Department of Microbiology

School of Life Sciences

Proposed Syllabus for

Integrated M.Sc. Microbiology

(Academic session 2019-2020)

Central University of Rajasthan NH-8, Bandarsindri, Kishangarh-305817

Dist. Ajmer

Name of Department: Department of Microbiology

Name of the Program: Integrated M.Sc. Microbiology

A. Program Eligibility

- 10 + 2 in Science Stream or equivalent of any recognized board in India with Biology as one of the optional subjects having 50% marks or equivalent grade in aggregate for general category and 45% or equivalent grade for SC/ST/OBC/PWD candidates.

B. Program Objectives

- Creating a microbiologist with understanding of interdisciplinary sciences
- Imparting hand on experience to students of different techniques and instrumentations of advances biological and interdisciplinary sciences
- Developing skilled manpower for both academic and industrial sector
- Inculcating the scientific ethics, temperament to contribute to field of science and help in nation building

C. Learning Outcomes

The Students successfully completing the course will have following skills

- Skilled manpower with basic knowledge in area of interdisciplinary sciences
- Specialization in area of microbiology
- Can pursue career in industries (skilled manpower)
- Can compete in national level competitive exams such as NET-JRF or GATE or International exams such as GRE-TOEFEL and can pursue career in higher studies
- Is able to study microflora of a particular area and its prospects in several fields.
- Demonstrate practical skills in the use of tools, technologies and methods common to microbiology, and apply the scientific method and hypothesis testing in the design and execution of experiments.
- In-depth knowledge in the structure of a repertoire of microorganisms, metabolism in the cell, knowledge of the concepts of molecular genetics and biosynthesis of proteins, enzymology, physiology, microbial pathogenicity, environmental and agricultural microbiology, genetic engineering, bioengineering and a good theoretical and practical insight into methods used to obtain this knowledge.
- Develop ability to independently carry out a complete scientific work process, including the understanding of theoretical background, hypothesis generation, collection and analysis of data, and interpretation and presentation of results.
- Has high competence and multidisciplinary project experience within selected topics related to microbiology and ability to contribute in a multidisciplinary team.
- Is capable to evaluate methods and results within the field of specialization critically.
- Is able to evaluate and apply relevant theory, methods and analytic approaches within the specialized field of microbiology, including statistical methods.
- Can assess and predict the technological, ethical and social effects of their own work /disciplines and of microbiology.
- Acknowledges health, safety and environment (HSE) issues in handling chemicals and biological materials; understands the environmental impacts associated with the activity; performs risk assessments and is familiar with safety instructions in his/her subject area.
- Can communicate scientific results to the general public and experts by writing well structured reports and contributions for scientific publications and posters, and by oral presentations.

D. Employability

- Skilled manpower suitable for academic and research institutions as technicians.
- Suitable for different government and non-governmental and private companies
- Skilled students who can do PhD and contribute to field of Microbiology

E. Proposed Syllabus for Integrated M.Sc. Programme (Microbiology) Academic Session-2019-20 & Academic session (2018-19) Third semester onwards

Course Structure: I-VI Semester

Semester	Course Code	Title	Credits	Total Credits
I	BIO-101	**Biology-I (T) Diversity of Life**	3	**18**
	BIO-102	**Biology Practical-I (P)**	1	
		Chemistry*****	3+1=4	
		Mathematics*****	4	
		Physics*****	4	
		English*****	2	
			18	
II	BIO-103	**Biology-II (T) Techniques for Biology**	4	**18**
		Chemistry*****	3+1=4	
		Mathematics*****	4	
		Physics*****	2+2=4	
		English/ICT*****	2	
			18	
III	BIO-201	**Biology-III (T) Biochemical Constituents of Life**	4	**18**
		Chemistry*****	3+1=4	
		Physics*****	4	
		Environmental Science*****	3	
		Open Elective II-(offered by the Social Science Department) *****	3	
			18	
IV	BIO-202	**Biology-IV (T) Structural Organization of Life**	3	**18**
	BIO-203	**Biology Practical-II (P)**	1	
		Chemistry*****	3+1=4	
		One Subject out of Maths/Physics/Statistics/CS/Economics*****	4	
	BIO-204	Open Elective-I (offered by the any Science Department) **Ecology and Evolution**	3	
		Open Elective-II (offered by the Social Science Department) *	3	
			18	
V	BIO-301	**Biology-V (T) Functional Organization of Life**	3	
	BIO-302	**Biology-VI (T) Reproductive Biology**	3	
	BIO-303	**Biology-VII (T) Genetics**	3	**18**
	BIO-304	**Biology Practical-III (P)**	3	
	BIO-305	Open Elective-I (offered by the Science Department) **Laboratory safety, Ethics in Bio-Sciences and Intellectual Property Right**	3	
		Open Elective-II (offered by other than Science Department) *****	3	
			18	
VI	BIO-306	**Biology-VIII (T) Interactive Biology**	3	**18**
	BIO-307	**Biology-IX (T) Introduction to Gene Technology**	3	
	BIO-308	**Biology-X (T) Trends in Biology**	3	
	BIO-309	**Biology Practical-IV (P)**	3	
		Open Elective I- (offered by the any Science Department) Current Trends in Environmental Sciences	3	
		Open Elective II- (offered by other than Science Department) *****	3	
			18	
VII	Integrated M.Sc. Microbiology *(Syllabus As per M.Sc. Microbiology I Semester) #*		24	**24**
VIII	Integrated M.Sc. Microbiology *(Syllabus As per M.Sc. Microbiology II Semester) #*		24	**24**
IX	Integrated M.Sc. Microbiology *(Syllabus As per M.Sc. Microbiology III Semester) #*		24	**24**
X	Integrated M.Sc. Microbiology *(Syllabus As per M.Sc. Microbiology IV Semester) #*		24	**24**

