University of Pune

M. Sc. Biodiversity – Monitoring and Utilization
Part - II

Revised Syllabus

Degree: Master of Science (M. Sc.)

Subject: Biodiversity

Faculty: Science

General Information

M. Sc. Biodiversity - Monitoring and Utilization (non-credit system) is a two year postgraduate course, comprising four semesters and is a unique program conducted at Abasaheb Garware College, Pune; since 2003. The course was sanctioned under Innovative Programs Scheme of University Grants Commission. 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, each with a focal theme:

- 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. Human ecology 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.
- In the third semester, students will have an option of whether to opt for 'theory course' or undergo a 'research methodology' course. Depending on the nature of the planned work for dissertation, student will do the theory course/ dissertation in first or second half of the second year. Students who have opted for dissertation in the third semester will do course work in the fourth semester and vice-versa.
- Dissertation and understanding research methodology is a vital component. Natural systems (Biodiversity), being dynamic, possess very high seasonality component. Several

of the projects are directed to field level research and need considerable time to be spent in the field.

Thus with a previous background of field knowledge and laboratory techniques complemented with scientific communication, the entire course tends to make the right kind of biologists that can translate the potential of country's Biodiversity into actual wealth.

Centre where the course is offered : Dept. of Biodiversity, MES Abasaheb Garware College, Pune – 411004.

Eligibility Criteria:

a. Bachelor in - Science / Engineering (any branch) / Agriculture / Fisheries / Pharmacy / Medicine with minimum 50% of marks
b. Clearing the entrance examination

Admission: The candidate must 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 University of Pune guidelines for self supported post graduate courses in colleges.

Course structure: M. Sc. Biodiversity (non-credit system) is a two year postgraduate course comprising of four semesters. Course structure follows standard format of 16 (University courses) + 4 (Departmental courses). Following is the outline of the course structure (with the marks in the parentheses).

Detailed course structure :

Semester	Course No.	Name of the Subject	Int. Marks	Ext. Marks	Total Marks
Semester I	BD 101	Plant Taxonomy and Diversity	20	80	100
	BD 102	Animal Taxonomy and Diversity	20	80	100
	BD 103	Microbial Taxonomy and Diversity	20	80	100
	BD 111 Practical	Taxonomy: Field Methods	20	80	100
	BD 112 Practical	Taxonomy: Lab Methods	20	80	100
Semester II	BD 201	Ecology and Evolutionary Biology	20	80	100
	BD 202	Conservation Biology	20	80	100
	BD 203	Quantitative Biology	20	80	100
	BD 211 Practical	Field Ecology Techniques	20	80	100
	BD 212 Practical	Quantitative Techniques in Ecology	20	80	100
Semester III	BD 301	Chemistry and bioactivity of secondary metabolites	20	80	100
	BD 302	Ex-Situ Conservation Methods	20	80	100
	BD 303	Genomics, Proteomics and Bioinformatics	20	80	100
	BD 311 Practical	Bioprospecting and Bioanalytical Chemistry	20	80	100
	BD 312 Practical	Molecular Tools in Biology	20	80	100
Semester IV	BD 401	Research Methodology and Scientific Communication	20	80	100
	BD 402	Dissertation *	80	320	400

* Departmental Course

Medium of instruction – English

Workload: The contact period for each semester will be 12 weeks, 4 lectures per course per week, each of 60 minutes duration. Work load for theory courses of college teacher entrusted with work of post-graduate teaching will be at the rate of one clock hour of post-graduate teaching equal to two periods of undergraduate teaching. Each laboratory course will occupy six hours / week / batch. The work-load for seminars / oral presentations of students will be 4

periods per week per class (M. Sc Part–I and M. Sc. Part–II). Dissertation will occupy equivalent workload of two laboratory courses i.e. 6 hours a week / practical course / batch.

Examination will be held at the end of each semester. Each course carries 100 marks, of which 80 marks are for external examination and 20 marks for internal examination. All theory courses are University courses, the external examination will be for 80 marks and for duration of 3 hours. Since Abasaheb Garware College is the only centre running this course, setting of exam papers and CAP will be done in the college as per University rules.

Guidelines for Internal and Project Assessment : The internal assessment is carried out for all the subjects. The assessment is based on seminars, paper presentations, debates and written examinations. Project evaluation and progress will be assessed by the Thesis Advisory Committee (TAC) which comprises of research guide, faculty coordinator and the expert in this field.

Biodiversity course being field intensive, visits to 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. Each practical course carries 100 marks and for duration of 3 days.

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

Evaluation of Dissertation: Following are the guidelines for evaluation of project. Details with break-up of marks is given under 'Dissertation' course. The assessment of this course will be carried at the end of the fourth semester.

- Understanding of the research problem and related basic concepts
- Extent of literature survey
- Understanding and involvement in designing the experimentation set up
- Data analysis and interpretation
- Logical reasoning for the interpreted results
- Presentation and Report writing skills
- Viva-voce
- Publication potential

University and Departmental courses : The dissertation course will be the departmental course and all other courses will be university courses.

