Semester 3 (Second Year)

Course Type	Code	Course	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total
Major Mandatory (4 + 4+4+2)	23ScBIOP311	Major Paper 1 (Theory)	Animal Biotechnology and Stem Cell technology	4	4	50	50	100
	23ScBIOP312	Major Paper 2 (Theory)	Bioprocess Engineering and Fermentation technology	4	4	50	50	100
	23ScBIOP313	Major Paper 3 (Practical)	Exercises in Biotechnology III (P)	4	4	50	50	100
	23ScBIOP314	Major Paper 4 (Theory)	Agricultural Biotechnology (T)	2	2	25	25	50
Major Electives (4)	23ScBIOP325	Major Elective 1 (Theory)	Ecology and Evolution OR Bio-entrepreneur & Start-up	4	4	50	50	100
	23ScBIOP326	Major Elective 2 (Theory)		4				

			designing					
RP (4)	23ScBIOP357	RP	Research Project	8	4	50	50	100
-	-	-	-	-	-	-	-	-
Total				26	22	175	175	350

Semester 4 (Second Year)

Course Type	Code	Course	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total

Major Mandatory (4 + 4+4+2)	23ScBIOP411	Major Paper 1 (Theory)	Genomics and Proteomics	4	4	50	50	100
	23ScBIOP412	Major Paper 2 (Theory)	Biochemical and Biophysical Technique	4	4	50	50	100
	23ScBIOP413	Major Paper 3 (Theory)	Industrial Biotechnology	4	4	50	50	100
	23ScBIOP424	Major Elective 1 (T/P)	Bioinformatics (T+P)	4	4	50	50	100
Major Electives (4)	23ScBIOP425	Major Elective 2 (Theory)	OR Applications in Biotechnology					
RP (4)	23ScBIOP456	RP	Research Project	12	6	75	75	150
-	-	-	-	-	-	-	-	-
Total				22	22	175	175	350

OE : Open Elective

AEC: Ability Enhancement Course

VEC: value Education Courses

CC : Co-Curricular Courses

IKS : Indian Knowledge System

OJT : On Job Training

FP : Field Project

VSC : Vocational Skill Courses

CEP : Community Engagement Project***Progressive Education Society's***

Modern College of Arts, Science and Commerce (Autonomous)

Shivajinagar, Pune - 5

Second Year of M. Sc. (Biotechnology)

(2023 Course under NEP 2020)

Course Code: 23ScBIOP311

Course Name: Animal Biotechnology and Stem cell technology

Teaching Scheme: TH: 4Hours/Week **Credit: 4 C (60 L)**

Examination Scheme: CIA: 50 Marks **End- Sem: 50 Marks**

Prerequisite:

- Basic Knowledge of Animal tissue culture and animal sciences and Stem Cells.

Course Objectives:

- To develop a sufficient background for those students who wish to study more advanced techniques in animal biotechnology.
- To improve the ability of thinking in advanced techniques in animal biotechnology.
- Basic knowledge on animal biotechnology and stem cell technology.

Course Outcomes:

- Expertise in various animal biotechnology and stem cell techniques.

  At the end of the course, the students will have sufficient scientific understanding of the animal sciences, animal tissue culture, and stem cell technology. This knowledge would be applicable in different industries.

CO No	Course Outcomes (COs)	Blooms cognitive Taxonomy level
CO	Gain basic knowledge of animal biotechnology	1

1		
CO 2	Learn initiation of cell culture and maintenance	2
CO 3	Understand the role of animal cells in producing cell products	2
CO 4	Commenting on usage of animal and stem cells in medical applications	2
CO 5	Apply their knowledge regarding extraction, isolation, characterization, andapplication of large-scale animal cell production in pharma industries.	3
CO 6	Distinguish between animal cells and stem cells applications involved in agricultural and pharma technology	4

Course Contents

Unit 1	Introduction to Animal tissue culture:	10 Lectures
	• Definition, principle, and significance of tissue culture. • Maintenance of sterility and use of antibiotics, Detection of Mycoplasma and viral contaminants. Prevention of Cross contamination • Logic of formulation of tissue culture media: natural, synthetic media, and sera. Sterilization of cell culture media and reagents. Introduction to the balance salt solutions and simple growth medium. Role of carbon dioxide in animal cell culture. • Various systems of tissue cultures with distinguishing features, advantages, and limitations. • Methodology: i. Primary culture: Behavior of cells, properties, utility with different examples ii. Explant culture. iii. Suspension culture. • Cell lines: Definition, establishment and maintenance. Normal and established	

	cell lines: Their characteristic features and utility, Characteristics of cells in culture. Contact inhibition, anchorage (in) dependence, cell-cell communication, Cell senescence. Cell and tissue response to various factors, • Organ culture: Methods, behavior of organ explant, and utility of organ culture. Histotypic and organotypic cultures Organ transplants, tissue engineering	
Unit 2	**Growth Studies of cell culture**	**5 Lectures**
	. • Growth studies: Cell proliferation, cell cycle, mitosis in growing cells. Freeze storing of cells and transport of cultures. Measurement of viability and cytotoxicity. • Cell cloning and types of cloning, cell synchronization, micromanipulation, Cell transformation. Separation of cell types: Various methods: advantages and limitations; Flow cytometry. • Nuclear transplantation, Cell hybridization, Transfection studies.	
Unit 3	**Mass production of biologically important compounds**	**10 Lectures**
	• Mass production of biologically important compounds. Harvesting of products, purification and assays. • Application of animal cell culture for in vitro testing of drugs, in production of human and animal viral vaccines and pharmaceutical proteins. • Growing cells in serum free media, scaling up, Hybridoma&monoclonals	
Unit 4	**Transgenic organisms**	**5 Lectures**
	• Transgenic animals: artificial breeding – in vitro fertilization and embryo transfer technology, artificial insemination, germ cell storage, • Genetic modifications – methods, Transgenic fish, and mammals (Mice, Sheep). Gene targeting: Targeted gene transfer. Mouse models for human genetic	