** Content for Paper will be designed and given by respective Department*

 # Content of Semester VII to X of Integrated M.Sc. Microbiology is similar to Syllabus of Lateral Entry M.Sc. Microbiology courses

Semester I

BIO-101 **Biology-I (T) Diversity of Life** **Credits 3**

Course Objectives

- To understand diversity and characteristic's features of different micro-organism
- To understand diversity and characteristic's features of lower to higher plants
- To understand diversity and characteristic's features of lower to higher animal

Learning Outcomes

- Capable of understanding different classifications of micro-organisms, plants and animals.
- Skill to identify the organisms into different group based on characteristic's feature

Course Structure

Unit I: Microbial Diversity and Diversity in Lower Plants

Bacteria: General characteristics, cell structure of bacteria and their components, mycoplasma, archaebacteria, cyanobacteria, microbes in extreme environments. Fungi: General characteristics and classification Viruses: General characteristics and classification.

Diversity in Lower Plants: General characteristics, reproduction, classification and economic importance of algae, lichens, bryophytes and pteridophytes, alternation and generation in bryophytes and pteridophytes, vascular system in pteridophytes, economic importance of bryophytes and pteridophytes.

Unit II: Diversity in Higher Plants and Diversity in Lower Animals

Diversity in Higher Plants: General characteristics, reproduction, classification of gymnosperms, life cycle of gymnosperms and angiosperms, salient features of botanical nomenclature, economic importance of gymnosperms and angiosperms.

Diversity in Lower Animals: General characteristics, classification of various groups of protozoans, porifera, coelenterate, helminthes, annelida, arthropoda, mollusc, and echinodermata. Canal system in sponges, polymorphism of sponges, different larvaes, classification, mechanism of formation, and significance of coral reefs.

Unit III: Diversity of Higher Animals

General features of hemichordates, cephalochardates & urochardates. General characters and classification of pisces, amphibia, reptilia, aves, and mammalia, parental care in fishes and amphibia, poison apparatus and biting mechanism of poisonous snakes, identification of poisonous and non-poisonous snakes, flight adaptation of birds, dentition in mammals, connecting links, flying and aquatic mammals.

Suggested Readings

1. Ananthanarayan and Paniker (2017) A text book of Microbiology, :10th Edition. Orient Blackswan Publisher, Delhi
2. Nigam HC. (2017) Biology of Chordates, 25th Edition Vishal Publishing Co.
3. Cambell and Reece: Biology (2016) Biology 11th Edition, Pearson
4. Kotpal, R.L. (2016) Modern Textbook of Zoology - Invertebrates Rastogi Publications, Meerut.
5. Willey, J. Sherwood L, Woolverton C, (2016), Prescott Microbiology. 10th Edition, McGraw-Hill Publisher, Columbus, OH
6. Kotpal RL. (2015) Modern Textbook Of Zoology Vertebrates. Rastogi Publications
7. Singh, Pandey, Jain. (2011). A Text Book of Botany- Rastogi Publication.
8. Ganguly, Das & Dutta. College Botany. (2011) New Central Book Agency.
9. Pelczar Mi J., Chan, E.C.S., Krieg, NR, (2009). Microbiology, McGraw-Hill publication

BIO-102 **Biology Practical-1** **Credit 1**

Course Objectives

- Demonstration of specimen observation of different micro-organism, lower plants and lower animals using museum specimen
- To understand diversity and characteristic's features of micro-organism, lower plants and lower
- Study of the transverse section of sycon, hydra, ascaris , hirudinaria and frog using models or chart.

Learning Outcomes

- Capable of understanding different classifications of micro-organisms, plants and animals.
- Skill to identify the organisms into different group based on characteristic's feature

Course Structure

List of laboratory practical

1. Specimen observation of Bacteria and viruses.
2. Microscopic observation of algae and cyanobacteria/
3. Specimen observation of bryophytes and pteridophytes.
4. Study of transverse sections/chart of the following: Sycon (as an example of Parazoa to show its structure, spicules and canal system), Hydra (as an example of diploblastic animal), Fasciola (as an example of triploblastic acoelomate animal), Ascaris (as an example of triploblastic pseudocoelomate animal), Hirudinaria (as an example of triploblastic schizocoelomate animal), Frog (as an example of triploblastic enterocoelomate animal)
5. Study of salient features and classification up to classes of the non-chordates with special emphasis on their adaptive characters using museum specimen.
6. Study of salient features and classification up to classes of the chordates using museum specimens.

Semester II

BIO-103 Biology-II (T) Techniques for Biology Credits 4

Course Objectives

- To understand basic principles of different techniques used in biological sciences such as chromatography, centrifugation, microscopy and spectrophotometry
- To understand the underlying principle used for detection and characterization of different bio-molecules such as protein, nucleic acids using techniques such as electrophoresis.

