Savitribai Phule Pune University

M. Sc. Biodiversity – Monitoring and Utilization

Credit and Semester System Syllabus
M.Sc. Part I
(2019)

Degree: Master of Science

Subject: Biodiversity-Monitoring and Utilization

Faculty: Science & Technology

Dr. Ankur Patwardhan
Chairman, BOS in Biodiversity

General Information

M. Sc. Biodiversity - Monitoring and Utilization (credit and Semester System) is a two year postgraduate course, comprising four semesters. The curriculum gives holistic coverage to the extremely valuable field of Biodiversity. Biodiversity is the largest source of potential wealth for the country, which remains grossly under explored. One of the reasons for the under utilization is the dearth of trained manpower. The current generation of biologists is largely divided into field-oriented taxonomists and ecologists on the one hand and the lab oriented functional and molecular biologists on the other. This divide has become a limiting factor in the study of Biodiversity. The present program intends to bridge the gap by inculcating excellence in field and laboratory biology simultaneously. This capacity building exercise will help generating wealth through a prudent and sustainable use of the country's bioresources.

The course consists of four semesters:

- The first year comprising two semesters is extensively field oriented and the second year is lab intensive.
- The first semester is devoted to taxonomy and diversity of various life forms and emphasizes on basic techniques of exploration of diversity.
- Second semester focuses on natural history and is supplemented adequately with quantitative techniques in biology and ecology. Biogeography component which forms the key component in shaping up of natural systems has also been included here.
- First and second semesters together emphasize on conceptual as well as empirical knowledge of the ways in which natural systems work.
- The first two semesters can make a good naturalist and ecologist.
- Third and fourth semester will expose students to various facets of environment, conservation and utilization of bioresources.

Eligibility Criteria:

a. Bachelor in - Science (any branch) / Agriculture / Fisheries / Pharmacy / Forestry / Medicine / Engineering (any branch) with minimum 50% of marks

b. Clearing the entrance examination

Admission: The candidate should appear for the entrance test. The merit list will be based only on marks obtained in entrance test. Marks of qualifying graduate examination will be considered for tie-breaking.

Fee Structure: As per Savitribai Phule Pune University guidelines for self supported post graduate courses in colleges.

Workload: There shall be 15 teaching clock hours per credit, out of which classroom contact hours will be 12 and 3 hours for preparation of in-semester continuous assessment comprising of seminars, mini projects, assignments, library notes, extension works and short quizzes. Each practical session will occupy six hours / week / batch.

Examination: Assessment shall consist of an in-semester continuous assessment and end of semester assessment as per Savitribai Phule Pune University rules.

Guidelines for Internal and Project Assessment: The in-semester evaluation (internal assessment) shall be carried out as per the guidelines given by university for credit and semester system. Biodiversity course being field intensive, visits to natural systems and forested landscapes forms an integral part of the overall practical component. Practical examination will combine both field and lab exercises that test the knowledge and understanding of the subject.

Standard of Passing: The award of grades, ATKT and marks for passing, etc. will be as per the Savitribai Phule Pune University rules.

Medium of instruction – English

Course structure: There shall be four semesters, at each semester there will be 3 theory courses and 2 practical courses. In the first semester, there shall be only core / compulsory credits (TC). Second semester shall consist of 2 core / compulsory credits and 1 non-core / optional credit (TNC). In the third semester, there shall be 1 core / compulsory credits and 2 non-core / optional credit. In fourth semester, there will be 1 core/ compulsory credit and 2 non-core / optional credit, for theory. Each practical course shall have 4 core / compulsory credits (PC). Following is the outline of the course structure.

Semester	Theory (48 credits)		Practical (32 credits)
	Core /Compulsory Course (credits)	Non-core /Optional Course (credits)	Core / Compulsory Course (credits)
I	12	00	08
II	08	04	08
III	04	08	08
IV	04	08	08

Detail course outline of M.Sc. – Part I

Semester	Course Code	Name of the Subject	Credits	
Semester I	BD - TC 101 Theory	Introduction to Plant and Animal Taxonomy and Diversity	4	Core
	BD - TC 102 Theory	Microbial Diversity and Molecular Biology	4	Core
	BD - TC 103 Theory	Introduction to Ecology and Biodiversity Management	4	Core
	BD - PC 111 Practical	Taxonomy and Diversity: Field Methods	4	Core
	BD - PC 112 Practical	Taxonomy and Diversity: Lab Methods	4	Core
Semester II	BD – TC 201 Theory	Research Methodology and Quantitative Biology	4	Core
	BD – TC 202 Theory	Population Ecology and Evolutionary Biology	4	Core
	BD – TNC 203 Theory	Biogeography	4	Non Core
	BD-TNC 204 Theory	Environmental Journalism and Media	4	Non Core
	BD – PC 211 Practical	Quantitative and Field Techniques in Ecology	4	Core
	BD-PC 212 Practical	Biodiversity Internship	4	Core
	Total Credits		40	

