification of foods and oriental foods; Basic principles of food spoilage and methods of food preservation; Milk and milk products, milk microflora and their estimation, milk-borne diseases and prevention; Food poisoining, food-borne diseases and prevention.
Air Microbiology: Microflora of air and methods of their estimation, minitoring air allergens, air-borne diseases and prevention.

UNIT III (13 hrs)

Soil Microbiology: Soil microflora and methods of their estimation, role of soil microorganisms, bioconversion and decomposition. Biological nitrogen fixation (symbiotic and non-symbiotic), microbial phosphorus solubilization and their importance in soil fertility and agriculture.
Aquatic Microbiology: Microbes in water and methods of their estimation (e.g. MPN), drinking water microbial standards and water purification; Water-borne diseases and prevention.

References:

1. Biology of microorganisms. Brock TB and Madigon MT. Prentice Hall.
2. Element of Microbiology. Pelczar J. and Chan ECS. Mac Graw Hill New York
3. General Microbiology. Schlegel HG, Cambridge Univ. Press.
4. Microbial Biology. Rosenberg E and Cohen IR. Saunders Coll. Pub.
5. The Microbial World. Stanier RY et al., Prentice Hall New Delhi.
6. Microbial Ecology. Atlas RM and Bartha R. Benjamin-Cummings Sci. Press, USA
7. Medical Microbiology. Cruickshank R. Churchill Livingstone, London
8. Bacterial Metabolism. Doelle HW, Academic Press, London
9. Instant Notes in Microbiology. Nickilin et al., Via Books Pvt. Ltd., New Delhi
10. Methods in Microbiology. Norris JR. Academic Press, London
11. Foof Microbiology. Adams MR and Moss MO, Panima Publ\., New Delhi
12. Microbiology and Immunology Concepts. Barrett JT, Lippincott-Raven, USA
13. Industrial Microbiology. Casida LE. Wiley Eastern Ltd., New delhi
14. Immunology. Elgert KD. Jon Wiley and Sons, USA
15. Advances in Agricultural Microbiology. Subba Rao NS, Oxford and IBH Pub., New Delhi.

BSS454 AQUATIC BIOLOGY

Course Outcomes:

After successful completion of the course, students will be able to :

- Gain a sound knowledge in hydrobiology with application point view.
- Understand how abiotic factors influence aquatic organisms.
- Discern the hydrological cycle and ocean water.
- Know how aquatic organisms adapted during the course of evolution.
- Understand the natural and artificial aquatic ecosystems.
- Comprehend the importance of estuaries, mangroves, marshes, tidal flats, coastal wetlands and coral reef community.
- Realize the impacts of aquatic pollution and how to use the biological strategies to prevent the pollution.
- Know the basic concepts of biological productivity of both flora and fauna.
- Gain the knowledge how to collect, separate and classify planktons, and their importance.
- Appreciate the economic importance of hydrophytes and halophytes.

UNIT I (13 hrs)

Hydrobiology: Properties of water including sea water. Hydrological cycle. Ocean water movement - El nino effects. Structural and functional adaptations of aquatic organisms to the abiotic factors such as temperature, light, salinity, pressure and dissolved oxygen.

UNIT II (13 hrs)

Aquatic ecosystems: Freshwater habitats - wetland and swamps, tank/pond, river, lake/reservoir. Physico-chemical conditions and biological composition of estuaries, mangroves/marshes, tidal flats and coastal wetlands. Marine habitats - types of sea shore environmental parameters and adaptations of pelagic, benthic and deep sea organisms. Coral reef community.

Aquatic pollution: characteristics, sources and types; eutrophication, red tide, shellfish poisoning; Biological control of aquatic pollution.

UNIT III (13 hrs)

Biological productivity: Basic concepts. Factors affecting productivity, measurement of productivity; Production and distribution of aquatic fauna; Planktonology-classification, distribution, collection and separation of plankton; blooms/ swarms of plankton and algal production. Hydrophytes - types, adaptations, distributions and economic importance. Halophytes - types, adaptations, economic importance. Sea weed -types and their distribution and economic importance.

References:

1. APHA, 1992. Standard methods for examination of water and waste water. 19th Ed. APHA, New York, USA.
2. Edmondosn, W.T., 1965. Freshwater Biology. John Wiley and Sons, New York.
3. Hynes, H.B.N., 1970. Ecology of running waters. Liverpool University, Press, U.K.
4. Hutchinson, G.E., 1967. A treatise on Limnology. John Wiley and Sons, New York.
5. John Brown et al., 1989. Sea water: Its composition properties and behaviour. Open University Publications, Pergamon Press, England.

6. Maitland, P.S., 1978. Biology of Freshwates blockie, glassgrow and London, U.K.
7. Munshi, J.D. and Munshi, J.S.D., 1995. Fundamentals of freshwater biology. Narendra Publishing House, Delhi.
8. Wetzel, R.G. 1975. Limnology, 2nd ed. W.B. Saunders.
9. Zhang et al., 1988. Marine planktonology. Chinese University Press, Beijing.
10. Nybakkan, J.N., 1982. Marine Biology – An ecological approach. Harper and Raw Publ., New York.
11. Thompson, M.F. and Tirmizi, N.M., 1995. The Arabian sea: living marine resources and the environment. A.A. Balkema & Rotterdam. 730 pp.
12. Qasim, S.Z., 1998. Glimpses of the Indian Ocean. Universities Press, Hyderabad. 206 pp.
13. Raffaelli, D. and Hawkins, S., 1996. Intertidal ecology. Chapman & Hall, London. 356 pp.
14. Reddy, P.A., 2000. Wetland ecology. Cambridge University Press, London. 614 pp.
15. Davis, C.C., 1995. The marine and fershwater plankton. Michigan State University, Michigan. 502 pp.

BSS455 METABOLISM AND BIOENERGETICS

Course Outcomes:

After successful completion of the course, students will be able to :

- Gain a sound knowledge in biochemical basis of life.
- Understand how anabolic and catabolic reactions occur and their regulatory mechanisms.
- Know various disorders associated with metabolic pathways.
- Understand the physiological importance of fat and water soluble vitamins and their metabolism.
- Explain the concept of bioenergetics and thermodynamic principles in biology.

Unit I (13 hours)

Overview of metabolism, Metabolism of carbohydrates, pathways and regulation, gluconeogenesis, glycogenolysis, anaerobic glycolysis, citric acid cycle, hexose monophosphate shunt. Metabolism of lipids, Biosynthesis of fatty acids, Oxidation of fat and fatty acids, beta, alpha and omega oxidation, ketogenesis and ketolysis, metabolisms of acylglycerols and sphingolipids, cholesterol synthesis, transport and excretion, lipoprotein metabolism

Unit II (13 hours)

Protein and aminoacid metabolism, nitrogen balance, transamination and deamination, catabolisms of aromatic and sulphur containing aminoacids, urea cycle and disorders, Metabolisms of purines and pyrimidines, metabolism and functions of fat soluble A, D, E and K and water soluble B complex (B1, B2, B3, B5, B6, B7, B9 and B12) & C vitamins

Unit III (13 hours)

Bioenergetics, Thermodynamic principles in biology, Concept of free energy. Energy rich bonds, Coupled reactions, Electron transport chain, oxidative phosphorylation, group transfer, Biological energy transducers, inhibitors of electron transport chain, uncouplers

References:

1. Voet, D., Voet, G. Biochemistry. 2nd Edition, John Wiley and Sons, (1994).
2. Stryer, L., Biochemistry. 4th Edition (2004).
3. Harper Biochemistry. Lange publications. 26th edition
4. Lehninger, A.L., Nelson, D.L., M.M. Cox. Principles of Biochemistry. CBS Publications (2001)
5. Thomas M. Devlin, 2nd Edition, "Text-book of Biochemistry with clinical correlations

PRACTICAL COURSES

BSP456 MOLECULAR BIOLOGY LAB

Course Outcomes:

After successful completion of the course, students will be able to :

- Enhance the theoretical knowledge in molecular biology through some lab experiments.
- Perform agarose gel electrophoresis and realize its applications in biological research.
- Familiar with how to isolate plasmid DNA, genomic DNA and total RNA from bacteria and other sources.
- Know how to execute restriction digestion and mapping of DNA.
- Gain the practical knowledge of designing primers and run the PCR reaction.
- Determine the purity of DNA and RNA
- Know how to operate the gel documentation instrument (Geldoc) and image development.