	disorders, Knockout mice. Biosafety issues and Bioethics associated with developing transgenic animals	
Unit 5	**Stem cell introduction**	**5 lectures**
	• Stem cells properties, potency, types, and functions. • Progenitor cells, embryonic germ cells, embryonic carcinoma cells. • Difference between Progenitor cells and stem cells. • Isolation and culture of embryonic stem cells, Hematopoetic stem cells, neuronal stem cells, embryonic germ cells, embryonic carcinoma cells.	
Unit 6	**Cell cycle control in Stem cells**	**5 Lectures**
	• Stem cell self-renewal and pluripotency: molecular mechanisms of cell cycle regulation in stem cells. • Stem cell niche.	
Unit 7	**Induced Pluripotent Stem cells**	**5 Lectures**
	• Introduction and history, limitations. • Challenges to overcome. • Promising non therapeutic applications: disease modeling and drug screening. • Anti-aging and anti-cancer applications. • Ongoing clinical trials.	
Unit 8	**Cancer & Cancer Stem cells**	**5 Lectures**
	• Cancer and cell cycle, oncogenes, and tumor suppressors. • Introduction and history of CSCs. • Signaling Pathways. • CSC and Cancer Therapy Resistance. • CSC Niche and Metastasis. • Clinical Relevance.	
Unit 9	**Therapeutic applications of Stem cells**	**5 Lectures**
	• Neurodegenerative disorders, spinal cord injury, diabetes, burns, cancer	
Unit 10	**Genetic Manipulation of Stem cells and human cloning**	**5 Lectures**
	• Micro nuclear injection • Transduction with recombinant retroviruses. • Targeted gene insertion. • Cre-LoxP recombination and production of	

	transgenic animals. • Monkey cloning in China • Biological, ethical and social considerations	

References:

1. R. Ian Freshney. Culture of Animal cells, 5rd Edition, 2010. A John Wiley & Sons, Inc., Publications, USA

2. R.W.Masters. Animal Cell Culture- Practical Approach, 3rd Edition, 2000, Oxford University Press. USA

3. Robert Lanza et al. Essentials of Stem Cell Biology", Academic Press, 2nd edition, 2006.USA

4. Text book of Animal Husbandary, 8th edition, (1998) G.C. Banerjee,Oxford and IBH Publishinco.Pvt. Ltd. India

5. Gene Transfer to Animal Cells, 1st edition (2005), R. M. Twyman, Taylor & Francis USA.

6. Essentials of Stem Cell Biology, 2nd edition, (2009) Robert Lanza, et al. Elsevier Academic Press, USA.

7. Stem cells and the future of regenerative medicine, 1st edition, (2002), National research council and Institute of medicine, National Academic press, Washington DC.

8. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA.

9. Handbook of Stem cells: Pluripotent Stem Cells; Second Edition (2013). Robert Lanza& Anthony Atala; Elsevier Academic Press, USA.

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Second Year of M. Sc. Biotechnology

(2023 Course under NEP 2020)

Course Code: 23ScBIOP312

Course Name: Bioprocess Engineering and Fermentation Technology

Teaching Scheme: TH: 4Hours/Week **Credit: 4C (60L)**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Prerequisite Courses:

- Students with B.Sc. in Biotechnology securing a minimum of 55% marks.

Course Objectives:

- To study the design and types of fermenters.
- To learn to manipulate the internal environment of a fermenter during the fermentation.
- To study the recovery steps of fermentation process.
- To study the production process of industrially important products using fermentation.

Course Outcomes:

On completion of the course, student will be able to–

CO No	Course Outcomes (COs)	Blooms cognitive Taxonomy level
CO 1	Define the limits of oxygen requirement of an organism	1
CO 2	Understand the behaviour of cells in a fermenter	2
CO 3	Prepare a fermentation media specific to an organism	3
CO 4	Illustrate pathways to produce fermentation products	4
CO 5	Assessment of analytical techniques used in product recovery	5
CO 6	Devise a media optimization experiment	6

Course Contents

Chapter	Title of the chapter	No. of lectures
Unit 1	**Basics of fermentation**	**8Lectures**
	• Historical perspective of fermentation • Design of fermenter: Construction material and Parts of fermenter • Types of Fermenters: Mechanically and non-mechanically agitated fermenters (Air lift, Bubble column fermenters)	
Unit 2	**Aeration, Agitation and Mass transfer in a fermenter**	**12Lectures**
	• Aeration and Agitation: Oxygen uptake in cell cultures, oxygen transfer from gas bubble to cell, determination of KLa, factors affecting KLa, importance of KLa. • Design of impellors with flow patterns. • Fermentation broth rheology: Newtonian and non-newtonian fluids, factors affecting broth rheology. • Power requirement for broth and air mixing, flow regimes in fermentation tank. • Mass transfer: Molecular diffusion and its role in bioprocess, convective mass transfer, two-film theory: Liquid-Solid, Liquid-liquid and Gas-liquid masstransfer equations and significance in bioprocess, Gas hold-up.	
Unit 3	**Media design, Optimization and Bioprocess Parameter control**	**10Lectures**
	• **Media design**: **Carbon sources:** Cane and Beet molasses, Malt, Corn, Starch, oils,hydrocarbons, alcohols; **Nitrogen sources**: Corn steep liquor, Soybean meal, peanut meal, buffers,chelators. • Precursors, Inhibitors, Inducers. • Antifoams- Mode of action, advantages, and disadvantages. • **Medium Optimization:** Classical Approach, Plackett and Burman design, Response Surface Methodology (RSM) • **Parameter Control**:Physical and Chemical Parameters: Temperature, pH, Dissolved oxygen, Microbial biomass, Fluid flow, Pressure, Weight,	