Learning Outcomes

- Know the basic principles of chromatography, centrifugation, microscopy and spectrophotometry
- Know the basic principles of electrophoresis techniques and immune-precipitation techniques .
- Know the advance techniques of microscopy such as confocal, and cryo electron microscopy
- Know the underlying principle used for detection and characterization of different bio-molecules such as protein, nucleic acids

Course Structure

Unit I: Chromatography and Centrifugation
Introduction to chromatography, paper chromatography, gel filtration, ion-exchange chromatography, affinity chromatography, hydroxyapatite chromatography, introduction to centrifugation techniques, differential and density gradient centrifugation, separation of different organelles

Unit II: Analysis of Biomolecules
Characterization of proteins and nucleic acids; different electrophoresis like AGE, PAGE, different gel staining methods, auto-radiography, electrophoretic mobility shift assay, chromatin immuno-precipitation.

Unit III: Microscopy
Principles and application of light microscope and electron microscope, magnification and resolution power, An introduction to advance microscopies like fluorescence, confocal, AFM, and cryo-electron microscopy.

Unit IV: Spectrophotometry
Principle and applications of UV-Vis Spectroscopy, An introduction to advance spectrometry like fluorescence, circular dichroism, NMR and mass spectrometry.

Suggested Readings

1. Wilson K, Goulding KH. (2018) Principles and Techniques of Biochemistry and Molecular Biology, Eight Edition , Edited by Hofmann A, Clokie S. Cambridge University Press
2. Plummer DT. (2017) An Introduction to Practical Biochemistry. 3rd Edition McGraw Hill Education
3. Philips, R. Kondev J, Theriot J, Garcia H. (2012). Physical Biology of the Cell. 2nd Edition Garland Science.

Semester III

BIO-201 Biology-III (T) Biochemical Constituents of Life Credits 4

Course Objectives

- To provide basic understanding of different chemical interactions and basics of biochemical reactions
- To provide the core principles of Carbohydrates, Lipids, Proteins Lipid and nucleic acids.
- To understand Organization of DNA into chromosomes and its function

Learning Outcomes

- Overview of major biomolecules- carbohydrates, lipids, proteins, amino acids.
- Conceptual knowledge of Proteins and its classification. Primary, secondary, super secondary, tertiary and quaternary structure. The peptide bond- Ramachandran plot.
- Understanding the basic of biochemical reactions, role of pH and buffers in biological systems and various biochemical studies and reactions.
- Understanding organization of DNA into chromosomes and its function

Course Structure

Unit I: Basics of Biochemical Reactions
Concept of different chemical interactions: covalent and non-covalent interactions and their importance in biological system, physical properties of water, concept of acid and bases, pH and buffer, definition of enzymes, co-enzymes, an introduction to kinetic parameters.

Unit II: Carbohydrate and Lipids Chemistry
Structure of classification of monosaccharides, disaccharides, and polysaccharides, reducing and non-reducing sugars, classification of lipids, fatty acids, triglycerides, phospholipids, water and fat-soluble vitamins.

Unit III: Protein and Nucleic acid Chemistry
Structural features of amino acids, classification of amino acids, peptide, structure of polypeptide, Ramachandran plot, protein folding, Structure of purine, pyrimidine, nucleoside & nucleotides, different types of DNA and RNA.

Unit IV: Organization of DNA into chromosomes and its function
Structure of chromatin and chromosomes, DNA replication of prokaryotes and eukaryotes, transcription, translation, regulation of gene expression: transcriptional, translational and post-translational.

Suggested Readings

1. Nelson DL, Cox MM (2017) Lehninger Principles of Biochemistry, 7th Edition. W. H. Freeman
2. Stryer L, Berg JM, Tymoczko JL. Gatto GJ. (2015) Biochemistry, 8th Edition. W. H. Freeman
3. Satyanarayana U, (2013), Biochemistry Elsevier
4. Voet DV, Voet JG. (2011) Biochemistry, Wiley
5. Karp G. (2015) Cell and Molecular Biology: Concepts and Experiments.5th Edition. John Wiley Publication.

Semester IV

BIO-202 Biology-IV (T) Structural Organization of Life Credits 4

Course Objectives

- To provide basic understanding cell organization, cell cycle and cell signalling
- To understand the plant structural organization eg. Vascular system, floral system and life cycle .
- To understand the structural organization of animals eg. Skeletal, nervous, sensory organ, circulatory, excretory and reproductive systems.

Learning Outcomes

- Overview of structural organization of cell, alongwith cell cycle and cell signaling.
- Capable to understand the plant structural organization eg. Vascular system, floral system and life cycle .
- Capable to understand the structural organization of animals eg. Skeletal, nervous, sensory organ, circulatory, excretory and reproductive systems.

Course Structure

Unit I: Cell Organization, cell cycle and signaling

Eukaryotic sub-cellular components: Nucleus, chromosomes, plasma membrane, endoplasmic reticulum, lysosomes, peroxisomes, Golgi apparatus, mitochondria, chloroplast, cytoskeleton.Mitosis and meiosis, cell cycle, cell-cell adhesion, extracellular matrix, interaction and communication between the cells (animal, plant and bacteria), cell signaling, differentiation and organogenesis.