1. Agarose gel electrophoresis
2. Isolation of plasmid DNA from bacteria and its identification by electrophoresis
3. Isolation of genomic DNA from various sources and its identification
4. Restriction digestion and mapping of DNA
5. Isolation of total RNA from various sources and gel electrophoresis
6. Design of primers and PCR
7. Determination of DNA/RNA purity by UV-Visible spectrophotometry
8. Demonstration of gel documentation and imaging

BSP457 BIOSTATISTICS AND BIOINFORMATICS LAB

Course Outcomes:

After successful completion of the course, students will be able to :

- Gain the skill to apply the central tendencies to solve the biological problems.
- Know how to apply the measures of dispersion.
- Understand how to do the scatter plot and correlate the biological data.
- Construct the frequency table.
- Understand how to solve the problems by applying Binomial, Poison & Normal distributions.
- Know how to perform statistical inference, t and F tests and analysis of variance.
- Make use of search engines, web lab viewer and Rasmols.
- Gain the practical knowledge in bioinformatics.
- Expertise operation of computers for analysing and interpreting various biological data.
- Develop the skill to use search engines, internet tools and databases.
- Gain the practical knowledge of restriction mapping and microarray techniques.

Biostatistics

1. Measurement of Central tendencies, mean, median, mode
2. Measures of dispersion range SD, CV &SE
3. Scatter plot, Simple Correlation & Regression, Multiple Correlations
4. Construction of frequency table
5. Theoretical distribution, Binomial poison & normal
6. Statistical inference, normal, t test, chi-square & F test

7. Analysis of Variance
8. Search engines
9. Web lab viewer and Ras mols

Bioinformatics

1. Introduction to bioinformatics
2. Basic feature of computers; flow charts and problems.
3. Search engines and internet tools.
4. Biological databases
5. Use of databases (e.g. BLAST, FASTA)
6. Restriction mapping
7. Micro array techniques

BSP458 APPLIED MICROBIOLOGY LAB.

Course Outcomes:

After successful completion of the course, students will be able to :

- Master quantitative and qualitative assessments of microflora of soil, water and air.
- Gain the skill of selective isolation of microbes.
- Understand the symbiotic association of microorganisms through experimentations.
- Become expert in morphological and biochemical tests for identification of microbes.
- Know how to assess the microbial quality of drinking water and milk.
- Perform microbiological assays for antibiotics and amino acids.

1. Quantitative and qualitative assessment of microflora of soil, water and air by direct and indirect methods.
2. Selective isolation of microbes (bacteria, actinomycetes, yeasts and fungi)
3. Studies on symbiotic association of microorganisms (rhizobia, cyanobacteria and arbuscular mycorrhizae)
4. Simple and special morphological and biochemical tests for identification of bacteria and fungi
5. Assessment of microbial quality of drinking water and milk
6. Microbiological assays (antibiotics and amino acids)

BSP459 AQUATIC BIOLOGY LAB

Course Outcomes:

After successful completion of the course, students will be able to :

- Know how to perform the qualitative analyses of water samples for various parameters.
- Enhance the knowledge of freshwater, marine and benthic organisms through specimen/ microscopic observations.
- Know how to prepare the temporary and permanent slides of planktons.
- Estimate the productivity of aquatic ecosystems.
- Gain the practical knowledge on hydrophytes, halophytes, sea weeds and sewage organisms.
- Know the food and feeding habits in fish.
- Know and become expert in usage of instruments for studies in aquatic biology.
- Understand the importance of field visits for learning Biology with special reference to aquatic biology.

1. Water quality parameters
2. Freshwater, marine and benthic organisms.
3. Preparation of temporary and permanent slides of plankton.
4. Estimation of productivity.
5. Hydrophytes, halophyes and sea weeds.
6. Food and feeding habits in fish.
7. Sewage organisms.
8. Instrumentation in aquatic biology
9. Field trips.

BSP460 METABOLISM AND BIOENERGETICS

Course Outcomes:

After successful completion of the course, students will be able to :

- Enhance the theoretical knowledge in metabolism and bioenergetics.
- Know how to perform spectrophotometric estimation of various metabolites.
- Diagnose some of the metabolic diseases through biochemical tests.
- Gain the skill to quantify vitamins and phenolics in plant samples.
- Become expert in calculations of standard free energy change, redox potential, and mitochondrial respiration.

1. Spectrophotometric estimation of metabolites: serum protein, sugar, creatinine, urea, uric acid
2. Colorimetric analysis of vitamins, ascorbic acid etc.,
3. Estimation of plant phenolics
4. Tests to measure glycosuria, proteinuria etc
5. Calculations in Bioenergetics: standard free energy change, redox potential, mitochondrial respiration etc.

OPEN ELECTIVE COURSES

BSE461 BIODIVERSITY

Course Outcomes:

After successful completion of the course, students will be able to :

- Gain theoretical knowledge and appreciate the importance of biodiversity.
- Understand the relevance of biodiversity in conservation.
- Become familiar with and understand the key terminologies of Ecology.
- Describe the levels of biodiversity organizations.
- Know about Indian ecological/geographical diversity, including Himalayan region, Desert.
- Western Ghats, Coastal region and Hotspots of biodiversity.
- Understand what is microbial diversity and its importance.
- Know how to culture bacteria in lab for various microbial products.

Unit I (13 hours)

Basic concepts and definitions, scope, biosphere, habitats, food chain, food web. Levels of biodiversity organizations – Genetic diversity, Species diversity and Ecosystem diversity. Indian ecological/geographical diversity: Himalayan Region, Deserts, Semiarid region, Gangetic plains, Western Ghats, Coastal region; Hotspots of biodiversity,

Microbial diversity : Bacteria, Cyanobacteria, Fungi and Lichens, Algae, Protozoa and viruses, habitat. Mushrooms – edible and nonedible. Plant and animal association with microbes. Beneficial and harmful microbes, Culture, Cultivation of bacteria. Microbial products.

Unit II (13 hours)

Plant diversity : Lower and higher group of plants, plant ecosystem and its classification. Major ecosystem types, tropical forests, temperate forests. Arid and Semiarid ecosystems, boreal forests, Arctic and Alpine systems, grasslands, wetland ecosystem. Marine ecosystems, Epiphytes, parasites and orchids. Values and uses of plant diversity.

Animal diversity: Lower and higher group of animals, their ecological niches.
Zoogeographical regions of the world and India. Animals in temperate, tropical and boreal forests, cave and mountains, Coastal ecosystems, mangrove and estuaries, coral reefs.

Unit III (13 hours)

Biodiversity Conservation: Causes and prevention of Plant and Animal biodiversity loss;
IUCN Red List Categories and Criteria;
Conservation strategies – *Ex-situ* and *In-situ* conservation, Protected ecosystems – Biosphere reserves, National parks, Sanctuaries, Botanical gardens, Sacred groves; Wildlife conservation and wildlife conservation act; Centers of diversity study.

References:

1. Daniel, J.C. A century of natural history. Bombay natural History Society, Bombay. M 697pp.
2. Dwivedi,A.P., 1993. Forests. International book Distributors, Dehra Dun. 352 pp.
3. Eugene, P. Odum, 1983. Basic Ecology. Saunders College, London.
4. Gugjisberg, C.A.W., 1970. Man and Wildlife, Arco Publishing Company Inc., New York.
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6. Korringa, P., 1976. Farming of marine organisms law in the food chain. Elsevier, Amsterdam. 264 pp.
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14. Brummit, R.K. 1992, Vascular Plant Families and Genera, Royal Botanic Gardens, Kew, England.
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16. IUCN, 1993. Draft IUCN Red List Categories. IUCN, Gland, Switzerland.
17. IUCN, 1994b. Guidelines for Protected Area Management Categories. WCMC, Cambridge and IUCN Commission on National Parks and Protected Areas. Gland, Switzerland.
18. IUCN, 1995. IUCN Red List Categories. IUCN, Gland, Switzerland.
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21. Lovelock, J,E. 1988a. The Earth as a living system. In: Wilson, E.O. and Peters, F.M. (Eds.) Biodiversity. National Academy Press, Washington DC, pp. 486-489.
22. Magurran, A.E. 1998. Ecological Diversity and its Measurememnt. Princeton Univ. Press, Princeton, NJ.
23. Pearce, D.W. and D. Moran 1994. The Economic Value of Biological Diversity. Earthscan London.