	Inlet and exit gas, foam, CO_2measurement • Use of computersin Bioprocess	
Unit 4	**Preservation and improvement of industrial microorganisms**	**10 Lectures**
	• Methods of preservation of microorganisms • Methods for strain improvement with examples: Mutant selection, Mutants with altered permeability, Auxotrophic mutants, Analogue resistant mutants, Protoplast fusion. • Role of rDNA technology in strain improvement • Inoculum build up for industrial fermentations for bacteria and fungi	
Unit 5	**Methods and equipment used in Downstream processing**	**10Lectures**
	• Basics of Downstream processing • Precipitation using salts, organic solvents,polyelectrolytes, acids, and bases. • Filtration methods: Plate and frame, Rotary Vacuum, and use of filter aids. • Centrifugation types: Basket, Tubular bowl,Scroll, Multichamber, Disc bowl. • Cell Disruption using Physico-mechanical and chemical methods. • Liquid- Liquid extraction: Principle, Co, and counter currentextraction. • Chromatography: Adsorption, Ionexchange, Gel and Affinity chromatographic techniques. • Membrane Processes: Ultra filtration, and Reverse Osmosis • Drying: Drum and Spray Drying • Whole broth Processing	
Unit 6	**Large scale production of some industrially important compounds**	**10 Lectures**
	• Vitamins- Vitamin C, Vitamin B12 • Organic acid- Citric Acid, Lactic acid • Antibiotics- Penicillin, Streptomycin • Butanol-Acetone • Amino acid- Glutamic acid, Lysine	

References:

1. Stanbury, P. F. and Whittaker, A. 1984. Principles of Fermentation technology,Pergamon press
2. Peppler, H. L 1979. Microbial Technology, Vol I and II, Academic Press.
3. Casida, L. E., 1984. Industrial Microbiology, Wiley Easterbs, New Delhi
4. Prescott. S.C and Dunn, C.G., 1983. Industrial Microbiology, Reed G. AVItech books.
5. A.H. Patel. 1985. Industrial Microbiology, Macmillan India Ltd.
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7. Schuler,M. and Kargi,F.Bioprocess Engineering -Basic Concept, Prentice Hall of India, New Delhi.
8. Lydersen. 1993. Bioprocess Engineering: Systems, Equipment & Facilities Ed. B. N.A. Delia & K.M. Nelson, John Wiley & Sons Inc.
9. Harrison,R, Todd, P2006.Bio separations science and Engineering, Oxford University Press.

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Second Year of M. Sc. (Biotechnology)

(2023 Course under NEP 2020)

Course Code: 23ScBIOP313

Course Name: Exercises in Biotechnology III

Teaching Scheme: TH: 8 Hours/Week **Credit: 4C (30P)**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Prerequisite:

- Basic Knowledge of Animal tissue culture and animal sciences.
- Basic knowledge of microbial biotechnology.

Course Objectives:

- To develop a sufficient background for those students who wish to study more advanced techniques in animal biotechnology.
- To improve the ability of thinking in advanced techniques in animal biotechnology.
- Basic knowledge on animal biotechnology.
- To develop an insight into the world of industrial fermentations and to give a basic knowledge of microbial cell functioning with respect to industrial productions.

Course Outcomes:

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

CO No	Course Outcomes (COs)	Blooms cognitive Taxonomy level
CO 1	Search for a better candidate to do bioremediation	1
CO	Understand the animal sciences, animal tissue culture	2

2	techniques. Understand various industrial processes	
CO 3	Application of knowledge of industrial processes on a large scale	3
CO 4	Illustrate chromosome preparation from cell line perform primary cell culture and evaluate growth	4
CO 5	Measure the amount of product formed from Solid state fermentation. Analyse parameters required to achieve sterile growth	5
CO 6	Test the effect of growth factors and toxins on cell proliferation	6

Course Contents: Animal Biotechnology

Practical 1	**Initiation of cell culture from chick embryo**	
	• Primary culture initiation from chick embryo	3
Practical 2	**Subculture of cell line**	
	• Subculture and maintenance of cell line in laboratory	3
Practical 3	**Growth studies by viable cell**	
	• Growth studies by viable cell count analysis	2
Practical 4	**Effect of growth factors**	
	• Effect of growth factors on cell proliferation	3
Practical 5	**Chromosome preparation**	
	• Chromosome preparation from cell line	2
Practical 6	**Study of effect of drug by MTT assay**	**2**

References:

1. A Manual of Basic Technique and Specialized Applications, Author R. Ian Freshney, Edition 6, Publisher John Wiley & Blackwell, 2011, ISBN 0470649356, 9780470649350
2. Cell culture from methods in enzymology vol LVIII, edited by William B. Jakoby and Ira H. Pastan. (Academic Press).
3. Chromosome Analysis Protocols John R. Gosden Springer Science & Business Media,

1994

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Practical 6	**Microbial Production, purification, and characterization of an industrially important enzyme**	**3**
	• Production of enzyme from microorganism, its purification and characterization.	
Practical 7	**Maintenance of the enzyme producer organism**	**2**
	• Maintenance of the isolated producer organism using at least two methods: Agar slants/ glycerol stocks /soil culture/ lyophilization.	
Practical 8	**Optimization of different parameters for the growth of the enzyme producer**	**3**
	• Optimization of different parameters of the isolated organism using conventional and Statistical design.	
Practical 9	**Study of bench top fermenter**	**1**
	• Study of different parts and assembly of the bench top fermenter.	
Practical 10	**Microbiological assay of an antibiotic**	**2**
	• Study the effect of an antibiotic on the growth of microorganism	
Practical 11	**Solid state fermentation**	**2**
	• Lab scale production of a product using solid state fermentation and estimating its concentration	
Practical 12	**Biosorption of dyes**	**1**
	• Biosorption of dyes using dead biomass of *Aspergillus niger* or brewer's yeast cells.	
Practical 13	**Demonstration of working of industrial fermenters by visiting a fermentation industry.**	**1**

References:

1. Stanbury, P. F. and Whittaker, A. (1984). Principles of Fermentation technology, Pergamon press.
2. Bergey's Manual of Systematic Bacteriology.