Unit II: Plant Anatomy

Plant cell wall and membranes; plant structure organization, anatomy of root, stem and leaves, floral parts, embryo and young seedlings, meristems, vascular system in plants, life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, cellular totipotency, clonal propagation, organogenesis and somatic embryogenesis, in-vitro fertilization.

Unit III: Animal Anatomy-I

Organizational level of animal body structure and function: tissue, body cavities, anatomy of integumentary, skeletal (articulations), muscular (skeletal, smooth & cardiac muscles), nervous (CNS and PNS; cranial nerves), sensory (eye, ear, nose, tongue).

Unit IV: Animal Anatomy-II

Cardiovascular (heart and blood vessels), blood circulation, lymphatic, Respiratory (structure of organs of respiration), digestive, urinary, male and female reproductive systems.

Suggested Readings

1. Nelson DL, Cox MM (2017) Lehninger Principles of Biochemistry, 7th Edition. W. H. Freeman
2. Stryer L, Berg JM, Tymoczko JL. Gatto GJ. (2015) Biochemistry, 8th Edition. W. H. Freeman
3. Grisham CM, Garrett RH. (2012) Biochemistry. 6th Edition. Brooks Cole
4. Voet DV, Voet JG. (2011) Biochemistry, Wiley
5. K.L. Moore, A.R. Delley. A. M. Abgur. (2017) Clinical Oriented Anatory. Lippincott Williams and Wilkins; Eighth, North American Edition.
6. Koelling C. (2016) Plant Anatomy, Morphology and Physiology. Syrawood Publishing House
7. Tortora GJ, Derrickson BH. (2013) Principles of Anatomy and Physiology. John Wiley & Sons.
8. David F. Cutler, Ted Botha, Dennis Wm. Stevenson. (2009) Plant Anatomy; An applied approach. Wiley –Blackwell Publication.
9. Pelczar Mi J., Chan, E.C.S., Krieg, NR, (2009). Microbiology, McGraw-Hill publisher
10. W. C. Dickson. (2000). Integrative Plant Anatomy. Academic Press

BIO-203 **Biology Practical-II (P)** **Credits 3**

Course Objectives

- Demonstrate the floral structure and diagrammatic representation of different plant families
- Demonstrate different plant and animal visualizing either transverse sections or models
- Bio-chemical estimation of sugarsm proteins and different body fluids

Learning Outcomes

- Hands on training to learn the floral structure and diagrammatic representation of different plant families
- Hands on training to learn different plant and animal visualizing either transverse sections or models
- Understanding the principle of bio-chemical estimation of sugar, proteins and different body fluids.

Course Structure

List of laboratory practical

1. Study of Floral characters and Floral diagram of representative member of some families: Malvaceae, Brassicaceae, Asclepiadaceae, Solanaceae, Euphorbiaceae, Poaceae
2. Study of type of ovary, ovules, placentation types, types of pollen grains and stages of dicot embryo.
3. Transverse section of leaf, stem and root for different plants in University campus.
4. Demonstration of phenomenon of osmosis and diffusion.
5. Demonstration of functioning of heart using model.
6. Counting of red blood corpuscles and white blood corpuscles
7. Determination of hemoglobin content.
8. Demonstration of blood grouping.
9. Identification of amino acids in the mixture using paper chromatography
10. Principle & operation of Spectrophotometer, Verification of Beer's Law Spectrophotometrically and Qualitative tests for identification of sugars
11. Estimation of protein by Biuret method and Folin Lowry method
12. Observation of permanent slides of mitosis and meiosis.

Open Elective I

BIO-204 **Ecology &Evolution** **Credits 3**

Course Objectives

- To provide basic understanding of ecological factors, population and community
- To understand the different components of ecology and ecosystem.
- To understand different theories of evolution and understand basics of conservation biology

Learning Outcomes

- Understanding of different ecological factors, concept of population and community
- Understanding of different components of ecology and ecosystem.
- Overview of different theories of evolution and basics of conservation biology

Course Structure

Unit-I: Ecological Factors, Population and Community
Ecological factors, Laws of limiting factors- Liebig's law of minimum, Shelford's law of tolerance. Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere, Levels of organization- species, population characteristics, species interactions: predation, herbivory, competition, parasitism, mutualism and commensalism. Population regulation, community characteristics, ecotone, edge effect & ecological Successions.

Unit-II: Ecosystem Ecology
Ecosystem - concept, structure (biotic and abiotic), food chain, food web, ecological efficiency, energy flow and production. Fixation of solar energy and sustenance of trophic levels, measurement and efficiency of primary production and secondary production, biogeochemical cycles, succession, homeostasis and stability of ecosystem. Microbial community in biosphere, biofilm and its ecological implication, microbial diversity, extremophiles.

Unit-III: Evolution and Conservation Biology
Concept of evolution and theories- Lamarckism, Darwinism, Neo Darwinism, isolation, mutation, speciation, germplasm and genetic drifts, Geographical range of species and range extensions, Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Gene duplication and divergence. Biodiversity and conservation: hotspots, causes of depletion, conservation methods and endangered species, wild life of India and its conservation.