Detail course outline of M.Sc. – Part II

Semester	Course Code	Name of the Subject	Credits	
Semester III	BD - TC 301 Theory	Scientific Communication and Biostatistics	4	Core
	BD – TNC 302 Theory	Wildlife and Conservation Biology	4	Non Core
	BD - TNC 303 Theory	Introduction to environment laws and policies	4	Non Core
	BD - TNC 304 Theory	Agrobiodiversity and Livestock diversity	4	Non Core
	BD - PC 311 Practical	Quantitative techniques and GIS	4	Core
	BD - PC 312 Practical	Dissertation	4	Core
Semester IV	BD – TC 401 Theory	Chemical Diversity	4	Core
	BD –TNC 402	Bioinformatics and Phylogenetics	4	Non Core
	BD – TNC 403 Theory	Socio-economic Aspects of Biodiversity	4	Non Core
	BD – TNC 404 Theory	Environment Management and Restoration	4	Non Core
	BD - PC 411 Practical	Bioactivity of Secondary Metabolites and Bioinformatics	4	Core
	BD - PC 412 Practical	Dissertation	4	Core
	Total Credits		40	

Semester I

Course Code and Title	Credit Title
BD – TC 101: Introduction to Plant and Animal Taxonomy and Diversity	Introduction: Concept of species, variation
	Study of plant groups
	Classification of Animal kingdom
	Animal Study Techniques
BD- TC 102: Microbial diversity and Molecular Biology	Introduction to microbial world
	Microbial Diversity and Taxonomy relationship
	Microbial Ecosystems and Microbial Ecology
	Introduction to Molecular Biology (Structure and Processes)
BD- TC 103: Introduction to Ecology and Biodiversity Management	Introduction to Ecology
	Endemism and Concept of Threatened Species
	Understanding Biodiversity
	Management of Biodiversity
BD - PC 111: Taxonomy and Diversity: Field Methods	Morphology of Major plant groups
	Documentation and dissemination
	Study of traps
	Morphology of key taxa
BD –PC 112: Taxonomy and Diversity: Lab Methods	I- Microbial Identification- Isolation of microbes from environmental sample
	Characterization of microbes
	Isolation and characterization fungi and protozoa
	II. Molecular tools- Genomics and Proteomics studies

Semester II

Course Code and Title	Credit Title
BD - TC 201: Research Methodology and Quantitative Biology	Introduction to scientific enquiry
	Types of research methodologies and importance of sampling
	Descriptive Statistics, Measures of central tendencies and Measures of Dispersion
	Probability distribution and Hypothesis testing
BD - TC 202: Population Ecology and Evolutionary Biology	Population growth and Population interactions
	History and development of evolutionary theory
	Life History Evolution
	Inter and Intraspecific interactions
BD - TNC 203: Biogeography	Introduction to Biogeography
	Dispersal and Migration
	Speciation, Island Biogeography
	Factors governing biodiversity
BD –TNC 204: Environment Journalism and Media	Environment and Need for Environmental Journalism
	Comparison between Traditional and Modern Journalism, Advent of Scientific Journalism
	Global and local issues related to Environment
	Environment Journalism and its Impact
BD – PC 211: Quantitative and Field Techniques in Ecology	Introduction to sampling and sample size
	Estimation of IVI, phytograph
	Introduction to Maps – Contours, Field Maps
	Introduction to computers
BD – PC 212: Biodiversity Internship	Internship related to Biodiversity/Conservation/Environment Protection related issues OR Review of biodiversity/Conservation/Environmental issues with the help of case studies

SEMESTER I

BD TC - 101: Introduction to Plant and Animal Taxonomy and Diversity

Objective: This course includes classroom teaching in theory of plants and animal classification and a practical, field-based approach in identification of these groups. The course aims to generate a competent field biologist. The approach in implementing this course is to make the student conversant with the use of taxonomic literature. We do not expect the students to learn formal taxonomy by heart. They should be able to choose and use appropriate taxonomic and identification keys efficiently for identifications. The assessment system will allow the students to use the literature in the exams.