BSE462 CANCER BIOLOGY

Course Outcomes:

After successful completion of the course, students will be able to :

- Understand the molecular biology of cancer development.
- Acquire the knowledge about cell transformation mechanisms and role of oncogenes and tumour suppressor genes.
- Gainthe idea how to perform the tests for identification of different types of cancers.
- Get the awareness about what all agents cause the cancers.
- Know how to treat cancers by immunotherapy and rational design of cancer therapeutics.
- Know about the mechanisms of neoplasia and signaling pathway.
- Gain the knowledge how to diagnose and treat cancers with conventional and advanced therapies.
- Appreciate the importance of nanotechnology in cancer diagnostics and treatments.
- Comprehend the genomic and proteomic technologies.
- Realize how to assess the risk factors and prevent cancers.
- Know about the mechanisms of neoplasia and signaling pathway.

Unit I (13 hours)

Cellular hallmarks of cancer, Molecular biology of cancer development, Cell transformation mechanisms, benign and metastatic tumour, Protooncogenes, Oncogenes and tumour suppressor genes, Cellular senescence, Telomeres, cellular immortalization and tumorigenesis, Carcinogen- types and identification tests

Unit II (13 hours)

Multistep tumorigenesis, Mechanisms of neoplasia and signaling, tumor virology, Growth factors, receptors and cancer, cytoplasmic signaling circuitry programs and cancer, Cell cycle control, Genome integrity and cancer, pRb and control of cell cycle clock, DNA damage checkpoints and repair, Mismatch repair pathway and cancer

Unit III (13 hours)

Tumor immunology and immunotherapy, rational design of Cancer therapeutics and diagnostics, Cancer nanotechnology, sequelae of cancer and its treatment, Genomic and proteomic technologies and application of new technologies in prevention, assessing risk, diagnostics and treatment of cancer.

References:

1. Weinberg RA (2006), Cancer Biology. Publisher- Garland Science.
2. Mc kinnell RG, Parchment RE, Perantoni AO and Pierce B (1998), The Biological Basis of Cancer. Cambridge University Press.
3. Kleinsmith JL (2005), Principles of Cancer Biology, Benjamin Cummings Publication.
4. Franks LM and Teich NM (1997), Introduction to the Cellular and Molecular Biology of Cancer (3rd edition), Oxford University Press.
5. Cancer Biology, Fourth Edition by Raymond W. Ruddon, Oxford university press, USA, 2007
6. Cancer Biology, Roger John Benjamin King, Mike W. Robins, Pearson/Prentice Hall, 2006.

III SEMESTER
HARD CORE COURSES

BSH501 ANIMAL PHYSIOLOGY 52hrs

Course Outcomes:
After successful completion of the course, students will be able to :

- Refresh the knowledge in animal physiology with the updated information.
- Gain a deep knowledge in gastrointestinal system and its associated disorders.
- Understand how the digestive processes take place and mechanism of absorption of nutrients.
- Know the structural and functional basis of nervous system.
- Understand the importance of various endocrine glands and hormones including their mechanism of actions.
- Recognize the health disorders associated with endocrine system.
- Gain the knowledge of structural organization and functions of muscular system.
- Appreciate the biological significance of water.
- Understand how the osmoregulation and excretion processes take place in aquatic and terrestrial vertebrates.
- Describe the general patterns of nitrogen and non-protein nitrogen excretion.
- Know the physiology of urine formation in mammals and renal diseases.
- Understand the concept of thermoregulation and adaptive features to regulate the body temperatures in diversified organism.
- Update the knowledge in receptor system, including the types, mechanisms of olfaction, vision, hearing, taste, touch and gravity.

Unit I (13 hours)

Gastrointestinal System: Digestive processes and mechanisms of absorption of dietary carbohydrates, proteins and lipids; coordination of digestive and absorptive activities; gastrointestinal disorders.
Nervous system: Neuron and nerve impulse conduction synapses, synaptic transmission and neurotransmitters; reflex mechanisms; functions of the sensory and motor areas of the CNS; autonomic nervous system.

Unit II (13 hours)

Endocrine system : Endocrine glands - pituitary, thyroid, parathyroid, adrenals, pancreas, ovary, testis and pineal: hormones - release, transport, mechanism of action and biological action; Neurohormones of the hypothalamus; endocrine disorders, Neuroendocrine system in Insecta and Crustacea.
Muscular system: Contraction of skeletal muscle; molecular basis of muscle contraction; energetics of muscular contraction; neuromuscular transmission and excitation contraction coupling ; muscle atrophy and dystrophy.

Unit III (13 hours)

Osmoregulation and excretion: Biological significance of water; Osmoregulation in aquatic and terrestrial vertebrates; regulatory mechanisms; Major functions of excretory system; Organs of excretion- Basic processes responsible for the formation of the excreted fluid; Functional types- Generalized excretory organs and Specialized excretory organs;

Classification of excretory organs and their distribution in the animal Kingdom; General patterns of nitrogen and non-protein nitrogen excretion; physiology of urine formation in mammals; renal diseases.

Unit IV (13 hours)

Thermoregulation: Thermoregulation-a phenomenon of homeostasis; Thermoregulatory adaptations-Physiological, Physical and Behavioral adaptations; Thermoregulation in aquatic and terrestrial invertebrates; Thermoregulation in Vertebrates-Fishes, Amphibians, Reptiles, Birds and Mammals.

Receptor system: Sensory receptors-classification and properties; Receptor Mechanisms: Chemoreceptors- gustatory receptors and olfactory receptors, Mechanoreceptors- Touch or pressure receptors, Pain receptors, Receptors concerned with equilibrium, gravity, acceleration and vibration, Phonoreceptors; Electromagnetic receptors- Photoreceptors Thermoreceptors; Special Senses- Neurophysiology of Vision, Hearing and Chemical senses.

References:

1. Berne, R.M. & Levy, M.N. 1991. Physiology. The C.V. Mosby Company, St. Louis.
2. Ganong, W.F. 1999. Review of Medical Physiology (19th Edition) Kotheri Book Depot, Bombay.
3. Wilson, J.A. 1979. Principles of Animal Physiology. MacMillan Pub., New York.
4. Hopkins, W.G. (1995). Introduction to Plant Physiology. John Wiley and Sons, Inc. New York.
5. Guyton, A.C. & Hall, J.E. 1996. Text Book of Medical Physiology. 9th Ed. W.B. Saunders Company, Philadelphia.
6. Jenson, D., 1976. Principles of Physiology, Appleton Century Crafts.
7. Gorbman, A & Bern, H.A. 1974. A text book of Comparative Endocrinology. Wiley Eastern.
8. Prosser, C.L. & Brown, 1983. Comparative Animal Physiology. W.B. Saunders Company.
9. Vander, A.J., Sherman, J.H. and Luciano, D.S, 1994. Human physiology – The mechanisms of body function. International edition (6th ed.). McGraw Hill, Inc. New Delhi.

BSH502 PLANT PHYSIOLOGY 52hrs

Course Outcomes:

After successful completion of the course, students will be able to:

- Improve the knowledge and appreciate the importance of plant physiology.
- Understand the role of various nutrients for growth of the plants, including for commercial crops.
- Gain a sound theoretical knowledge of sand culture and soil culture.
- Know how to implement the advanced version of farming such as hydroponics and aeroponics.
- Understand how to rectify the mineral deficiencies.
- Comprehend the various concepts of water relation in plants and physiological processes.
- Recognize the factors affecting transpiration, guttation, and impact of anti- transpirants.
- Know the physiology of plant growth and role of various growth regulators.
- Know how photosynthesis occurs and factors affecting.