Suggested Readings

1. Botkin, Daniel B. and Keller, Edward A. (2014). Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons.
2. Krebs, C. (2008) The Ecological World View. CISIRO Publishing
3. McArthur, (2006) Microbial Ecology, Elsevier.
4. Odum, E.P. (2005) Fundamentals of Ecology. Cengage.

Semester V

BIO-301 Biology-V (T) Functional organization of Life-Physiology Credits 3

Course Objectives

- To provide basic understanding of functional organization of life
- To understand the physiology of microbes, plants and animals.

Learning Outcomes

- Understanding of functional organization of life
- Understanding of the physiology of microbes such as growth kinetics , metabolism and electron transport
- Understanding of the physiology of plants such as photosynthesis, respiration, plant hormones and photoreceptors
- Understanding of the physiology of animals such as transportation of fluids and gases such as respiration and circulation. Different type of hormones and its action

Course Structure

Unit I: Microbial Physiology

Common nutrient requirements and nutrient uptake in microbes, microbial growths- measurement, growth curve, effect of environmental factor on growth. An introduction to metabolism of carbohydrates, nucleic acid, lipids and proteins, microbial electron transport system

Unit II: Plant Physiology

Water movement in plant, transpiration, photosynthesis, respiration and photorespiration, nitrogen metabolism, physiological effects and mechanisms of action of plant hormones, photoreceptors-phytochromes, cryptochromes and phototropins, photoperiodism

Unit III: Animal Physiology

Exchange and transport of gases, regulation of respiration, physiology of circulatory system, physiology of execratory system, organization of nervous system, synapses and synaptic transmission, endocrine and exocrine glands, hormones, regulation of hormone secretion, mode of action, effects of abnormal secretions of hormones and placental hormones.

Suggested Readings

1. K.L. Moore, A.R. Delley. A. M. Abgur. (2017) Clinical Oriented Anatory. Lippincott Williams and Wilkins; Eighth, North American Edition.
2. Koelling C. (2016) Plant Anatomy, Morphology and Physiology. Syrawood Publishing House
3. Willey, J. Sherwood L, Woolverton C, (2016), Prescott Microbiology. 10th Edition, McGraw-Hill Publisher, Columbus, OH
4. Barrett K, Brooks H, Boitano S, Barman S. (2015) Ganong's Review of Medical Physiology, Twenty-Fifth Edition (Lange Medical Book)
5. Hall JE. (2015). Guyton and Hall Textbook of Medical Physiology, 13th Edition. Elsevier.
6. Tortora GJ, Derrickson BH. (2013) Principles of Anatomy and Physiology. John Wiley & Sons.
7. Taiz L, Zeiger E. (2010). Plant Physiology Fifth Edition, Sinauer Associates, Inc
8. Reddy, Rao, Reddy, Reddy, Chary. (2007). University Botany III (Plant Taxonomy, Plant Embryology, Plant Physiology), New Age International.
9. Trivedi PC. (2006) Advances in Plant Physiology; I. K. International Publishing House

BIO-302 Biology-VI(T) Reproductive Biology Credits 3

Course Objectives

- To provide basic understanding of reproduction in different life forms
- To understand the reproduction in microbes, plants and animals.

Learning Outcomes

- Understanding of reproduction in different life forms
- Understanding of the phenomenon of reproduction in microbes such as bacteria, algae, virus and protozoan's.
- Understanding of the different components of reproduction in plants such as flowering, pollination, fertilization and seed dispersal mechanism.
- Understanding of the different components of reproduction in animals, different stages of embryos development and basic of embryo transfer technique

Course Structure

Unit I: Microbial Reproduction
Basic of microbial reproduction, Bacterial- Conjugation, transformation and transduction and Fungal reproduction- vegetative, asexual, and sexual, Algal Reproduction: vegetative, asexual and sexual. Viral reproduction: lytic and lysogenic cycle, reproduction of phages, Protozoan Reproduction (Amoeba, Paramecium and Plasmodium).

Unit II: Plant Reproductive and Developmental Biology
Reproductive development, induction of flowering, flower as a modified determinate shoot. flower development, genetic and molecular aspects, anther and pollen biology, pollination and fertilization, seed and fruit development, seed structure, types and their dispersal mechanisms.

Unit III: Animal Reproductive and Developmental Biology
Reproductive strategies and reproductive cycles in vertebrates, spermatogenesis, oogenesis, hormonal regulation in gametogenesis in male and female, physiology of male and female reproduction, mechanism of fertilization, types of eggs and pattern of cleavage, gastrulation and fate map, comparison of cleavage and gastrulation in sea urchin, frog and chick embryos, In-vitro fertilization, embryo transfer technology.

Suggested Readings

1. Gilbert SF, Barresi MJF, (2016), Developmental Biology 11th Edition Sinauer Associates
2. Albertis B, Jhonson A, Lewis L, Morgan D, Raff M, Roberts K, Emeritus, Walter P, (2014) Molecular Biology of the Cell. 6th Edition, Garland Science
3. Bhojwani, S.S. and Bhatnagar, S.P. (2014). The Embryology of Angiosperms, Vikas Publishing House. Delhi.
4. Karp G. (2007) Cell and Molecular Biology. John Wiley Publication.
5. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
6. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.