A. a. **Introduction: Concept of species, variation** **(1 credit)**

Theory of plant taxonomy:
Introduction to major plant groups
Evolutionary relationships between plant groups
-Conquest of land
- Englerian and Ranalian School of thought, Concept of primitive flower

b. Nomenclature and History of plant and animal taxonomy
- Brief history of plant and animal taxonomy
- Concept of Taxon
- ICN, ICZN, ICTV and ICNCP rules
- Principles and rules of Taxonomy
- Typification concept, Principle of Priority
- Valid and scientific names, Rules regarding coining
- Ethical and Humane treatment to animals, DOs and DON'Ts of collection of specimens
- Preservation of plants and animal specimens for taxonomic purposes.

c. Systems of classification and their application
- Overview of Natural, Artificial and Phylogenetic systems
- Linnaeus, Bentham and Hooker, APG systems of classification of plants

B. Study of plant groups **(1 credit)**

a. Morphology of major plant groups
- Bryophytes (General features)
- Pteridophytes (General and special features, Significance of heterospry)
- Gymnosperms (General features, Similarities with Angiosperms)
- Angiosperms

b. Study of important families of Angiosperms
- Primitive and advanced families including: Nymphaeaceae, Annonaceae, Malvaceae, Anacardiaceae, Leguminosae, Rubiaceae, Combretacae, Apocynaceae, Asteraceae, Lamiaceae, Moraecae, Euphorbiaceae, Orchidaceae, Poaceae

C. Classification of Animal kingdom (1 credit)

a. Study of invertebrate's upto class level for Echinoderms, Annelids, Molluscs, Arthropods (study in detail about Crustacea, Arachnida, Chilopoda, Diplopoda, Hexapoda) and insecta
b. Study of vertebrate orders- Amphibians, Reptiles, Birds, Fish, and Mammals
c. Minor phyla and their importance in phylogeny, connecting links.

D. Animal Study Techniques (1 credit)

a. Methods of Field data collection for taxonomic studies
b. Use of techniques like net sweeping, pit fall traps, light traps, Berlese funnel, smoking, aspirators, mark-recapture
c. Use of Taxonomic literature and study of key characters for identification of the specimen (key taxa such as Amphibians, reptiles, insects, birds, fish)
- Photodocumentation of diagnostic features
- Referencing, citation and Preparation of keys, reports

Reference

1. Naik, V. N. (1984). *Taxonomy of Angiosperms.* Tata McGraw-Hill Education.
2. Heywood,V., Burmitt, R., Culham, A. and Seberg, O. (2007). *Flowering plant families of the world.* Kew Books (Europe) Firefly Books (North America).
3. Pandey, B. P. (2001). *A textbook of Botany:Angiosperms- Taxonomy, Anatomy, Economic Botany and Embryology.* S. Chand, Limited.
4. Cooke, T.C. (1958a reprint edition) *Flora of the Presidency of Bombay Presidency—Vol. 1 to 3*. Botanical Survey of India, Kolkata
5. Singh N.P and S. Karthikeyan (eds.) (2000). *Flora of Maharashtra—Vol. I and II Series 2*. Botanical Survey of India, Kolkata
6. Talbot, W.A. (1911). *Forest Flora of the Bombay Presidency and Sind . Vol. 2* (Poona : Government Photozicographic Press).
7. Jain, D.K. and Singh, V. (2012). *Taxonomy of Angiosperms. 8th Ed.* Rastogi Publications.
8. Maiti, R. K. and Singh, V. P. (2009). An introduction to Modern Economic Botany. Agrobios.
9. Kochhar, S. L. (2012). *Economic Botany In the Tropics, 4/e.* Macmillan Publishers India.
10. Nehra, S. (2007). *Economic Botany.* Pointer Publishers.
11. Hill, A. F. (). *Economic Botany: A Textbook of Useful Plants and Plant Products 2nd edition*. McGraw-Hill.
12. Simpson, B. and Ogorzaly, M. (2001). *Economic Botany: Plants in our world*. McGraw-Hill.

13. Smith, M. A. (1943). *The fauna of British India, Ceylon and Burma including the whole Indo-chinese Sub- region Reptilia and Amphibia.3(Serpentes)* London: Taylor and Francis.
14. Alcock, J. (2009) Animal Behavior: An Evolutionary Approach (9th edition). Sinauer Associates, Sunderland, MA.
15. Ali, S.and Ripley,S. (1999). *Handbook of birds of India and Pakistan Edn.2* Oxford University Press.
16. Daccordi, Triberti and Zanetti (1988). *The MacDonald Encyclopedia of Butterflies And Moths*. Macdonald, London.
17. Ali, S. and Ripley, S.D. (1983). *A pictorial Guide to the Birds of the Indian Subcontinent.*
18. Bombay Natural History Society and Oxford University Press.
19. Prater, S.H. (1971). *The book of Indian animals. 3rd Edn,* Bombay Natural History Society and Oxford University Press.
20. Preston-Mafham and Preston-Mafham. (2003). *Primates of the World.* Facts On File Inc.
21. Kotpal, R.L. (2005). *Arthropoda. 11th Edn*. Rastogi Publications.
22. Kotpal, R.L. (2012). *Modern Text Book of Zoology, Invertebrates, 10th Edn.* Rastogi Publications.
23. Preston-Mafham. (1993). *The Encyclopaedia of Land Invertebrate Behaviour.* London: Blandford Press.
24. Ashlock, P.D. (1991). Principles of Systematic Zoology, 2nd Edn. Mcgraw-Hill College.