Unit I (13 hours)

Plant nutrition: Trace elements and their role, major and minor elements in soil and plants; Essentiality of elements- Sand culture, Soil culture, Hydroponics, Aeroponics; Mineral deficiencies and their rectification, nitrogen, phosphorus and sulfur metabolism.

Unit II (13 hours)

Water relations in plants: water requirements, Physical forces involved in water absorption, Osmotic system, Water potential, Site and path of water absorption; Ascent of Sap, mechanism of translocation of water and solutes; Factors affecting water absorption; Transpiration- Types of transpiration, structure and functions of stomata, mechanism of stomatal movement, Factors affecting transpiration , Guttation, anti-transpirants.

Unit III (13 hours)

Plant Growth and Growth Regulators- Plant growth, Growth curve, measurement of growth, Phytohormones: Biosynthesis, Mechanism of action and application of auxins, gibberellins, cytokinins, ethylene, abscisic acid; Vernalin, Florigen, Morphactins; Phytochromes.

Unit IV (13 hours)

Photosynthesis: Chloroplast and photosynthetic pigments; Concept of photosynthetic unit; Hill reaction; Oxygenic and anoxygenic photosynthesis; Concept of pigment system; Stages of photosynthesis- cyclic and non-cyclic photophosphorylation, Photorespiration; carbon dioxide fixation in C3 & C4 plants, CAM plants; Factors affecting photosynthesis.

References:

1. Hopkins, W.G. (1995). Introduction to Plant Physiology. John Wiley and Sons, Inc. New York.
2. Devlin, R.M. 1983. Plant Physiology. CBS Publications & Distributors, New Delhi.
3. Hopkins, W.G. (1995). Introduction to Plant Physiology. John Wiley and Sons, Inc. New York.

4. Kochhar, P.L. 1978. Plant Physiology. Atmaram, New Delhi.
Noggie, Ray G. 1986. Introductory Plant Physiology. Prentice Hall of India Pvt. Ltd. New Delhi.
5. Prasad M., 1997. Plant Ecophysiology. John Wiley & Sons, New York.
6. Salisbury, F.B. and C.W. Ross, 1992. Plant Physiology. Wordsworth Publishing Company, California.
7. Verma, V. 1975. Plant Physiology. Embkay, New Delhi.

SOFT CORE COURSES

BSS 503 APPLIED ECOLOGY 39hrs

Course Outcomes:

After successful completion of the course, students will be able to:

- Enhance the knowledge in the field of ecology and appreciate the applications.
- Understand varied aspects of biodiversity, hotspots of biodiversity: Western Ghats and Eastern Himalayas.
- Know about the wildlife management, including the administrative and judicial measures.
- Gain the knowledge of forest and landscape ecology and how to do watersheds management.
- Know the basics of fisheries and how to do aquaculture for commercial production of prawn, seaweed, oyster, mussel and fin fish.
- Understand the impacts of aquatic pollution.
- Get a good knowledge of population ecology and various terminologies.
- Know the pray-predatory dynamics, life-history strategies, energy budgets and reproductive strategies.

Unit I (13 hours)

Biodiversity: types, significance, distribution and measurements. Megadiversity countries, hot spots, biodivesity of Western Ghats and Eastern Himalayas.
Wildlife management: Present status of threatened wildlife of Western Ghats; Conservation, Administrative and Judicial measures.
Forest and landscape ecology: types of forests and their distribution with reference to Western Ghats; Vegetation mapping; Plant-animal interactions; Integrated pest management. Landscape Ecology - watersheds management.

Unit II (13 hours)

Fisheries: Aquatic resources - fish, mollusca and crustaceans. Aquatic wildlife; Conservation and management of aquatic wildlife. Aquaculture - prawn culture, seaweed culture, oyster culture, mussel culture, fin fish culture and the environment. Aquatic pollution, Eutrophication and shellfish poisioning.

Unit III (13 hours)

Population ecology: Demography-life tables; population structure-recruitment patterns, settlement and migration; population growth-growth patterns, age and growth, allometry, growth parameters; biotic parameters-predation, pray-predatory dynamics, competiton, mutualism and population regulation; lifehistory strategies-life history traits, longivity and survival rates, energy budgets, and reproductive strategies, *k*-selection and *r*-selection.

References:

1. Burn, A.J., Coaker, T.H. and Jepson, P.C., 1987. Integrated pest management. Academic Press, London. 474 pp.
2. Daniel, J.C. A century of natural history. Bombay natural History Society, Bombay. 697 pp.
3. Dwivedi,A.P., 1993. Forests. International book Distributors, Dehra Dun. 352 pp.
4. Eugene, P. Odum, 1983. Basic Ecology. Saunders College, London.
5. Govardhan Veerelapati, 1993. Remote sensing and water management in commend areas. International Book Distributors, Lucknow. 353 pp.
6. Green, R.H., 1979. Sampling design and statistical methods for environmental biologists. Wiley, New York. 257 pp.
7. Gugjisberg, C.A.W., 1970. Man and Wildlife, Arco Publishing Company Inc., New York.
8. Gulland, J.A., 1971. The fish resources of the Ocean, FAO/Fishery News (Books) Limited, England. 255 pp.
9. Gulland, J.A., 1977. Fish population dynamics. John Wiley & Sons, London. 372 pp.
10. Gulland, J.A., 1983. Fish stock assessment: A manual of basic methods. FAO/Wiley New York. 223 pp.
11. Gutierrez, A.P., 1996. Applied population ecology. John Wiley and Sons, Inc. New York. 300 pp.
12. Hanski, I.A. and Gilpin, M.F., 1997. Metapopulation ecology. Academic Press, San Diago. 512 pp.
13. Haywood, V.H. and Watson, R.T., 1995. Global biodiversity assessment. United Nations Environmental Programme,New York.
14. Jhingran, V.G., 1988. Fish and Fisheries of India. Hindustan Publishers, New Delhi. 666 pp.
15. Korringa, P., 1976. Farming of marine organisms law in the food chain. Elsevier, Amsterdam. 264 pp.
16. Levinton, J.S., 1982. Marine ecology, Prentice Hall, Englewood Cliffs. 526 pp.
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18. MacArthur, R.H. and Nilson, E.O., 1967. The theory of Island biogeography. Prinston University Press, Prinston.
19. Otto Kinne, 1976. Marine ecology. Vol.III – Cultivation. John Wiley & Sons, London. 577 pp.
20. Paul-Wostl, C., 1995. The dynamic nature of ecosystems. John Wiley & Sons, New York. 267 pp.
21. Pianka, E.R., 1983. Evolutionary ecology. Harper and Rav, New York. 416 pp.
22. Pielou, E.C., mathematical ecology. Wiley, New York, 385 pp.
23. Pook, R.W., 1974. An introduction to qualitative ecology. McGraw Hill, Tokyo. 532 pp.
24. Qasim, S.Z., 1999. The Indian Ocean Images and realities. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. 340 pp.
25. Roughgarden, J.J., 1987 Science of ecology. MacMillan, New York. 710 pp.
26. Sivaraju, V.V., and Balachandran, I., 1994. Ayurvedic drugs and their plant sources. 27. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. 570 pp.
27. Southwood, T.R.E., 1978. Ecological methods, Chapman and Hall, London. 524 pp.
28. Techniques to maintain biological diversities, 1988. SIRC, London.
29. Tiwari, S.K., 1985. Readings in Indian Zoogeography. Today and Tomorrow's Printers and Publishers, New Delhi. 604 pp.
30. Zaika, V.E., 1970. Specific productivity of aquatic invertebrates. Wiley, New York, 154 pp.