BIO-303 Biology-VII(T) Genetics Credits 3

Course Objectives

- To provide basic principle genetics or gene transfer from one generation to other in different life forms.
- To understand fundamental of genetics, mendelian and non mendelian inheritance, molecular genetics
- To understand different concepts of human and population genetics.

Learning Outcomes

- Understanding basic principle genetics or gene transfer from one generation to other in different life forms.
- Understanding fundamental of genetics, mendelian and non mendelian inheritance, molecular genetics
- Understanding different concepts of human such as abnormalities and genetic counseling.
- Understanding different concepts of population genetics such as Hardy-Weinberg principle, evolutionary agents, fitness, selection and speciation

Course Structure

Unit I: Basic of Genetics
Introduction to genetics, pre-Mendelian, Mendelian and non-Mendelian inheritance, genetic linkage, recombination and crossing over, chromosomal basis of inheritance, mutations and mutagenesis, genetic basis of sex determination, extra-nuclear inheritance, exchange of genetic material.

Unit II: Molecular Genetics
Plasmid replication, copy number control, incompatibility, maintenance, curing & function, distribution & importance. Composite transposons, replicative and non-replicative transposons, Tn-transposons and evolution, mobile genetic elements, methods of genetic transfer: Transformation, Conjugation, Transduction and sexduction, mapping genes by interrupted mating, fine structure analysis of genes.

Unit III: Human Genetics and Population Genetics
Chromosomal abnormalities: aneuploidy, translocation and deletion. Genetic counseling. Hardy-Weinberg principle, evolutionary agents, selection, fitness, migration and random drift, modes of speciation (allopatric and sympatric).

Suggested Readings

1. Snustad DP, Simmons MJ. (2015) Principles of Genetics, 7th Edition , Wiley.
2. Albertis B, Jhonson A, Lewis L, Morgan D, Raff M, Roberts K, Emeritus, Walter P (2014) Molecular Biology of the Cell. 6th Edition, Garland Science
3. Anthony J.F. Griffiths, Susan R. Wessler, Sean B. Carroll and John Doebley. (2011) Introduction to Genetic Analysis: International Edition.
4. Brown TA. (2011) Introduction to Genetics: A Molecular Approach. Garland Science
5. Karp G. (2007) Cell and Molecular Biology. John Wiley Publication.

BIO-304 **Biology Practical- III** **Credits 3**

Course Objectives

- Demonstration of experiments related to anatomy of flowering plants
- Handling of different microbiological equipments, basic experiments of microbiology such as media preparation, sterilization, media preparation and isolation of bacteria and fungus
- Demonstration of microbial reproduction and mendelian genetics
- Demonstration of experiments to understand concept of food web, ecological pyramids and community analysis

Learning Outcomes

- Hand on experiment understanding anatomy of flowering plants
- Hand on experiment for handling of different microbiological equipments
- Capable of performing basic experiments of microbiology such as media preparation, sterilization, media preparation and isolation of bacteria and fungus
- Hand on experiments for the performing microbial reproduction via conjugation and transformation and performing mendelian genetics in pea plant and drosophila
- Understanding the ecological concepts of food web, ecological pyramids and community analysis

Course Structure

List of laboratory practical

1. Study of cross-section of reproductive structure of flowering plants.
2. Preparation of different media for bacterial and fungal isolation.
3. Demonstration of Autoclave, laminar air flow, hot air oven, centrifuge and pH meter: principle and its working
4. Demonstration of serial dilution, pouring, plating and streaking.
5. Identification of micro-organisms: simple staining, differential staining, acid fast staining, capsule staining, spore staining and motility
6. Demonstration of microbial reproduction, Bacterial- Conjugation, transformation and transduction.
7. Demonstration of mendalian genetics using pea plant and drosophila
8. Qualitative and Quantitative studies of Plant communities.
9. Demonstration of food web from the given set of data, (Representative of a natural ecosystem).
10. Field activity for construction of ecological pyramids of number, biomass, energy from the given set of data (Representative of a natural ecosystem).

BIO-305 Open Elective I: Laboratory safety, Ethics in Bio-Sciences and Intellectual Property Rights **Credits 3**

Course Objectives

- To provide different safety measures while working in laboratories.
- To understand ethics associated with handling, testing and disposal of biological life forms.
- To introduce the students to basic concepts of different type of intellectual property right. .

Learning Outcomes

- Understanding different safety measures and precautions while working in laboratories.
- Understanding the ethics associated with handling, testing and disposal of biological life forms.
- Understanding the basic concepts of different type of intellectual property right.

Course Structure

Unit I. Laboratory Safety

Laboratory safety guidelines and regulations, standard operating protocols (SOP),use of Genetically Modified Organisms (GMOs) and their release in the environment. Laboratory safety measures for production of transgenic organisms. Hazardous Materials used in Bio-sciences, their Handling and Disposal. Good Laboratory Practice (GLP) and Good Manufacturing Practice (GMP).