BD TC 102: Microbial diversity and Molecular biology

Objective: Microbial taxonomy has taken a different route than plant and animal taxonomy, the emphasis being on cultivation and applications. The course attempts to develop a new "culture" of microbiologists with a naturalistic mindset and who are equally good in the field and the lab. The classical natural history approach of biology has been almost absent in microbiology. The limitations of classical taxonomy and the technological advances in molecular biology have revolutionized the nature of taxonomy. For microorganisms in particular, molecular taxonomy is largely replacing conventional taxonomy. The course intends to impart training in the concepts as well as techniques in molecular biology.

A. Introduction to microbial world (1 credit)

a. History of microbes, Biogenesis and abiogenesis theory, theory of biochemical evolution. Magnitude, occurrence and distribution. Introduction to microbiome.
b. Concept of genus, species, criteria for classification (Bacteria, viruses, protozoa, fungi and algae)
c. Cultivation of microbes: Culturable (aerobic and anaerobic microbes) and Unculturable bacteria (metagenomics) - Growth curve analysis

B. Microbial Diversity and Taxonomy relationship (1 credit)

a. Taxonomic methods: Classical, phenetics, cladistics and Polyphasic approach.
b. Morphological Methods, chemotaxonomy-cell wall composition analysis, Lipids and fatty acid profile analysis (FAME), Protein profiles and isozymes analysis (MALDI), genotyping methods- DNA- DNA hybridization, G+C ratio, 16sRNA sequencing, Metagenomic analysis.
c. Bergey's manual- systematics and determinative bacteriology.

C. Microbial Ecosystems and Microbial Ecology (1 credit)

a. Microbial ecosystems and effects of environmental factors- Marine and fresh water ecosystem: environment of bacteria, bacterial growth, its regulation by environment conditions, bioindicators.
b. Microbial Interactions- Benevolent interaction (control within microbial communities of rhizosphere, animal microbe interaction such as fungus and insect; Mammal and parasitic load, bacteria and squid, Bird and *Enterococci*, fungi and fish stock).
c. Antagonistic interaction, competition, antibiosis and predation.

D. Introduction to Molecular Biology (Structure and Processes) (1 credit)

a. Genome organization: Structure of Prokaryotic genome, Eukaryotic genome, Organelle genome.(A, B and Z forms), DNA replication, transcription, Tm value, and structure of t-RNA, r-RNA, and m-RNA, estimation of nucleic acids.
b. DNA typing methods, Microsatellite- short tandem repeats, DNA fingerprinting, gene editing tool-CRISPER Cas.

c. Gene expression and regulation- Introduction to operon.
d. Tools in genomics: DNA modifying enzymes, PCR, Vectors, Cloning, Transformation
e. Translation in prokaryotes and eukaryotes: Properties of amino acids structure of proteins, Determination of size of proteins-PAGE,SDS PAGE

Reference

1. Breed et. al. (1952). *Bergey's Manual of Determinative Bacteriology. 7th Edition,* The Williams and Wilkins Company, Baltimore.
2. Breed and Buchanan. (1982). *Bergey's Manual of Determinative Bacteriology. 9th Edition,* The Williams and Wilkins Company, Baltimore.
3. Watve, M.G and Paknikar, S.K. (1996). *Microbiology: A practical approach, Manali Prakashan-Pune*
4. Prescott, L.M., Harley, J.P., and Klein D.A. (2005). *Microbiology, 6th Edn.* MacGraw Hill Companies Inc.
5. Pelczar, M. J, Jr. and Chan, E.C.S. (1981). *Elements of microbiology.* Tokyo: Kogakusha-McGraw Hill. 21
6. Stanier, R.Y., Adelberg, E.A. and Ingraham, J.L. (1987) *General Microbiology, 5th Edn.* Macmillan Press Ltd.
7. Tortora, G.J., Funke, B.R. and Case, C.L. (2006). *Microbiology: An Introduction. 8th Edn.* Pearson Education Inc.
8. Mukerji, K. G. and Manoharachary, C. (2010). *Taxonomy And Ecology Of Indian Fungi,* I. K. International Pvt Ltd.
9. Nelson, D. L. and Cox, M. M. (2002). *Lehninger's Principles of Biochemistry,* Mac
10. J. T. Bonner., *Researches on cellular slime moulds: selected papers*
11. Zimmer, C. (2011). *The planet of Viruses.* University Chicago Press.
12. Benjamin Lewin. (2008), *Genes IX, Jones and Bartelett Publishers Inc*.
13. Khanna P., (2008) *Cell and Molecular Biology, I.K. International Publishing House Pvt.*
14. Weaver R., (2007) *Molecular Biology*, *4th Edition, McGrew Hill Science.*

BD TC 103: Introduction to Ecology and Biodiversity Management

Objectives: The aim of this course is to provide students an insights into the way in which biodiversity is managed at different levels – from local people to the Govt. Along with biodiversity management, students should understand the importance of natural resources, their traditional use and current issues related to these. Students will also learn about basics of conservation.