BSS 504 IMMUNOLOGY **39hrs**

Course Outcomes:

After successful completion of the course, students will be able to:

- Gain a sound knowledge in immunology from basics to advanced levels.
- Know the history and appreciate the scope of immunology.
- Realize the meaning of various terminologies in immunology.
- Understand the structural and functional basis of immune cells and organs.
- Comprehend how body defence against microbial infection.
- Get a detailed picture of antigens and antibodies.
- Know about different types of autoimmune diseases, AIDS and tumor-immunology.
- Understand how to perform immunization and production vaccines.
- Master the theoretical knowledge of various immunological techniques, including, ELISA, RIA, Fluorescent activated cell sorter.
- Know the biomedical importance of hybridoma technology for production of monoclonal antibodies.
- Know how to do in-*vitro* fertilization, embryo transfer, super ovulation and cloning.

UNIT I (13 hrs)

Immunology: History and scope of immunology; Immunity, classification of immunity; Host defence: cellular, tissue and humoral immunity; Acquired immunity; Primary and secondary lymphoid organs; Microbial defence: invasion, antigens, toxins; Antibiodies: Production, structure, classification and functions; Antigen-antibody reactions.

UNIT II (13 hrs)

Autoimmune diseases:Thyrotoxicosis, Systemic Lupus Erythromatosis, Antinuclear antibodies, hypersensitivity; Tumour immunology– tumor antigens, immunosurveillance,

immunological escape. Immune deficiency diseases– AIDS; Immunological tolerance, Immunization and vaccines.

UNIT III (13 hrs)

Immunological techniques: Precipitation and agglutination, immunodiagnosis, ELISA, RIA, immunoblotting and immunofluorescence; Flourescent activated cell sorter (FACS); Hybridoma technology, production and application of monoclonal antibodies; *In-vitro* fertilization, embryo transfer, super ovulation and cloning; Juvenile hormone analogues.

References:

1. Cellular and molecular immunology – Abul K. Abba, Andrew H. Lichtman, Jordan S.Pober-Saunders Co.
2. Essential immunology – Ivan Riott 8th edition Blackwell publishers, 1988
3. Handbook of expt. Immunology vol.1,2. Wier DM Blackwell scientific Pub.
4. Immunology – Janis Kuby. Freeman and co publishers, 2000
5. Immunology – 3rd edition. Ivan Riott, Jonathan Brostoff and David Male. Mosby publishers
6. Immunobiology- 3rd edition Janeway and Travers. Churchill Livingstone publicat
7. Practical immunology. Hudson etal Blackwell scientific Pub., 1986
8. Immunology. Elgert KD. Jon Wiley and Sons, USA
9. Microbiology and Immunology Concepts. Barrett JT, Lippincott-Raven, USA

BSS 505 ECOTOXICOLOGY 39hrs

Course Outcomes:

After successful completion of the course, students will be able to:

- Gain a sound knowledge in the field of ecotoxicology both basics and advanced with application point of view.
- Know various terminologies used in toxicology in general and ecotoxicology in particular.
- Know how to perform bioassays for assessment of toxicity.
- Understand how the biotranformation and detoxification of xenobiotics occurs at different levels.
- Gain the knowledge how to do the toxic risk and environmental impact assessments.
- Know about the atmospheric toxicants and their impact on climate.
- Enhance the knowledge of consequences of air pollution, including acid rain, photochemical smog, global warming, ozone depletion and haze.
- Know about how alcohol, tobacco, food additives, petroleum and petroleum products induce adverse effects.
- Understand how to scientifically use and the impact of reckless usage of pesticides.
- Know how to give antipodal therapy during pesticide poisoning.
  Get a detailed knowledge of toxicities of various metals.

Unit I (13 hours)

Introduction, definition and various facets of ecotoxicology; Kinds of toxicity; time & dose response relationships; factors influencing the toxicity; Bioassay.
Metabolism of toxic substances: biomagnification, biotransformation and detoxification; Effects of environmental toxicants- sub cellular, cellular, individual, population and ecosystem levels. Toxic risk assessment: Methods, monitoring, importance and surveillance of risk assessmen; Environmental Impact Assessment.

Unit II (13 hours)

Atmospheric toxicants: Major sources, types and standards; Primary pollutants-Carbon monoxide, sulphur oxides, nitrogen oxides, particulate matter, hydrocarbons, asbestos and CFC's; Secondary pollutants; Impact of air pollutants on climate-Acid rain, photochemical smog, global warming, ozone depletion and haze.
Toxicity of Alcohol, tobacco & its products, food additives, petroleum & petroleum products.

Unit III (13 hours)

Pesticides: Definition, classification, usage and exposure; Insecticides: Organochlorines -(DDT, cyclohexane, aldrin and endosulfan; Poisoning and treatment; Organophosphates and carbamates-Examples, sources, effects and treatment; herbicides, fungicides, rodenticides, endocrine disrupters. PCBs and Dioxins.

Metal toxicity - History, sources, emissions, effect of mercury, cadmium, arsenic and lead on metabolism and environment.

References:

1. Boudou, A. 1997. Aquatic toxicology. Vol. I and II.
2. Diwakar Rao, P.L. 1990. Pollution control Hand book, Utility Publications Ltd., Secunderabad. India.
3. Eaton, A. D., Clesceri, L.S. & Greenberg, A.E. 1995. Standard Methods for the Examination of Water and Wastewater. APHA, Washington.
4. Gupi P.K. and Salunke, D.K. 1985. Modern Toxicology. Vol.I, II and III. Metropolitan Publications, Delhi.
5. Hommadi, A.H. 1990. Environmental and Industrial safety. Indian Bibliographics Bureau, Delhi.
6. Jorgensen, S.E., Modelling in Ecotoxicology. Elsevier, Amsterdam.
7. Lewin, S.A. et al., 1988. Ecotoxicology : Problems and approaches. Springer - Verlag, Tokyo, New York.
8. Lewin, S.A. et al., 1989. Ecotoxicology: Problems and approaches. Springer - Verlag, Tokyo, New York.
9. Moriarty, F., 1975. Pollutants and animals : A factual perspective. George Allan & Unwin Ltd., London.
1. Omkar, 1995. Concepts of Toxicology. Chand & Co., Jallandar.
2. Schmitz, R.J. 1996. Introduction to water pollution biology. Asian Books Pvt. Ltd., New Delhi.
12. Trivedi, P.R. and Sudarshan, K. 1995. Global environmental issues. Commenwealth Publications, New Delhi.
13. Vernberg et al., 1981. Biological monitoring of marine pollutants. Academic Press, New York.

PRACTICAL COURSES

BSP 506 ANIMAL PHYSIOLOGY LAB

Course Outcomes:
After successful completion of the course, students will be able to:

- Enhance the theoretical knowledge in animal physiology with laboratory experiments.
- Gain the practical skill to conduct the experiments to learn the subject.
- Know how to experiments to understand the gastrointestinal functions.
- Visualize the factors affecting enzyme activities in digestion of food stuffs.
- Gain the skill to estimate enzyme activity.
- Gain the practical knowledge in neuroendocrinology.
- Know how to do sperm count, sperm morphology and sperm motility
- Become skilled determining the histochemical detection for understanding muscle physiology.
- Perform some experiments for better understanding of osmoregulation.
- Know how to conduct qualitative tests for excretory products.
- Demonstrate how active transport occurs and it significance.

1. Gastrointestinal function -
    1.1 Factors affecting enzyme activities in digestion of food stuffs.
    1.2 Quantitative estimation of Enzyme (amylase) activity.
2. Neuroendocrinology –
    2.1 Effect of hormones on blood glucose in rats.
    2.2 Study of estrous cycle in mice
    2.3 Study of sperm count, sperm morphology and sperm motility
3. Muscle Physiology -

3.1 Histochemical detection of SDH activity in red and white muscle fibres.

4. Osmoregulation -
    4.1 Estimation of Fluid balance in an animal.
    4.2 Osmotic relationship in animals at the level of cell as well as entire organism.
5. Excretion -
    5.1 Qualitative tests for excretory products.
    5.2 Demonstration of active transport.

BSP507 PLANT PHYSIOLOGY LAB

Course Outcomes:

After successful completion of the course, students will be able to:

- Expand the theoretical knowledge of plant physiology with laboratory experiments.
- Realize the importance each nutrient in plant growth through experimentation and observation.
- Observe mineral deficiency symptoms in plants.
- Know how to perform the tests for understanding water relations.
- Understand the photosynthesis by conducting some allied experiments.
- Understand the role of growth hormones in plants.