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Second Year of M.Sc. Biotechnology
(2023 Course Under NEP 2020)

Course Code : 23ScBIOP 314 Course Name : Agricultural Biotechnology

Teaching Scheme: TH: 2 Hours/Week **Credit : 2C (30 L)**

Examination Scheme: CIA : 25 Marks **End-Sem : 25 Marks**

Prerequisite Courses:

- To know Basic agriculture and its applications

Course Objectives:

- To Study Skill development in all crucial tasks of the Agriculture industry
- To learn Structure, functioning, objective, and mandates of the Agri based Industries

After successful completion this course student will be able to:

CO No	Course Outcomes (COs)	Blooms cognitive Taxonomy level
CO 1	Learn and understand the basics of agriculture practices	1,2
CO 2	Understand the use of biotechnology in agricultural practices	2
CO 3	Examine the use of biotechnology tools such as transgenics hybridization to improvement in practices	3
CO 4	Apply gained information to determine possible outcomes of various techniques	3
CO 5	Analyse and examine the ethics and its importance in agriculture	4,5
CO 6	Design , plan innovative agriculture practices to improve productivity	6

Course Contents

Unit	Topic	30 Lectures
Unit 1	**Agronomy**	**5 lectures**
	• Cropping patterns in different agro-climatic zones of the country. • Impact of high-yielding and short-duration varieties on shifts in cropping patterns. • Concepts of various cropping and farming systems. • Organic and Precision farming. • Package of practices for production of important cereals, pulses, oil seeds, fibers, sugar, commercial and fodder crops.	
Unit 2	**Forestry**	**5 lectures**

	• Important features and scope of various types of forestry plantations, such as socialforestry,agroforestry, and natural forests. • Propagation of forest plants. Forest products. • Agroforestry and value addition. • Conservation of forest flora and fauna.	
Unit 3	**Weed Science**	**2 lectures**
	• Weeds, their characteristics, dissemination, and association with various crops; their multiplications; cultural, biological, and chemical control of weeds.	
Unit 4	**Soil science and nutrient management**	**7 lectures**
	• Soil- physical, chemical, and biological properties. • Processes and factors of soil formation. • Soils of India, Mineral and organic constituents of soils and their role in maintaining soil productivity. • Essential plant nutrients and other beneficial elements in soils and plants. • Principles of soil fertility, soil testing and fertilizer recommendations, integrated nutrient management. • Bio fertilizers.	
Unit 5	**Horticulture and landscaping**	**5 lectures**
	• Major fruits, plantation crops, vegetables, spices and flower crops. • -Package practices of major horticultural crops. • Protected cultivation and high-tech horticulture. • Post-harvest technology and value addition of fruits and vegetables. • Landscaping and commercial floriculture. • Medicinal and aromatic plants. • Role of fruits and vegetables in human nutrition.	
Unit 6	**Agricultural economics**	**3 lectures**
	• Economics of different types of farming systems. • Marketing management – strategies for development and market intelligence. • Price fluctuations and their cost; role of cooperatives in agricultural economy; types and	

	systems of farming and factors affecting them. • Agricultural price policy. • Crop Insurance	
Unit 7	**GM Crops**	**3 lectures**
	• Current state of Transgenic Crops • Concern About GM Crops, • Regulation of GM Crops and Products • European Union (EU) ,EU Regulatory Framework for GM Foods, • Future Developments in the Science of plant Biotechnology	

References:

1. Economics and Farm Management - by John Westra, Kent Olson
2. Soil Science - D.K Das or Brady
3. Agronomy by Yellamananda Reddy
4. Plant Breeding by B.D. Singh
5. Genetics by B.D.Singh
6. Physiology by Pandey & Singha
7. Introduction to Horticulture - Kumar
8. Handbook of Agriculture by ICAR
9. Agricultural Extension Education in India
10. Pathology - Singh
11. Entomology - Vasantha Raj & David
12. The Hindu - Survey of Indian Agriculture
13. Agriculture Statistics - Dept. of Agriculture
14. The Hindu- Special Issue on Agriculture

Course Code: 23ScBIOP325 **Course Name: Ecology and Evolution**
Teaching Scheme: 4 Hours/Week **Credit : 04**

Examination Scheme: CIA: 50Marks **End-Sem: 50 Marks**

Prerequisite Courses:

- Basic knowledge of Environment, Ecology and Environmental Biotechnology

Course Objectives:

- To explain students about environment and its importance
- To summarize knowledge regarding ecosystems, populations, communities and their conservations
- To apply concepts and mechanisms of ecology in conservation of biodiversity
- To simplify vital concepts from evolution
- To perceive various concepts about behavior
- To improve the understanding of connection between brain, behavior and evolution

Course Outcomes:
On completion of the course, student will be able to –

CO No	Course Outcomes (COs)	Blooms Cognitive Taxonomy level
CO 1	Recall basic concepts from environment, ecology and evolution	1
CO 2	Summarize ecology with respect to ecosystems, populations and communities	2
CO 3	Apply ecology to conserve biodiversity	3
CO 4	Examine various behavioral and evolutionary aspects and mechanisms	4
CO 5	Evaluate evolution through paleontology, molecular and behavioral aspect	5
CO 6	Discuss concepts regarding brain, behavior and evolution	6