A. Introduction to Ecology (1 credit)

a. Concept of habitat, niche and guild, resource partitioning
b. Ecological succession
c. Adaptations (Mimicry, Camouflage, protection, aquatic habitat)

B. Endemism and Concept of Threatened Species (1 credit)

a. Indicator species., Keystone species
b. Types of Endemism and rarity
c. IUCN categories and criteria, Area of occurrence and extent of occurrence

C. Understanding Biodiversity (1 credit)

a. Biodiversity concept (richness & evenness), biodiversity hot-spots, diversity-stability relationship
b. Forest and habitat types of the world with emphasis on India and Maharashtra
c. Biodiversity profile of India and its comparison with the world.
d. Biotic and abiotic factors affecting species richness
e. Community characteristics

D. Management of Biodiversity (1 credit)

a. Basic conservation methods, In-situ management of biodiversity, introduction to protected area system in India. Reserve forests, sanctuaries, National Parks, Biosphere Reserve and its role in biodiversity management. Review of existing protected areas and analysis of coverage of biodiversity values by protected areas.
b. Ex-situ management of biodiversity, various methods, Role of zoos, biodiversity parks, gene banks, tissue culture etc. in biodiversity management. Introduction to the concepts of captive breeding. Examples of captive breeding and re-introduction programmes in maintaining biodiversity.

Reference

1. A walk on the wild side (an information guide to National Parks and Wildlife Sanctuaries of Karnataka), Karnataka forest Department.
2. Chapman, J.L. and Reiss, M.J. (1998). Ecology: Principles and applications. Cambridge University Press.
3. Gadgil, M. et. al. A Methodology Manual for Documenting People's Priorities for Biodiversity and Conservation. Shrustiygyaan.
4. Gary E Davis, Science and Ecosystem Management in National Parks, The University of Arizona Press, Tucson, 1996
5. India's 4th national reports on convention on Biodiversity, MOEF 2009.
6. Magguran, A.E. (1996). Ecological diversity and its measurements. Princeton University.
7. Sutherland, W. (2006). Ecological census technique: A Handbook, 2nd Edn. Cambridge University Press.
8. Odum, E. and Barett, G. (2005). Fundamentals of Ecology. Thomson Brooks/Cole.

BD – PC 111: Taxonomy and Diversity: Field Methods

A. Morphology of Major plant groups (1 credit)

- Expected ability- field identification of at least 100 species (Bryophytes, Pteridophytes, Gymnosperms with emphasis on Angiosperms)
- Study of identification characters
- Vegetative characters (Leaf type, arrangement, shapes)
- Sexual characters (Floral morphology, study of fruits)

B. Documentation and dissemination (1 credit)

- Collection and preservation of plant specimens
- Use of taxonomic literature
- Preparation of keys, reports
- Use of photography in scientific documentation and Photomicrography
- Visit to herbaria, gardens, repositories
- Visit to ecosystems (aquatic, forest, lateritic plateaus)

C. Study of traps (1 credit)

- Dry and wet preservation techniques
- Collection and morphology of insects and arachnids

D. Morphology of key taxa (1 credit)

- Visit to fish market, morphometry
- Field key characters of amphibians, reptiles
- Visit to forests/ecosystems for birds, studying butterfly, mammalian diversity

BD PC - 112 Taxonomy and Diversity: Lab methods

I. Microbial identification

A. Isolation of microbes from environmental sample (1 credit)

(air, water and soil: example Actinomycetes, and cyanobacteria)

- Cultivation- media (enrichment, selective), pure culture isolation
- Observing bacteria (Staining techniques – monochrome, differential, negative, Motility)

B. Characterization of microbes (1 credit)

- Biochemical tests
- Screening of Acid and Antibiotic producing bacteria etc.

C. Isolation and characterization fungi and protozoa (1 credit)

- Types of vegetative forms, types of spores, fruiting bodies. Using taxonomic keys.
- Methods of cultivation and identification of Protozoans
- Visit to culture collection centre

II. Molecular tools:

D. Genomics and Proteomics studies (1 credit)

- Isolation of Genomic (bacterial/animal/ plant) and plasmid DNA,
- Restriction digestion, ligation and Transformation in Prokaryotic systems
- Isolation of cellular protein, SDS-PAGE

SEMESTER II

BD TC 201 Research methodology and Quantitative Biology

Objective: Quantitative techniques are essential in Life sciences. The course introduces the student to the statistical tools and their applications. The student should able to choose right kind of tool for answering a given question in a given situation. The tests can be carried out using available software.