Unit II. Bioethics

Introduction to bioethics, ethical Issues in Genetic Manipulations and Genetically Modified Organisms: foods and crops, GMO labeling, Ethical issues involved in stem cell research and use. Use of animals in research and testing and alternatives for animals in research. Animal cloning, human cloning and their ethical Aspects. Testing of drugs on human volunteers. Organ transplantation and ethical issues. Ethical, legal and social implications of Human Genome Project

Unit III Intellectual Property Right

Intellectual Property Rights. Introduction to Patent and Process Involved in Patenting. Patenting Living Organisms, Patent of agricultural technology, and their implications for India and other developing countries. Copyright, trademark, trade secret, Traditional Knowledge and Geographical indication. Commercial Exploitation, and Protection of IPR. Participation in Biosafety and Protection of Biodiversity. Indian Biodiversity Act

Suggested Readings

1. Singh. B.D. 2010 Biotechnology Expanding Horizons, Third Edition, Kalyani Publishers
2. Bioethics and Biosafety in Biotechnology by Sree Krishna V., New Age International (P) Ltd., Publ., Mumbai. 2007
3. Intellectual Property Rights by Deborah E. Bouchoux., Delmar Cenage Learning. 2005
4. Biodiversity and Conservation by G. Melchias, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2001
5. An Advanced textbook on Biodiversity: Principles and Practice by K.V. Krishnamurthy, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2003.
6. The Indian Environmental Protection Act (EPA), 1986
7. Rules for manufacture, use/import/export and storage of hazardous microorganisms or cells Act, 1989
8. Food Safety and Standards act (Government of India), 2006
9. Intellectual Property Rights on Biotechnology by Singh, KC, BCIL, New Delhi

Semester VI

BIO-306 Biology-VIII (T) Interactive Biology Credits 4

Course Objectives

- To understand different interaction between different life form such as plant-microbe and animal-microbes interaction**.**
- To understand basic of human immunity and concept of antimicrobials to control pathogenic effects of microbes in plant and animals.

Learning Outcomes

- Capable of understanding different interaction between different life form such as plant-microbe and animal-microbes interaction**.**
- Capable of understanding basic of human immunity and concept of antimicrobials to control pathogenic effects of microbes in plant and animals
- Understanding concepts of virulence, host parasite relationship, evolution of virulence and concept of antibiotic resistance

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Course Structure

Unit I: Plant-Microbe Interaction
Basic concepts of plant pathology and phytobacteriology, mutualism, commensalism, parasitism, Plant microbe symbiotic interactions. Plant pathogen interactions**,** Bacterial plant diseases, their symptoms, and control, general concepts of plant immunity, Virulence determinants of plant pathogenic bacteria, plant immunity, application of plant-microbe interaction in genetic engineering.

Unit II: Animal- Microbe Interaction
Interaction of host and microbes process of recognition and entry in host cells by different pathogens, human microbiome and their symbiotic relation, rumen ectosymbiosis, Host parasite relationship, microbial diseases in animals, alteration of host cell behavior by pathogens.

Unit III: Human Immunity
Introduction to immune system, innate and acquired immunity, antibody, major histocompatibility complex, complement systems, T and B-cell maturation and differentiation, antigen processing and presentation, hypersensitive reaction and autoimmune disease.

Unit IV: Microbial Response to antimicrobial therapeutics
History of antimicrobial discovery, antibiotics used to control animal and plant pathogens, mode of action of antimicrobial molecules and response of pathogen, modulation of the host immune response, evolution of virulence and resistance of bacteria, virus and other pathogens.

Suggested Readings

1. Willey, J. Sherwood L, Woolverton C, (2016), Prescott Microbiology. 10th Edition, McGraw-Hill Publisher, Columbus, OH
2. Pelczar Mi J., Chan, E.C.S., Krieg, NR, (2009). Microbiology, McGraw-Hill publisher
3. Kuby, J. (2006) Immunology 6th Edition W.H. Freeman and Company, New York

BIO-307 Biology-IX (T) Introduction to Gene Technology Credits 4

Course Objectives

- To understand principle of cloning, different vectors and host of RDT**.**
- To know about different tools of gene based technology
- To understand protein expression in bacteria, animal and plants
- To understand basic of genetic engineering and gene therapy

Learning Outcomes

- Capable of understanding different principle of cloning, different vectors and host used during RDT
- Knowing different tools used for gene based technology
- Capable of understanding basic protein expression in bacteria, animal and plants.
- Capable of understanding basic of genetic engineering and gene therapy

Course Structure

Unit I: Cloning and Expression Vehicles
Enzymes in DNA manipulation, restriction digestion, ligation (adapters, linkers etc.) and transformation (chemical, physical and biological; transformation efficiency, competence), vectors & hosts of RDT: plasmid, phage, cosmid, phagemid, YAC, BAC, Ti plasmid vectors, cloning and expression, vector for bacterial, plant and animal systems.

Unit II: **Tools for Gene Technology**
Polymerase Chain Reaction: general concept, primer designing, PCR efficiency, various types (Gradient, Inverse, Multiplex, Reverse Transcriptase PCR, real time PCR), PCR product cloning, 5' and 3' RACE, molecular cloning of DNA or RNA fragment in bacterial and eukaryotic (plant & animal) systems.

Unit III: **Protein Expression in Bacteria, Animal and Plants**
Expression of recombinant proteins using bacterial, animal and plant vectors. Over expression of proteins in bacteria, plant and animal-general idea, basic idea of protein engineering, protein array & their applications.