Course Contents

	ECOLOGICAL PRINCIPLES	60 lectures
Unit 1	**The Environment**	**03**
	• physical environment • biotic environment • biotic and abiotic interactions	
Unit 2	**Habitat and Niche**	**03**
	• concept of habitat and niche • niche width and overlap • fundamental and realized niche • resource partitioning • character displacement	
Unit 3	**Population Ecology**	**03**
	• characteristics of a population • population growth curves • population regulation • life history strategies (r and K selection) • concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations	
Unit 4	**Species Interactions**	**03**
	• types of interactions • interspecific: competition, herbivory, carnivory, pollination, symbiosis	
Unit 5	**Community Ecology**	**03**
	• nature of communities • community structure and attributes • levels of species diversity and its measurement • edges and ecotones	
Unit 6	**Ecological Succession**	**03**
	• types; mechanisms • changes involved in succession • concept of climax	
Unit 7	**Ecosystem Ecology**	**03**
	• ecosystem structure; ecosystem function; • energy flow and mineral cycling (C,N,P); • primary production and decomposition; • structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine)	
Unit 8	**Biogeography**	**03**
	• major terrestrial biomes • theory of island biogeography • biogeographical zones of India	
Unit 9	**Applied Ecology**	**03**

	• environmental pollution • global environmental change • biodiversity: status, monitoring and documentation • major drivers of biodiversity change • biodiversity management approaches	
Unit 10	**Conservation Biology**	**03**
	• principles of conservation • major approaches to management • Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves)	
	EVOLUTION AND BEHAVIOUR	
Unit 11	**Emergence of evolutionary thoughts**	**05**
	• Lamarck; Darwin–concepts of variation • adaptation, struggle, fitness and natural selection • Mendelism; Spontaneity of mutations; The evolutionary synthesis	
Unit 12	**Origin of cells and unicellular evolution**	**05**
	• origin of basic biological molecules • abiotic synthesis of organic monomers and polymers • concept of Oparin and Haldane • experiment of Miller (1953) • the first cell • evolution of prokaryotes • origin of eukaryotic cells • evolution of unicellular eukaryotes • anaerobic metabolism, photosynthesis and aerobic metabolism	
Unit 13	**Paleontology and Evolutionary History**	**05**
	• the evolutionary time scale • eras, periods and epoch • major events in the evolutionary time scale • origins of unicellular and multi cellular organisms • major groups of plants and animals • stages in primate evolution including Homo	
Unit 14	**Molecular Evolution**	**05**
	• concepts of neutral evolution, molecular divergence and molecular clocks • molecular tools in phylogeny, classification and identification • protein and nucleotide sequence analysis • origin of new genes and proteins • gene duplication and divergence	
Unit 15	**The Mechanisms**	**05**
	• population genetics – populations, gene pool, gene frequency	

	• Hardy-Weinberg Law • concepts and rate of change in gene frequency through natural selection, migration and random genetic drift • adaptive radiation • isolating mechanisms • speciation • allopatricity and sympatricity • convergent evolution • sexual selection • co-evolution	
Unit 16	**Brain, Behavior and Evolution**	**05**
	• approaches and methods in study of behavior • proximate and ultimate causation • altruism and evolution-Group selection, kin selection, reciprocal altruism • neural basis of learning, memory, cognition, sleep and arousal; biological clocks • development of behavior • social communication • social dominance • use of space and territoriality • mating systems, parental investment and reproductive success parental care • aggressive behavior • habitat selection and optimality in foraging • migration, orientation and navigation • domestication and behavioral changes	

References:

1. Verma, P. S., & Agarwal, V. K. (2004). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: Evoloution and Ecology*. S. Chand Publishing
2. U Satyanarayana. (2005). *Biotechnology* Books and Allied (P) Ltd, Kolkata, Reprint 2011.
3. Manuel C. Molles Jr. (2008) *Ecology Concepts and Applications*, University of New Mexico, McGraw Hil, Higher Education, 4th Edition
4. Odum, E. P., & Barrett, G. W. (1971). *Fundamentals of ecology* (Vol. 3, p. 5). Philadelphia: Saunders.
5. Anthony J. F. Griffiths, Susan R. Wessler, Richard Lewontin, Sean B. Carroll. (1976). *An Introduction to Genetic Analysis* 9th Edition, W H Freeman & Co; 9th edition (16 February 2007). SBN-10 0716768879 ISBN-13 978-0716768876
6. Daniel L. Hartl and Elizabeth W.Jones. (1998) *Genetics: Principles and Analysis*, fourth edition, Jones and Bartlett Publishers, Sudbury, Massachusetts, ISBN 0-7637-0489-X
7. Strickberger, Monroe W. (1990). *Evolution*, Boston : Jones and Bartlett
8. Manning A and Dawkins MS. An Introduction to Animal Behaviour. Cambridge

University Press, USA.

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Second Year of M. Sc. (Biotechnology) (2023 Course)

Course Code: 23ScBIOP325 Course Name: Bio-entrepreneur & Start up designing

Teaching Scheme: 4 Hours/Week **Credit: 4C(60L)**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Teaching Scheme: TH: 4Hours/Week

- **Prerequisite:**
- Idea and creativity dream of Business

- **Course Objectives :**

- Acquiring Entrepreneurial spirit and resourcefulness
- To explore new vistas of entrepreneurship and generate innovative business ideas
- Understanding the importance of entrepreneurship for economic development

- **Course Outcomes:**

After successful completion this course student will be able to:

CO No	Course Outcomes (COs)	Blooms cognitive Taxonomy level
CO 1	Learn basics of entrepreneurship	1
CO 2	Understand the process of start up	2
CO 3	Analyse the various components required for an entrepreneur and start up	3
CO 4	Evaluate the possibilities required for a start up design	4
CO 5	Hypothesise the outcomes of a start up	5

CO 6	Design a start up using skills learnt	6

Course Contents

Unit No	Topic	60 Lectures
Unit 1	**Introduction to Entrepreneurship**	**10 Lectures**
	• concept of entrepreneurship, • Need and Importance of entrepreneurship • The history of entrepreneurship development, • Skills and characteristic of successful entrepreneurs; • Entrepreneurship process; • Role of entrepreneurship in economic development,	
Unit 2	**An Entrepreneur and Entrepreneurship Journey**	**10 Lectures**
	• Types of Entrepreneurs • Ethical Entrepreneurship • Entrepreneurial Value: Values, Attitudes and Motivation. • The entrepreneurial decision process, and role models, • Role of Society and Family in the growth of an entrepreneur.	
	• **Activity : Motivational games to boost the decision power, accuracy andAttitude of the students**	
Unit 3	**Starting the venture**	**10 lectures**
	Generating business idea – • Sources of new ideas, • Methods of generating ideas, • Creative problem solving, • Competitor and industry analysis; • Feasibility study : i) Financial feasibility. ii) Market feasibility:-Marketing plan: marketing research for the new venture, Steps in preparing marketing plan,	
	Activity : **1. Organization of 'Brain Storming' session for generating Creative Business idea** **2. Market survey/Marketing Strategy**	
Unit 4	**Preparing a Business Plan:**	**10 lectures**