A. Introduction to scientific enquiry and Research Ethics (1 credit)

a. History of Natural Science (pre-Darwinism)
- Transition from Natural History to Enquiry based study in biology
- Phases of Scientific Enquiry

b. Problem identification/ beginning of scientific approach / Hypothesis
- Choosing an appropriate system/s (Species, Ecosystem, Forest Type etc.)
- Social implications of research (case studies)
- Animal experimentation ethics, wild-life ethics and human experimentation ethics
- Ethics in data collection, handling, project management
- Literature review

c. Design of a study / Plan of work
- Data Collection and Analysis
- Summary and Conclusions

B. Types of research methodologies and importance of sampling (1credit)

a. Observation based
- Questionnaires, Surveys, and PBR

b. Experimental studies
- Meta-analysis
- Theoretical approaches

c. Importance of sampling in research
- Role of the study design and standard experimental designs in the choice of sampling technique
- Sampling effort in context of statistical analysis
- Limitations of sampling natural systems with examples

C. Descriptive Statistics, Measures of central tendencies and Measures of Dispersion (1 credit)

a. Need and application of statistics.
b. Data classification and representation - Classification of data, tabulation, graphical representation.
c. Measures of central tendencies and significance
d. Measures of dispersion – absolute and relative and significance

D. Probability distribution and Hypothesis testing (1 credit)

a. Central limit theorem, Probability distributions – binomial, poisson, normal.
b. Non-Normal distributions
c. Hypothesis testing and statistical inference, concept of Null hypothesis, alternative hypothesis, significance level, Type I and II errors.

Reference

1. Anthony M. Graziano, Michael,L. Raulin, Research Methods: A Process of Inquiry 6th Ed
2. Barrow and Tipler (1988) The Anthropic Principle, Oxford University press
3. Bowles, K. L. (1977) Problem Solving using Pascal, Berlin: Springer- Verlag.
4. Dawkins, R. (1998). Unweaving the Rainbow,Penguin Publication, London
5. Grafen, A. and Ridley, M., (2006) Richard Dawkins: How a scientist changed the way we think. Oxford University Press.
6. Martha Davis (2005) Scientific Papers and Presentations
7. Maynard Smith, J. (1986) The Problems of Biology, Oxford: Oxford University Press
8. Medawar, P. B. and Medawar, J. S. (1977). The Life Science: Current Ideas of Biology,
9. Wildwood House, London
10. P. B. Medawar, Advice to a young Scientist
11. Strunk, Jr., W. White, E.B., (1979) The Elements of Style, 3rd Ed.,
12. Anderson, D.R.; Sweeney, D.J. and Williams, T.A.. (1994) Introduction to Statistics: Concepts and Applications. West Group.
13. Zar, J.H. (1999). Biostatistical Analysis, 4th Edn. Northern Illinois University.
14. Bailey, N.T.J. (1959). Statistical methods in Biology, English Universities Press Limited.

BD TC 202 Population Ecology and Evolutionary Biology

Objectives: This course introduces students with the basic concept of population and its interaction. It highlights the proximate and ultimate mechanisms that give rise to biological diversity. The basic concept of population and evolution

A. Population growth and Population interactions (1 credit)

a. Growth types and growth models: exponential, logistic and chemostat models and their variants.
b. Populations with age structure, age class distributions, Effect of environment on population growth, stochasticity in growth
c. Growth efficiency and growth yield: Laws of thermodynamics, energetics of growth, biomass conversion rates. r and K selection strategies.

B. History and development of evolutionary theory (1 credit)

a. Darwinism
b. Neodarwinism: spontaneous mutation controversy, effects of natural selection on populations, stabilizing and dispersing selections, Levels of selection, group selection controversy, selfish gene theory.
c. Kin selection and sociobiology, evolution of cooperation, sociality, game theory.
d. Evolution and stability of sex, sexual selection, evolution of secondary sexual characters

C. Life History Evolution (1 credit)

a. What is life history, variations in life histories,
b. Optimal Resource allocation (resource allocation hypothesis), important life history trade-offs, semelparity and iteroparity, Lack's hypothesis
c. Plant phenology,resource allocation in root vs shoot, when to produce flowers, seeds
d. Effects of climate change on life histories/ phenology

D. Inter and Intraspecific interactions (1 credit)

a. Types of interactions, Empirical and experimental studies on population interactions
b. Intraspecific interactions: models of competition, ways to reduce intraspecific competition (territorial behaviors, dispersal, infanticides, etc.)
c. Interspecific interactions: predator-prey dynamics, Host-parasite ecology, interspecific competition, niche separation