1. Plant nutrition-

1.1 Observation of mineral deficiency symptoms in plants.

2. Water relations -

2.1 Experiments to demonstrate the diffusion pressure deficit in plant cell.

2.2 Determination of stomatal index, stomatal frequency and measurement of stomatal aperture.

2.3 Determination of water potential

3. Photosynthesis -

3.1 Separation and estimation of chloroplast pigments.

3.2 Demonstration of Kranz anatomy

4. Growth hormones and their regulation -

4.1 Experiments to demonstrate the effect of hormones on shoot apex.

BSP508 APPLIED ECOLOGY LAB

Course Outcomes:

After successful completion of the course, students will be able to:

- Enhance the theoretical knowledge of applied ecology with lab experiments and field visits.
- Appreciate the diversity of plant and animal life in the world.
- Realise the essence of plant-animal interactions and pray-predator relationship.
- Recognize the medicinal properties of plants and understand the importance of their conservation.
- Gain the skill of landscapes analysis through remote sensing data.
- Know how to identify the freshwater and marine fishery resources.
- Gain the skill to estimate growth parameters and determine the probability of death.
- Gain the knowledge how to conduct survey, collection of samples through field visits.

1. Biodiversity
2. Terrestrial biodiversity
3. Aquatic biodiveristy
4. Plant-animal interactions
5. Endangered medicinal plants.
6. Landscapes analysis through remote sensing data.
7. Freshwater fishery resources
8. Marine fishery resources
9. Estimation of growth parameters
10. Life-tables
11. Pray-predator relationships
12. Field trips

BSP509 IMMUNOLOGY LAB

Course Outcomes:

After successful completion of the course, students will be able to:

- Improve the knowledge in immunology with lab experiments.
- Know how perform the blood film preparation.
- Gain the skill to isolate lymphocytes and perform ouchterlony double diffusion assay.
- Become familiar with conducting radial immune-diffusion and apply DOT-ELISA technique.
- Gain a practical knowledge of immunological diagnosis of pregnancy and infection.
- Know how to perform rocket immune-electrophoresis and detection of allergens.

1. Study of immune system in rats
2. Blood film preparation and study of immune cells
3. Isolation of lymphocytes
4. Study of insect hemocytes
5. Ouchterlony double diffusion assay
6. Radial Immunodiffusion technique
7. Immunological diagnosis of pregnancy and infection
8. DOT- ELISA technique
9. Rocket immunoelectrophoresis method
10. Detection of allergens: Pollen Count by sticky slide method

BSP 510 ECOTOXICOLOGY LAB

Course Outcomes:

After successful completion of the course, students will be able to:

- Gain the knowledge how toxicology and ecology are integrated.
- Know what all safety measures to be taken in laboratories.
- Know how to determine acute and chronic toxicities through bioassays.
- Become skilled conducting experiments on solid wastes.
- Know how to estimate oil and grease in water sample.
- Discern clean and polluted water.\
- Know how to perform the spot test for detection of metals and other toxic pollutants.
- Become expert how to detect food adulteration.
- Observe and realize the impact of metal on plant germination and growth.
- Gain a practical knowledge how to perform GC analysis for food samples for pesticide residues.

1. Good Laboratory Practices
2. Safety notices in environmental toxicological studies.
3. Bioassay experiments using different test systems.
4. Behavioural study of the fish under exposure to toxicants.
5. Experiments on solid waste
6. Estimation of oil and grease in water sample.
7. Demonstration of catalase activity in polluted waters.
8. Spot test for detection of metals, residual chlorine, nitrite poisoning, fluoride toxicity food adulterants and pesticide residues.
9. Effect of $CdCl_2$ on germination of Bengal gram.
10. Effect of toxicants in meristematic tissue (Onion root tips).
11. GC analysis of pesticide residues in food samples.

OPEN ELECTIVE COURSES

BSE 511 POLLUTION AND BIOREMEDIATION 39hrs

Course Outcomes:

After successful completion of the course, students will be able to:

- Gain a good knowledge in environmental pollution and bioremediation.
- Know air, water and land pollutants and their impacts.
- Realize the impacts of water pollution on aquatic biota and human health.
- Know what causes and how we are responsible for acid rain, photochemical smog, global warming, ozone depletion and haze.
- Understand the concept of bioremediation and how to use microorganisms, plants and enzymes to detoxify contaminants.
- Know how to do biological treatment of liquid wastes and solid wastes.

UNIT I (13 hours)

Environmental pollution: Types of pollution – Air, water, land, sound and radioactive pollution.

Water pollutants: Major sources- Domestic, municipal, industrial and agriculture; types and standards; Impact of water pollution on aquatic biota and human health.

UNIT II (13 hours)

Atmospheric Pollutants: Major sources, types and standards; Primary pollutants- Carbon monoxide, sulphur oxides, nitrogen oxides, particulate matter, hydrocarbons, asbestos and CFC's; Secondary pollutants; Impact of air pollutants on climate-Acid rain, photochemical smog, global warming, ozone depletion and haze.

UNIT III (13 hours)

Remediation: Types of remediation- Physical, chemical and biological; Bioremediation- *in-situ* and *ex-situ* bioremediation; Phytoremediation; Microbial remediation; Biological treatment of liquid wastes and solid wastes.

References:

1. Diwakar Rao, P.L, 1990. Pollution control Hand book, Utility Publications Ltd., Secunderabad, India.
2. Eaton, A.D., Clesceri L.S. & Greenberg, A.E., 1995. Standard Methods for the Examination of Water and Wastewater, APHA, Washington.
3. Moriarty, F., 1975. Pollutants and animals; A factual perspective. George Allan & Unwin Ltd., London.
4. Schmitz, R.J, 1996. Introduction to water pollution biology. Asian Books Pvt. Ltd., New Delhi.
5. Trivedi, P.R. and Sudarshan, K., 1995. Global Environmental issues, Commonwealth Publications, New Delhi.
6. Vernberg *et al*., 1981. Biological monitoring of marine pollutants, Academic Press, New York.
7. George, A., 2000. The Ecology of sea shores, CRC Press.
8. Agrawal, K.C., 2002. Environmental Pollution: Causes, Effects and Controls.
9. Binoda C. Sabata, 1995. River Pollution in India.
10. Khetan S.K., 2000. Microbial Pest Control.
11. James, G.A., 1999. Ethical Perspective on Environmental issues in India.

BSE512 STEM CELL BIOLOGY AND REGENERATIVE MEDICINE 39hrs

Course Outcomes:

After successful completion of the course, students will be able to:

- Gain the knowledge in stem cell biology from basics to advanced with application point of view.
- Know different terminologies of stem cell biology and regenerative medicine.
- Discern different types of stem cell and their applications.
- Understand the state-of-the-art technologies, applications and ethics in research of stem cell biology.
- Know what is regenerative medicine and its significance in the modern world.
- Realize procedures involved in regenerative medicines up to molecular level.
- Understand the legal and ethical aspects of stem cell research and applications.
- Comprehend the biomedical relevance of nanotechnology.
- Know the principles and applications of tissue engineering.