\	• Introduction to Business and its Environment • Components of a business plan, • Meaning and significance of a business plan • Challenges of New Venture Strategies • Start-up Policy Framework and Incentives • drawing business plan • Preparing project report; • Business Plan Preparation • Presenting business plan to investors • Execution of Business Plan	
	• **Activity : Presentation on Business plan /Start-up business plan**	
Unit 5	**Entrepreneurship as Problem Solving**	**6 lectures**
	• Entrepreneurs- as problem solvers. • Risk taking-Concept; types of business risks. • Barriers to Entrepreneurship. • Support structure for promoting entrepreneurship (various government schemes).	
Unit 6	**Dimensions of Entrepreneurship**	**4 lectures**
	• Entrepreneurial Culture • Entrepreneurial Society • Women Entrepreneurship • Rural Entrepreneurship	
Unit 7	**Strategic Frameworks for Decision**	**6 lectures**
	• Vision, Mission, Objective and Goal • Porter's 5-Forces Model • SWOT Analysis • Competitive Strategies	
	• **Activity : Story of successful business man**	4 Lectures

Reference Books:

1.Entrepreneurship, Hisrich, Robert D., Michael Peters and Dean Shepherded, , Tata McGraw Hill, ND

2. Entrepreneurship, , Brace R., and R., Duane Ireland, , Pearson Prentice Hall, New Jersy (USA).

3. Entrepreneurship, Lall, Madhurima, and ShikhaSahai, Excel Book, New Delhi.

4. Entrepreneurship Development and Small Business Enterprises, Charantimath, Poornima, Pearson Education, New Delhi.

5. Entrepreneurship : New Venture Creation – David H. Holt

6. Entrepreneurship : Hisrich Peters

7. The Culture of Entrepreneurship- Brigitter Berger

8. Dynamics of Entrepreneurship development and Management: Entrepreneurship, Project Management, Finances, Programmes, and Problems – Vasant Desai (2009)

9. Entrepreneurship Development – Dr. P.C. Shejwalkar

10. Thought Leader : Shrinevas Pandit

11.Leadership and new Science : Margrat wheatly

12. Handbook of Entrepreneurship Research: An Interdisciplinary Survey and Introduction (International handbook series on Entrepreneurship) (2003) : Zolten J ACs, David B. Audretch

Pearson Education, New Delhi.

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous)

Shivajinagar, Pune - 5

Second Year of MSc (Biotechnology)

(2023 Course under NEP 2020)

Course Code: 23ScBIOP411 **Course Name: Genomics and Proteomics**

Teaching Scheme: TH: 4 Hours/Week **Credit: 4 C (60 lectures)**

Examination Scheme: CIA: 50 Marks **End-Sem :** 50 Marks

Prerequisite Courses:

- Basic knowledge of Molecular Biology and genomes of organisms

Course Objectives:

- To Study advanced and applied techniques of genomics and proteomics
- To learn various applications of genome and proteome analysis of model organisms and various other organisms.

Course Outcomes:

CO No	Course Outcomes (COs)	Blooms cognitive Taxonomy level
CO 1	Study and understand the terms genomics and proteomics	1,2
CO 2	Understand the importance of both in obtaining data	2
CO 3	Understanding the techniques used and Analyzing data	3
CO 4	Analysing the data and its relevance to structure and function of genome and proteome	4,5
CO 5	Hypothesise outcomes from data for application	5
CO 6	Predict possible applications	5,6

Course Contents

Unit	Title	60 lectures
Unit 1	**Genomics**	**10 Lectures**

	• Genomics and Proteomics overview, omes and omics, • Concepts and applications: Genome overview with model organisms example • Comparative genomics - Goals, bioinformatics of genome annotation, methods and limitations. • Structural genomics –Goals, methods, applications. • Functional genomics –Goals, methods, applications.	
Unit 2	**Transcriptomics and Microarray**	**10 lectures**
	• Introduction to transcriptomics and expression profiling DNA and RNA Microarray –Preparation, working and analysis • Investigative techniques –EST, SAGE, SNP • DNA and RNA Microarray – Preparation, working and analysis. Microarray databases and bioinformatics tools.	
Unit 3	**Applications of genomics**	**10 lectures**
	• Metagenomics • Toxicogenomics • Pharmacogenomics • Basic research • Medical Genetics	
Proteomics		
Unit 4	**Introduction & concept of proteomics**	**7 lectures**
	Protein structure-function relationship, Types of Proteomics: • Protein expression proteomics	

	• Structural Proteomics, • Functional Proteomics	
Unit 5	**Techniques in proteomics:**	**12lectures**
	Protein Isolation and Separation techniques • Structural analysis of proteins- X-ray crystallography and NMR spectroscopy • 2 D electrophoresis • Mass Spectrometry: MALDI_TOF, ESI Tandem, Ion Trap, Peptide mass fingerprinting • LC-MS, (SILAC) - Chemical tagging, fluorescence, radio-labeling	
Unit 6	**Protein expression profiling**	**7 lectures**
	• Protein expression profiling • Protein-protein interaction • Methods for detection of protein-protein interactions - Yeast 1, 2 and 3 `hybrid systems – Phage display – • Proteomics and Protein microarrays, databases, and allied bioinformatics tools.	
Unit 7	**Applications of Proteomics**	**4 lectures**
	• Health care**,** Biomarkers in disease diagnosis, • Identification and characterization of novel proteins	