Reference

1. Dennett, D.C. (1995). Darwin's dangerous idea, Evolution and Meaning of Life. Simon & Schuster.
2. Simpson, G.G. (1949). The meaning of evolution, A Study of the History of Life and of Its Significance for Man. Oxford University Press.
3. Milner, R. (1999). Charles Darwin: Evolution of a Naturalist. Universities Press.
4. Magguran, A.E. (1996). Ecological diversity and its measurements. Princeton University.
5. Odum, E. and Barett, G. (2005). Fundamentals of Ecology. Thomson Brooks/Cole
6. Alcock, J.(1984) Animal behavior: an evolutionary approach.9th edition. Sinauer Associates.
7. Jon C. Herron, Scott Freeman (2013) Evolutionary Analysis, 4th edition Pearson Education.
8. Hartl and clark, Principles of population genetics second edition Sinauer Associates.

BD TNC 203: Biogeography

Objective: Species in nature are the part of complex community, the organization and stability of which is important in conservation. This course discusses the patterns of distribution of species and the reasons for the same. Also, it discusses factors affecting biodiversity.

A. Introduction to Biogeography (1 credit)

a. Origin and development of the Earth, Geological time scale and development of life
b. Zoogeographical realms, types and their characteristic faunal divisions, biogeographical regions of India,
c. Patterns and types of distributions, theories of distribution, affinities of organisms
d. Application of biogeography – Remote Sensing & Geographical Information System (GIS)

B. Factors governing biodiversity (1 credit)

a. Introduction to major vegetation regions of the world (Biomes)
b. Exotic species (invasives / alien species), strategies used by alien species.
c. Effect of climate on shaping vegetation types
d. Effect of disturbance on diversity

C. Dispersal and Migration (1 credit)

a. Centres of dispersals and pattern of dispersal, Mobility and migration, Geographical checks or barriers to dispersal / movement.
b. Routes of dispersal, Vicariance
c. Adaptation and competition, Species range, territoriality.

D. Speciation, Island Biogeography (1 credit)

a. Meaning and scope, types of speciation.
b. Variety of Island habitats, Problems of isolation, Hazards of island life, effects of inbreeding, dispersal, Opportunities for adaptive radiation.
c. Case studies – Real Island, functional island, Island biodiversity models.

Reference

1. Mani, M.S. (1974). Biogeography of India,1st Edn. Springer.
2. Abele, L.G. (1982). Systematics, the fossil record and biogeography. Proceedings of the Biological Society of Washington 93(2): 362-372
3. Gadgil, M. et. al. A Methodology Manual for Documenting People's Priorities for Biodiversity and Conservation. Shrustiygyaan.

4. A walk on the wild side (an information guide to National Parks and Wildlife Sanctuaries of Karnataka), Karnataka forest Department.
5. Malhotra, K.C. et. al. (2001). Cultural and Ecological Dimensions of Sacred Groves in India. INSA, New Delhi.
6. Who's Eden? An overview of community approaches to wildlife management. (1994) International institute of environment and development (IIED).
7. Ganguli, P. (1998). Gearing up for Patents: The Indian Scenario. Hyderabad Universities Press (India).
8. Chapman, J.L. and Reiss, M.J. (1998). Ecology: Principles and applications. Cambridge University Press.
9. Huggett, Richard J. (1998) Fundamentals of biogeography. by Routledge 11 New Fetter Lane, London EC4P 4EE

BD TNC 204 - Environmental Journalism and Media

Objective: Media plays a very important role in the dissemination of issues related to biodiversity. The course aims to give exposure to the students regarding the aspects of journalism and media for effective communication of biodiversity and environment issues.

A. Environment and need for environmental journalism **(1 credit)**

a. Introduction to media and its aspect from to environment protection and conservation: Concepts and perspective.

b. Environment and society

c. Relation of environment with development, economy and health

d. Analysis of current status of environmental journalism

B. Comparison between traditional and modern journalism, advent of scientific journalism

(1 credit)

a. Types of media – an overview, classification of media

b. Historical perspectives

c. Comparison of traditional with modern media

d. Scientific journalism – A role in environmental issues and societal progress

e. Environment reporting- Source and collection of data for environment report writing. Collection of data, laws and ethics involve in reporting.