Unit IV: Genetically Engineered Organism and Gene Therapy.
Strategies for gene transfer to plant cells, generation and significance of transgenic plants, production of transgenic mice, ES cells can be used for gene targeting in mice, transgenic animals, basic introduction to knocked down, knocked-out, gene editing and gene therapy.

Suggested Readings

1. Nelson DL, Cox MM (2017) Lehninger Principles of Biochemistry, 7th Edition. W. H. Freeman
2. Karp G. (2015) Cell and Molecular Biology: Concepts and Experiments.5th Edition. John Wiley Publication.
3. S. B. Primrose & R. M. Twyman (2007) Principles of Gene Manipulation and Genomics (Seventh Edition);. Blackwell Publishing.
4. Lewin B (2007) Genes IX , 9th Revised Edition, Jones and Bartlett Publishers
5. Christopler H. (1995) Gene cloning and Manipulating, Cambridge Universoty Press
6. Nicholl, D.S.T (1994) An Introduction of Genetic Engineering, Cambridge University Press.

BIO-308 Biology-X (T) Trends in Biology Credits 4

Course Objectives

- To understand recent trends in area of applied biotechnology such as microbial, plant and animal biotechnology
- To understand recent trends in computational techniques , tools and software's used for solving problems of biological sciences

Learning Outcomes

- Understanding recent trends in area of applied microbial biotechnology such as fermentation for production of bio-molecules, meta-genome studies, and molecular identification of microbes
- Understanding recent trends in area of plant and animal biotechnology such as tissue culture breeding in plants, photo based bioremediation
- Understanding of advance techniques such as RFLP, AFLP, SNPs, SSCP, QTL analysis CRISPR-Cas technology and Cre-Lox technology
- Understanding recent trends in computational techniques , tools and software's used for solving problems of biological sciences

Course Structure

Unit I: Trends in Microbial Biotechnology

Microbial fermentation and production of small and macro molecules, Application of production of therapeutics, and diagnostics, Bioresource and uses of biodiversity, metagenome analysis, molecular approaches to microbial strain identifications

Unit II: Trends in Plant Biotechnology

Tissue culture methods for plants, transgenic plants, Omics methods and their application to agriculture, breeding in plants, Bioremediation and phytoremediation, Biosensors, basic of molecular marker-RFLP, AFLP, SNPs, SSCP, QTL analysis.

Unit III: Trends in Animal Biotechnology

Animal cell culture methods and its application, breeding in animals, transgenic knockdown and knockout animals, Omics approaches and its application to health and gene therapy, various methods of gene editing and changes like CRISPR-Cas technology, Cre-Lox technology etc.

Unit IV: Trends in Computational Biology

Introduction to genomics, proteomics, transcriptomics, DNA, RNA, protein and genome sequence databases, searching for sequence database, an introduction to computational modeling of biological systems

Suggested Readings

1. Freshney RJ, (2016) Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Wiley Blackwell
2. Reinert J, Bajaj YS (2013) Applied and fundamental Aspects of Plant Cell, Tissue, and Organ Culture, Narosa Publishning House.
3. Xiong J (2006) Essential Bioinformatics, Cambridge University Press
4. Mount DW (2001) Bioinformatics: Sequence and Genome Analysis, University of Arizona, Tucson
5. Crueger W, Crueger A, (2000) A text of Industrial Microbiology, 2nd Edition, Panima Publishing Corp.
6. Stanbury PF, Ehitaker H, Hall SJ (1997) Principles of Fermentation Technology., Aditya Books (P) Ltd.

BIO-309 **Biology Practical-IV (P)** **Credits 3**

Course Objectives

- Demonstration of different molecular biology techniques such as isolation of genetic material, electrophoresis, primer designing, PCR, restriction digestion and preparation of competent cell
- Demonstration of computational tools and software's used for solving problems of biological sciences

Learning Outcomes

- Capable of performing different molecular biology experiments such as isolation of genetic material, electrophoresis, primer designing, PCR, restriction digestion and preparation of competent cell
- Capable of downloading gene and protein sequences from different databases and performing BLAST and phylogentic tree preparation using MEGA tool

Course Structure
List of laboratory practical

1. Isolation of DNA and RNA from bacteria.
2. SDS Page for given protein sample.
3. Primer designing
4. Polymerase chain reaction.
5. Isolation of Plasmid.
6. Restriction digestion and ligation
7. Preparation of competent cell
8. Demonstration of antibiotic resistance in different microbes.
9. Downloading various sequences from GenBank in FAST format,
10. Demonstration of BLASTn, BLASTp and phylogentic tree preparation using MEGA software.

**Note: Content for Paper will be designed and given by respective Department*

*# **Note:** Content of Semester VII to X of Integrated M.Sc. Microbiology is similar to Syllabus of Lateral Entry M.Sc. Microbiology courses*

Semester	Syllabus Content	Credits
VII	Integrated M.Sc. Microbiology *(Syllabus As per M.Sc. Microbiology I Semester)*	24
VIII	Integrated M.Sc. Microbiology *(Syllabus As per M.Sc. Microbiology II Semester)*	24
IX	Integrated M.Sc. Microbiology *(Syllabus As per M.Sc. Microbiology III Semester)*	24
X	Integrated M.Sc. Microbiology *(Syllabus As per M.Sc. Microbiology IV Semester)*	24