Reference Books:

1. Bioinformatics - From Genomes to Drugs (2001) Thomas Langauer (editor) WileyVCH; 1st edition
2. Bioinformatics-Sequence and Genome Analysis (2004) David W Mount Cold Spring Harbor Laboratory Press; 2nd edition
3. Comparative Genomics Webb Miller et al Annu. Rev.Genomics Hum.Genet 2004, 5, 15-56
4. DNA microarrays and gene expression (2002) P Baldi and G W Hatfield Cambridge University Press
5. Functional Genomics : Methods and Protocols (2003) M J Brownstein, A B Khodursky Humana Press
6. Genome analysis and bioinformatics (2009) Sharma T R I.K. International Publishing House Pvt. Limited
7. Genome and proteome annotation: organization, interpretation and integration G A Reeves et al J.Roy.Soci. 2009,6, 129-147
8. Introduction to genetic analysis (2008) Griffiths et al W. H. Freeman 12. Introduction to genomics (2007) Arthur M. Lesk OUP Oxford
9. Daniel C. Liebler, Introduction to Proteomics. Humana Press.
10. Twyman RM, Principle of Proteomics. BIOS Scientific Publishers. (2004).
11. Kamp RM, Methods in Proteome and Proteome Analysis. Springer. (2004).
12. Jolles P and Jornvall H, Proteomics in Functional Genomics: Protein Structure Analysis Birkhauser (2000).

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Modern College of Arts, Science and Commerce (Autonomous)

Shivajinagar, Pune - 5

Second Year of M. Sc. (Biotechnology)

(2023 Course under NEP 2020)

Course Code: 23ScBIOP413 **Course Name: Industrial Biotechnology**

Teaching Scheme: TH: 4Hours/Week **Credit: 4C (60 L)**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Course Objectives:

1. To understand the use of living cells to generate industrial products.
2. To study the production process of some important products like enzymes, antibiotics, biopigments etc.

Course Outcomes:

At the end of the course, the students will:

CO No	Course Outcomes (COs)	Blooms cognitive Taxonomy level
CO 1	Understand the concept of industrial biotechnology	2
CO 2	Comment on pharmaceutical industry	2
CO 3	Understand the importance of FDA	2
CO 4	Chart pathways for industrial production	3
CO 5	Implement lessons learnt in industries	3
CO 6	Analyse the process of drug designing. Solve problems related to various industries	4,6

Course Contents

Unit 1	Introduction to Industrial Biotechnology	5 Lectures
	• Introduction to Industrial microbiology • Introduction to Biopharmaceutical industry • Introduction to Biosimilars and Health care • Introduction to Agriculture Industry	

Unit 2	**Production of Biopharmaceuticals**	**10 Lectures**
	• Introduction to Biotherapeutics like Vitamins, Antibiotics, Hormones, Enzymes, Hematopoietic Growth Factors and Coagulation Factors. • Discovery of protein or peptide-based therapeutics • Production of Biopharmaceuticals using Synthetic Biology Approach (e.g., Artemisinin) • Production of Industriallyimportant fungal, and Bacterial enzymes.	
Unit 3	**Drug Development and drug discovery**	**10 Lectures**
	• Target identification and validation, Role of In-silico studies in drug development. • Pre-clinical studies: Animal models for *in vivo* activity of drugs testing. • Toxicity studies in pre-clinical trials: Cytotoxicity, Genotoxicity, Reproductive toxicity, and Carcinogenicity • Clinical trial phases and design: Phase I, II, III and IV • Pharmaco-informatics, Pharmacovigilance.	
Unit 4	**Biosensor Technology**	**8 Lectures**
	• Basics of Biosensor technology • Study of various components used in biosensors • Types of Biosensors: Biocatalysts based biosensors, bio affinity-based biosensors & microorganisms-based biosensors • Applications of Biosensors: Environmental monitoring, medicine, and health care (for glucose monitoring, DNA analysis), agriculture and food.	
Unit 5	**Production of Antimicrobial Compounds, Vaccines and Bio pigments, Bio flavors**	**10 Lectures**
	• Production of Antibiotics: Tetracycline, Kanamycin, and ampicillin • Production of Vaccines: Killed, Live attenuated, Toxoid, and DNA vaccines with one example each. • Production of Bioflavors and Biopigments.	
Unit 6	**Role of microorganisms in different industries**	**10 Lectures**

	• Production of Alcoholic beverages like Wine, Fruit Wine and beer using Fermentation. • Bioplastic production using microorganisms (biochemical pathways used by the microorganisms to produce Biopol, microbial rubber, and adhesive polymers). • Role of microorganisms in Biotransformation processes to form: Indigo from Indole and Dihydroxy acetone from Glycerol (Pathway studies).	
Unit 7	**Role of regulatory authorities in drug development processes**	**7 Lectures**
	• Overview of Good Practices • The role of Food and Drug Administration (FDA) in drug approval process • Indian drug regulations, and pharmacopeia • Market issues of drug patenting and licensing in Pharma industry.	

References:

1. An Introduction to synthetic drugs- Singh & Rangnekar, Himalya Publishing House, 1980.
2. Principles of Medicinal chemistry-Foye, L W Publishers 2008.
3. Biopharmaceuticals, Biochemistry and Biotechnology- Gary Walsh, Wiley Pub, 2nd Edn. 2003.
4. Industrial Pharmaceutical Biotechnology- Heinrich Klefenz- Wiley-VCH Edn, 2002
5. Biopharmaceutical Drug Design and Development-S Wu Pong, Y Rojanasakul, and J Robinson, Humana Press 1999.
6. Pharmaceutical Biotechnology- K Sambamurthy and Ashutosh Kar, New age International Publishers-New Delhi 2006.
7. Maheshwari, D. K. et. al., Biotechnological applications of microorganisms, IK. International, New Delhi, 2006
8. Stanbury, P. F. et. al., Principles of Fermentation Technology, 2nd Edition, Elsevier, UK, 1995.
9. Waites, M. J. et. al., Industrial Biotechnology: An Introduction, Blackwell publishing, UK, 2007.
10. Gary Walsh (2003) Biopharmaceuticals: Biochemistry and Biotechnology, 2nd Edition, John Wiley & Sons, Inc.
11. Daan J A Crommelin (2010), Pharmaceutical Biotechnology, 2nd Edition, Taylor & Francis Group.
12. Rodney J. Y. Ho (2013) Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, 2ndEdition, John Wiley & Sons, Inc.