Unit 1 (13 hours)

Basics of stem cell biology, origin, development, types and properties of stem cells, embryonic stem cells and induced pluripotent stem cells (iPSCs), foetal (amniotic, umbilical cord blood and stem cells from other embryonic tissues), adult stem cells- Hematopoietic stem cells, mesenchymal stem/stromal cells, neural stem cells, hepatic stem cells and skeletal muscle stem cells, cancer stem cells, state-of-the-art technologies, applications and ethics in research of stem cell biology and differentiation

Unit II (13 hours)

Introduction and principles of regenerative medicine, cell based therapies, pluripotency and regenerative medicine, Cell-cell interactions in tissue regeneration, Isolation and culture of stem cells, Viral and non viral vectors in stem cell research, Genome editing and use of genetically engineered stem cells. Applications of stem cell based therapies in bone, blood, cardiovascular regeneration, musculoskeletal repair, hepatocyte and neuronal transplantation, legal and ethical aspects of stem cell research and applications

Unit III (13 hours)

Nanotechnology: Definition, nanomaterials and their applications; Regenerative medicine, biomaterials and scaffolds in regenerative medicine, principles and applications of tissue engineering, modes of cell and tissue delivery, in situ tissue engineering and bioartificial organs, GMP and regenerative medicine

References:

1. Lodish et al. Molecular Cell Biology. 6th Ed., W.H. Freeman & Co. 2008.
2. Harvard Stem Cell Institute (HSCI) Stem Book can be accessed at http://www.stembook.org.
3. NIH Stem Cell Information Home Page. In *Stem Cell Information* Bethesda, MD: National Institutes of Health, U.S. Department of Health and Human Services. Available at http://stemcells.nih.gov
4. Stem Cell Research New Frontiers in Science and Ethics Edited by Nancy E. Snow ISBN: 978-0-268-01778-1, Publication Year: 2004
5. Stem Cell Transplantation: Biology, Processing, and Therapy Editor(s): Anthony D. Ho, Ronald Hoffman, Esmail D. Zanjani Print ISBN: 9783527310180 Online ISBN: 783527608744 2006
6. From Microscopes to Stem Cell Research: Discovering Regenerative Medicine (Chain Reactions) Sally Morgan ISBN-13: 9781432907006, 2008
7. R. Lanza, J. Gearhart et al Essential of Stem Cell Biology. (2009), Elsevier Academic press.
8. R. Lanza and I. Klimanskaya, Essential Stem Cells Methods. (2009), Academic Press.
9. J. J. Mao, G. Vunjak-Novakovic et al (Ed): Translational Approaches in Tissue Engineering & Regenerative Medicine 2008, Artech House, INC Publications.
10. Robert Lanza et al. Principles of Tissue Engineering, 3rd Edition. Academic Press; 3 edition (August 21, 2007)
11. Stein et al. Human Stem Cell Technology and Biology: A Research Guide and Laboratory Manual.Wiley-Blackwell; 1 edition, 2011

IV SEMESTER

HARD CORE COURSES
BSH551 BIOTECHNOLOGY 52hrs

Course Outcomes:
After successful completion of the course, students will be able to:

- Understand how to make use of the knowledge in basic science to develop technologies.
- Know the recent advancements in the field biotechnology.
- Gain the knowledge about different types of bioreactor and fermentation technologies.
- Know how to produce bioplastics as an eco-friendly strategy.
- Get a good awareness about production and utility of biofertilizers and biopesticides.
- Know how to apply the techniques of aseptic plant tissue culture.
- Comprehend how to produce various hybrid plants.
- Know the significance of microorganisms in pharmaceutical industries.
- Become familiar with animal cell line culture and production of transgenic animals.
- Enhance the knowledge about rDNA technology with recent developments.
- Get an idea how to run the PCR, RT-PCR and DNA fingerprinting.

UNIT I (13 hrs)

Aims and scope of biotechnology, basic concepts of biotechnology, traditional and modern biotechnology. Microbial Biotechnology: Fermentation techniques: Fermenters and bioreactors. Batch, submerged (SmF), solid substrate (SSF) and continuous fermentation. Fermented foods, oriental foods, silage, probiotics, single cell proteins, production of hormones and growth factors. Microbial polysaccharides, bioplastics, cell immobilization and its applications. Biopesticides (fungi, bacteria and viruses). Biofertilizers, plant-growth promoting microorganisms, biocontrol agents and bioprotestants. Transgenic microbes and their applications.

UNIT II (13 hrs)
Plant Biotechnology: Plant tissue culture laboratory and aseptic techniques, culture media, callus induction, organogenesis, somatic embryogenesis, micropropagation, production of secondary metabolites, selective markers, somaclonal variation, synthetic seeds and cryopreservation. Haploid production: pollen, anther and ovule cultures. Cell suspension cultuere, protoplast culture, protoplast fusion ahd hybridoma technology. Transgenic plants, production of disease-, salinity-, pest-, herbicide-, drought-resistant and high yielding varieties of plants. Production of improved varieties using Ti plasmids. Application of rhizobia and mycorrhizas in plant tissue culture. Plant-derived vaccines and antibodies.

UNIT III (13 hrs)
Animal Biotechnology: Animal cell culture techniques, culture media, primary and secondary cell cultures, cell lines and cell strains and growth factors. Stem cells, gene expression in cell culture, organ culture, histotypic culture; Natural and synthetic cell culture media composition; cytotoxicity and cell viability assays; Transgenic animals and their uses. Animals as biorareactors.

UNIT IV (13 hrs)

Molecular Biotechnology: Gene manipulation, restriction enzymes, DNA insertion through vectors, clone selection and expression of cloned genes. Expression systems and their applications: Escherichia coli, Streptomyces, yeast, baculovirus and animal cells as cloning hosts. Analysis of DNA-DNA sequences, mutagenesis and gene expression, DNA amplification, PCR and RtPCR techniques and DNA fingerprinting.

References:

1. Comprehensive Biotechnology, Vol. 1, 2, 3 & 4 Murray Moo Young, Pergamon Press
2. Industrial Biotechnology, Cruger & Cruge
3. Microbial Biotechnology, Alexander, G, WH Freeman and Company
4. Microbial Technology. Peppler, Vol. 1 & 2
5. Biotechnology in Agriculture and Forestry. Bajaj YPS series. Springer Verlag Pub.
6. Biotechnology of Higher Plants - Russell.
7. Plant Cell and Tissue Culture. A Lab manual. Reinert J. Narosa Pub.
8. Plant Biotechnology. Mantell and Smith. Cambridge Univ. Press.
9. Animal Transgenesis and Cloning by Louis-Marie Houdebine John Wiley & Sons.
10. Animal Cell Culture and Technology by Michael Butler BIOS Scientific Publishers.
11. Basic Cell Culture: A Practical Approach (Practical Approach Series) by J. M. Davis, Oxford university press, oxford

SOFT CORE COURSES

BSS 552 ENVIRONMENTAL PHYSIOLOGY 39hrs

Course Outcomes:

After successful completion of the course, students will be able to:

- Enhance the knowledge how the organisms are physiologically adapted to various environmental conditions.
- Know the basic principles of plant responses to environment.
- Understand the physiology of flowering, senescence and abscission.
- Gain the knowledge about stress physiology; how the plants response to various biotic and abiotic stress.Know how plant adapted to the radiation environment.
- Comprehend the physiology of circulation and respiration, including under special environmental conditions, such as high altitude and deep sea diving.
- Know how some respiratory diseases are caused.

Unit I (13 hours)

Principles of plant responses to environment; Problems of environment; Ecotypes - the role of genetics.
Photoperiodism and its significance, endogenous clock and its regulation and development. Physiology of flowering, Senescence- types, causes , physiology of senescence and its significance; Abscission.

Unit II (13 hours)

Stress physiology: Plant response to biotic and abiotic stress. Stress tolerance, HR and SAR, water deficit and drought resistance, salinity stress, metal toxicity, freezing and heat stress, oxidative stress; Plant adaptation to the radiation environment.

Unit III (13 hours)

Circulation: Types of heart and body fluids (blood and lymph); buffering properties of blood; blood circulation ; Physiology and patterns of circulation ; Circulatory physiological features in special environment Viz., high altitude, deep sea diving.
Respiration: Transport of oxygen and carbon dioxide; regulatory mechanisms of respiration, respiratory physiological features in special environments viz. high altitude, deep sea diving; respiratory diseases.

References:

1. Schmidt-Nielson, K. 1981. Animal Physiology Adaptations and Environment. Cambridge University Press, Cambridge.
2. Prosser, C.L. & Brown, 1983. Comparative Animal Physiology. W.B. Saunders.
3. Hoar, W.S. 1976. (2nd Edition). General and Comparative Physiology. Prentice Hall of India, New Delhi.
4. Wilson, J.A. 1979. Principles of Animal Physiology. MacMillan Pub., New York.
5. Hopkins, W.G. (1995). Introduction to Plant Physiology. John Wiley and Sons, Inc. New York.
6. Galston, A.W., 1989. Life processes in plants. Springer- Verlag, New York.
7. Nobel P.S., 1999. Physico-chemical and Environmental plant physiology.
8. Academic Press, SAn Diego, U.S.A.
9. Taiz and Zeiser, E., 1998. Plant physiology. Wordsworth Publishing Co., California, U.S.A.