C. Global and local issues related to environment **(1 credit)**

a. Environment and development

b. Biodiversity conservation

c. Pollution

d. Energy

e. Management of natural resources

f. Climate change

D. Various media and their contribution in documentation of their success stories

(1 credit)

a. Environmental journalism and its impact:

- Generation of awareness amongst masses
- Conversion into action, social response.
- Policy making
- Implementation level

b. Contribution of media- Print media, Audio media, Audio visual media, and Social media

c. Discussions based on Case studies

Reference:

1. Aruna murthy, Vasundhara, Bhuwaneshwar, (2005) *EIA process in India and its drawbacks*

2. Corporate document repository, www.fao.org

3. Dr Y Prabhanjan Yadav, *Role of communication in climate change and sustainable development*, Global media journal, Indian ed vol 2, no 2

4. J. Taylor Miller, Thomson*, Environmental sciences*

5. Michael P Murphy and Luke A. J . O' Neill*. What is life? the next 50 years*

6. Priya Uttam, K 'Cherry and Tripat Kaur, *Global environmental issues*

7. Ramsar convention – India, Current science, vol-101, no 10, 25th Nov 2011

8. R S Deshpande, *Current land policy issues in India*

9. Rachael Carson (1962), *The silent spring,* Houghton Mifflin

10. Richard Mabey , *The oxford book of nature writing*

11. State mineral policy and related matters (manual) govt of Maharashtra, 1999.

Important links / websites

1) www.myfootprint.org

2) www.ramsar.org

3) www.moef.nic.in

BD PC 211 Quantitative and Field Techniques in Ecology

A. (1 credit)

a. Introduction to sampling and sample size.

b. Sampling units- Quadrats and Transects

c. Sampling of various life forms plants (herbs, shrubs, trees) and key animal taxa

d. Species area curve,

e. Girth class distribution, Regeneration

B (1 credit)

a. Estimation of IVI, phytograph

b. Biomass estimation

c. Estimation of Ecological indices, Indices of α-diversity, species rarefaction, β-diversity similarity and dissimilarity indices, species abundance distribution

d. Estimating bird, insects, mammal densities using appropriate strategies

C. (1 credit)

a. Introduction to Maps – Contours, Field Maps

b. Study of SOI Toposheets and its use in sampling

c. Use of Compass and GPS for making field maps

D. (1 credit)

a. Introduction to computers

b. Introduction to Excel. Use of spreadsheets

c. Use of excel in univariate analysis

Statistical packages for performing statistical tests

d. Use of BD Pro, PAST

e. Use of clustering algorithms.

f. Simulation models of growth and population interactions

BD-PC 212 Biodiversity Internship

Objective: The compulsory academic internship consists of minimum 75 hours completed during 15 weeks of work outside the institution and it intends to give students a unique learning opportunity, allowing them to put many of the concepts and methods learned in the classroom into practice in a realistic professional setting. While securing an internship is primarily the responsibility of the student depending on his/her own interest related to the field of biodiversity, the internship coordinator provides substantial aid in locating a position and in ensuring that the work experience is relevant and appropriate to the student's study. The internship can take place at any institute (government agencies, NGOs, research institutes, private sector companies, consultancies) or any relevant organization working with the community (local people, farmers, tribals etc), that can provide and supervise an internship at the M.Sc level.

Students may choose to do their internship in and around Pune City preferably. To receive credits for the internship, the student must write an internship report, which will be evaluated by their field supervisor and their supervisor from within the department.

Internship will be a 4 credit course for which students will have to complete min 60 hours of training. Maximum 2 days per week will be allotted for the internship.

Student can also work on a review pertaining to biodiversity/Conservation/Environmental issues with the help of case studies and develop a critical case study.

The assessment of the Internship is for total of 100 marks, out of which the university examinations assessment – end-semester - will be for 50 marks and the in-semester assessment will be for 50 marks.
Grid for marks distribution-

In-semester Evaluation (Internal examiner - 50M)	End-semester Evaluation (External Supervisor - 50M)
Concept note - 10 M	Responsibility and Reliability: Demonstrates a consistent level of self-discipline, organization, and dependability - 10 M
Monthly reports - 10 M	Initiative - 10 M Planning and organization, addressing a problem - 10 M
Mid term presentation- 15 M	Oral Communication skills: Effectively communicates verbally in a concise, articulate, and professional manner- 5 M
Final presentation - 15 M	Written communication skills / Report - 15 M

Guidelines for Biodiversity Internship Evaluation

Students will undertake an Internship in the second semester. Final evaluation of the internship shall be conducted at the end of the second semester as per the rules of SPPU.

1. In case of internship more than one student can approach to a single agency. The Internship report will be prepared individually as per the thesis format. Submission of the report will be at the end of the semester. One copy of the report will be preserved in the department.

2. Students must submit a registration form duly completed at the start of second semester. The form should contain details like the proposed area of work, brief description of the problem, name and signature of the student and supervisor. In case of projects chosen outside the department, a copy of the consent letter or mail from the supervisor must be attached with the form. For project works chosen outside College, involving other research Institutes and supervisors, there should be one faculty coordinator from Dept. of College who will interact with the student throughout the internship period.

3. Assessment will be as per the norms laid by SPPU. Students may present their work using posters, blackboard, transparencies, model or LCD projector.

4. The assessment will be carried out on the basis of the points given above in the grid.