13. Gary Walsh (2007) Pharmaceutical Biotechnology: Concepts and Applications. John Wiley & Sons, Inc.
14. Oliver Kayser, Heribert Warzecha (2012) Pharmaceutical Biotechnology: Drug Discovery and Clinical Application s, 2nd Edition. John Wiley & Sons, Inc.
15. Handbook of Biosensors and Biosensor Kinetics. Ajit Sadana, Neeti Sadana. Elsevier Science. 2011. ISBN: 978-0-444-53262-6.

Progressive Education Society's

Modern College of Arts, Science and Commerce,
Shivajinagar, Pune - 5
Second Year of MSc (Biotechnology)
(2023 Course under NEP 2020)

Course Code: 23ScBIOP424 **Course Name: Bioinformatics (T+P)**
Teaching Scheme: TH: 4 Hours/Week **Credit: 4 C (30 lectures+15 Practicals)**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 marks (**25 T+25P)

Prerequisite Courses:

- Basic knowledge of Molecular Biology, cell biology ,genomes and proteomes of organisms

Course Objectives:

- To Study advanced and applied techniques of bioinformatics
- To learn sequence, structure and function relationship of gene as well as protein sequences.

Course Outcomes:

On completion of the course, student will be able to–

- Study various sequence and structure to function relationship of organisms.
- Apply information about various tools to study applications of gene and protein sequences.

CO No	Course Outcomes (COs)	Blooms cognitive Taxonomy level
CO 1	Learn the basics of bioinformatics and understand	1,2
CO 2	Understand the different software for use	2
CO 3	Use the software such as swissprot, Blast etc to look at protein structure	3,
CO 4	Analyse data obtained	4
CO 5	Hypothesise possible structures or features of proteins	5
CO 6	Predict the structure, function and compare proteins	6

Course Contents

Unit	Title	30 lectures
Unit 1	**Introduction to Bioinformatics**	**6 Lectures**
	• Concepts and applications • Biological Databases Concept, types, specialization, limitations. Data retrieval from various databases, Homology searching and their applications.	
Unit 2	**Sequence alignment**	**10 Lectures**
	• Algorithms, Scoring Matrices, • Pairwise sequence alignment, • Multiple Sequence Alignment (MSA)	
Unit 3	**Phylogenetic analysis**	**2 Lectures**
	• Phylogenetic tree and phylogenetic tree construction methods.	
Unit 4	**Structural Bioinformatics**	**10 Lectures**
	• Protein structure basics, • Ramachandran plot, • Protein structure- function relationship • Molecular Modeling • Acquisition and visualization of molecular structures • Sequence and Structure based predictions- Simulation of Molecular interactions • Protein motifs and domain prediction, Protein profiles and Hidden Markov Model (HMM)	
Unit 5	**Immunoinformatics**	**2 Lectures**
	• Databases, epitope prediction and vaccinology.	

References:

1. A text book of bioinformatics (2008) Sharma, Munjal and Shankar. Rastogi Publications, Meerut.
2. Bioinformatics-Sequence and Genome Analysis (2004) David W Mount Cold Spring Harbor Laboratory Press; 2nd edition, USA
3. BLAST (2003) Joseph Bedell, Ian Korf, Mark Yandell. O'Reilly Media, USA
4. Essential Bioinformatics (2006) Jin Xiong Cambridge University Press; 1st edition,

Cambridge
5. Introduction to Bioinformatics (2008) Arthur M. Lesk OUP, Oxford
6. Immunoinformatics (2008) Schönbach, Ranganathan, Brusic Springer, New York
7. Principles of proteomics (2004) Twyman Richard Taylor & Francis, UK
8. Protein Structure Prediction, methods and protocol (2000) David M. Webster Springer, New York

Practicals

Practical	**Title**	**15 Practicals**
Practical 1	**Introduction to Biological Databases**	**2 P**
	• Publicly available Database study and searching PubMed, NCBI, DDBJ, EMBL, UniProt, PDB	
Practical 2	**Retrieval of sequences and Sequence analysis**	**2 P**
	• Retrieval of sequences and Sequence analysis by: BLAST, FASTA	
Practical 3	**Multiple Sequence Analysis and Phylogenetic tree construction**	**3 P**
	• Multiple Sequence Analysis: ClustalW (JalView), MUSCLE, TCoffee	
Practical 5	**Visualization and study of 3D molecular structures**	**1P**
	• RASMOL, Swiss PDB viewer	
Practical 6	**Potential energy calculations**	**1P**
	• Potential energy calculations:Swiss PDB viewer	
Practical 7	**Mutation and energy minimization of proteins**	**1P**
	• Mutation and energy minimization of proteins	
Practical 8	**Homology Modeling**	**1P**
	• Swiss PDB viewer, ExPAsy	
Practical 9	**Protein classification, domain identification, signature matching**	**2 P**
	• PFAM, Prodom, Prosite	
Practical 10	**Immunoinformatics**	**2 P**
	• IMGT database search for IG, TR and MH	

References:

1. Samal, Kailash& Rout, Gyana. (2014). Bioinformatics Practical Manual.

2. Practical Bioinformatics1st Edition by Michael Agostino Garland Science.
3. Bioinformatics Practical Manual September 2015 Greate Space Independent Publishing. Platform 7290 Investment Drive # B North Charleston SC United States.