10. Baldwin, E. 1964. An Introduction to comparative biochemistry Cambridge Univ. Press, Cambridge.
11. Berne, R.M. & Levy, M.N. 1991. Physiology. The C.V. Mosby Company, St. Louis.
12. Ganong, W.F. 1971. Review of Medical Physiology (5th Edition) Kotheri Book Depot, Bombay.
13. Guyton, A.C. & Hall, J.E. 1996. Text Book of Medical Physiology. 9th Ed. W.B. Saunders Company, Philadelphia.
14. Jenson, D., 1976. Principles of Physiology, Appleton Century Crafts.

BSS 553 DEVELOPMENTAL BIOLOGY 39hrs

Course Outcomes:

After successful completion of the course, students will be able to:

- Gain a good knowledge of developmental biology and its relevance importance in biomedical field.
- Know how to conduct the experiments to understand various aspects of developmental biology.
- Understand how the female and male gametes are produced, both in plants and animals.
- Comprehend the process of cell differentiation at the molecular level.
- Understand how the early developmental events occur in vertebrates.
- Know how the genes play role in axis specification and embryogenesis.

Unit I (13 hours)

Introduction: Chief events in animal development; History of thoughts and conceptual developments; experimental embryology; the concepts of differential gene activity. Gametogenesis in animals: Spermatogenesis; Oogenesis; Molecular events during fertilization. Gamatogenesis in a few plant systems; early development in a typical plant.

Unit II (13 hours)

Cell differentiation: Definition and concept, Mechanism of gene action during cell differentiation; Factors influencing cellular differentiation. Creating multicellularity Cleavage types; gastrulation; Fate maps; Concepts of determination; Morphogenetic cell movements- cell adhesion and contact inhibition. Competence and induction, totipotency; Nuclear transfer experiments.

Unit III (13 hours)

Morphogenetic determinants in egg cytoplasm; Germ cell determinants and germ cell migration; Early vertebrate development-cell movements, Neurulation, mesoderm and endoderm; Developmental patterns in metazoans; Body axes - establishment of body axes in mammals; Genetics of axis specification in *Drosophila*; Homeobox concept - homeotic genes

References:

1. Gilberts, E. II. 1986. Gene activity in Early Development. Academic Press. New York.
2. Browder, I.N., C.A. Erickson, W.R. Jefeery, 1991. Developmental Biology, 3rd ed. Saunders, Philedephia.
3. Russo, V.E.A. et al., 1982. Development - the Molecular Genetic Approach. Springer-Verlag-Berten.
4. Cartwazhl, T., 1994. Animal cells as Bio-reactors. Cambridge University Press, New York.
5. Development genetics of higher organism, as prier in developmental biology. MacMillan Press, New York
6. Berrill, N.J. Developmental Biology. Tata McGraw Hill.
7. Developmental Biology: A guide for experimental study. Sineer Associates, MA, USA.
8. Sussman Maurice. Animal growth and development. Prentice Hall
9. Buttery P.J. Control and Manipulation of animal growth. London.

PRACTICAL COURSES

BSP 554 BIOTECHNOLOGY LAB

Course Outcomes:
After successful completion of the course, students will be able to:

- Become familiar with PCR and sequencing techniques
- Enhance the theoretical knowledge in biotechnology with laboratory skill.
- Gain the practical knowledge how to conduct the experiments for easy understanding of the subject.
- Get the skill how to do vermicomposting and mushroom cultivation.
- Know how to make use of expert solid surface fermentation technique for production of antibiotics.
- Perform the test to check the nutritional and anti-nutritional qualities of edible seeds.
- Know how to soil testing and its importance in farming.
- Gain the basic skill of plant tissue culture techniques and production of hybrid varieties.
- Know how to produce biogas from organic wastes.
- Conduct tests for checking functional properties in food.

1. Production and analysis of vermicompost
2. Identification, collection and cultivation of mushrooms
3. Submerged and solid-substrate fermentation.
4. Production and assessment of enzymes, mycotoxins, organic acids and antibiotics.
5. Isolation and induction of root nodules by rhizobia
6. Isolation and mass production of arbuscular mycorrhizal spores.
7. Plant tissue culture
8. Evaluation of nutritional and antinutritional qualities of edible seeds.
9. Evaluation of soil qualities (e.g. texture, bulk density and water holding capacity)
10. Evaluation of soil components (e.g. nitrogen, phosphours, organic carbon)
11. Pattern of decomposition of organic matter (e.g. leaf and woody litter)
12. Biogas production
13. Functional properties of food (e.g. water absorption capacity, gelation, foaming and emulsion)
14. Analysis of DNA and protein sequences.

BSP555 ENVIRONMENTAL PHYSIOLOGY LAB

Course Outcomes:
After successful completion of the course, students will be able to:

- Expand the knowledge in environmental physiology conducting experiments with application point of view.
- Know how to determine blood indices, blood pressure and thermal tress.
- Demonstrate rate of transpiration, effect of temperature on the rate of respiration.
- Know how to check the seed health and effect of salinity on seed germination.
- Gain the skill to find out the viability of seeds, inducers and inhibitors of germination.
- Realize how plant responses against salinity and metal stress.
- Know how to apply radioisotope methodology

1. Haematology -
   1.1 Determination of blood indices
   1.2 Determination of blood pressure.
2. Respiration -
   2.1 Estimation of oxygen consumption by the organism under stressed condition (thermal stress).
   2.2 Demonstration of rate of transpiration by photometry.
   2.3 Effect of temperature on the rate of respiration.
3. Seed physiology –
   3.1 Seed health testing.
   3.2 Determination of percent viability of seeds by germination method.
   3.3 Germination inducers and inhibitors
   3.4 Determination of β-amylase activity in germinating seeds.
   3.5 Effect of salinity on seed germination.
4. Stress Physiology-
   4.1 Plant responses against salinity and metal stress
   4.2 Radioisotope methodology and its principles (GM Counter and Scintillation Counter)

BSP 556 DEVELOPMENTAL BIOLOGY LAB

Course Outcomes:

After successful completion of the course, students will be able to:

- Improve the knowledge in developmental biology with practical skill.
- Know the importance of model organisms in developmental Biology.
- Gain the skill how to isolate and mount the imaginal discs, sex comb and genital plate.
- Enjoy the subject with microscopic observation of sperms and eggs.
- Know about the developmental mutants in Drosophila and Arabidopsis.
- Know how to do vital staining technique for the study of chick embryo.
- Know how to study the spermatogenesis with microscopic observations and staining technique.

2. Study of model organisms used in developmental Biology.
3. Isolation and mounting of imaginal discs.
4. Structure of sperms and eggs in a few reproductive animals.
5. Isolation and mounting of sex comb and genital plate in *Drosophila.*
6. Study of developmental mutants in *Drosophila* and *Arabidopsis*.
7. Spiral cleavage and general development in snail.
8. Study of hemimetabolous and holometabolous development in insects.
9. Life cycle and metamorphosis in frogs.
10. Structure of *Drosophila* and chick egg.
11. Study of chick embryo by vital staining technique.
12. Developmental stages in frog.
13. Developmental stages in chick.
14. Study of spermatogenesis in rat and structure of sperms in a few reproductive animals.

BSP 557 PROJECT WORK

Course Outcomes:

After successful completion of the course, students will be able to:

- Gain the knowledge how to carry out a research based study on a selected topic.
- How to do field work for collection of sample, questionnaire-based survey and analyse.
- Get the skill how to apply the research methodologies to conduct lab / field based study.
- Experience how to write the dissertation and present the research data.
- Know how to select a problem, framing the objectives, literature review, and tabulation of results and interpretation of results.
- Understand different types of standard methods of citation and references.
- Build up the capacity to carry out a research project independently.
- Absorb / get appointment in the industrial sectors based on the theme of the project work.