Semester III

BD-301 : Chemistry and bioactivity of secondary metabolites

Approach :

Secondary metabolites are good source of medicinal compounds. Thus, it is essential to isolate, identify and characterize them. The course outlines the methodology and trains the students in methods of detecting and assaying such compounds.

1. Primary and Secondary Metabolites (2)

a. Importance of Primary and Secondary metabolites
b. Production of Secondary Metabolites (from Plants, Animals and Microbes)

2. Natural Product Chemistry

a. Introduction to classes of Naturally occurring compounds: Fatty acids, Alkaloids, Terpenoids, Steroids, Flavonoids, Anthocyanins, Carbohydrates, Complex compounds, Essential oils, (2)

b. Extraction of Phytochemicals: Maceration, Soxhlet extraction, Steam distillation, Hydrodistillation, Wax extraction, Fractional crystallization, Fractional distillation, Spinning band distillation etc. (4)

c. Analysis of Crude Extracts and Pure Phytochemicals : (14)

- Physical Methods- Significance of M P, B P, Optical Rotation.
- Elemental analysis – Determination of C, H, N, S and empirical formula
- Chromatographic Techniques – TLC, Column Chromatography, HPLC, GC, Preparative chromatography techniques,
- Spectral methods: Applications of UV-VIS, IR, ^{1}HNMR, ^{13}CNMR and Mass Spectroscopy for structural determination of complex organic molecules

3. Screening of bioactive molecules (10)

Bioassays

a. Antimicrobial

- Direct and Indirect Methods to determine effect of antimicrobial agents: (turbidometry, nephalometry, microscopy, electrical resistance, electrical impedance, flow cytometry, microcalorimetry, radiometry, respirometry.)
- Susceptibility testing for – antimicrobial, antiviral agents
- Antimicrobial testing in liquid media – factors affecting assay techniques.
- Antimicrobial testing in agar media – kinetics of zone formation (Fick's law), gradient plate technique, disk/well diffusion techniques, factors affecting diffusion tests.

b. Pharmacological
- Anti-inflammatory assays, Antipyretic assays etc.

c. Anti-cancerous

d. Evaluation of Bioactivity of Plant extracts, Purified fractions, Secondary metabolites

4. Drug Development:

a. Toxicological Evaluation of New Chemical Entities (NCE) (7)
- Toxicity (-hepato, -nephro, -cardio, -neurotoxicity)
- Toxicological evaluation of drug: LD50, Acute, subacute, chronic toxicity
- Tolerability
- Mutagenicity (Ames test, Micronucleus test), Carcinogenicity, Teratoginecity and allergy testing.
- Experimental animal infections, Animal models for activity
- Uses of cell lines: cytotoxicity testing

b. Screening of drugs
- Correlation between in vitro and in vivo sensitivity testing and clinical outcome.

b. Introduction to Drug Action (4)

c. Introduction to Vaccines (2)

d. Steps towards commercialization of drug and Introduction to Pharmacopoeia (3)

Suggested Readings:

1. Trease & Evans, (2008), *Pharmacognosy 15th Ed,* Elsevier Publication (India)
2. N. R. Krishnaswamy, (1999), *Chemistry of Natural Products*, Universities Press (India) Pvt. Ltd.
3. Kavanagh Frederick, (1963), *Analytical Microbiology Volume I and II,* Academic Press, London
4. Satoskar et al, (2009) *21st Ed*, *Pharmacology and Pharmacotherapeutics,* Popular Prakashan
5. Lorian.V., (2005), *Antibiotics in laboratory medicine, 5th Ed,* Williams & Wilkins Publication
6. Agarwal S. S. and Paridhavi M., (2007), *Herbal Drug Technology,1st Ed* Universities Press (India) Pvt. Ltd
7. Silverstein R. M., Bassler G. C., (1968), *Spectrometric Identification of Organic Compounds,2nd Ed*.
8. Matham V., (2011), *Essentials of Toxicology*
9. National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). *Methods for dilution antimicrobial susceptibility testing for bacteria that grows aerobically. Approved Standards M7-A4*. Villanova, PA: NCCLS, 1997.
10. National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). *Performance standards for antimicrobial susceptibility testing; 12th information supplement (M100-S1)*. Villanova, PA; NCCLS: 2002

BD-302: Ex-Situ Conservation Methods

Approach:

With increasing anthropogenic disturbances, there is a need to undertake conservation measures. Ex- situ methods of Conservation are used for protecting populations of such fast depleting species. It involves selection of appropriate varieties and their cultivation. One of the most successful modern techniques that supplement traditional plant breeding practices is tissue culture. Higher set of skills and techniques are needed for successful tissue culture and this course intends to inculcate them in the students.

1. Molecular Tools for diversity studies (7)

- Significance of Molecular Tools in Diversity and Conservation Studies
- RFLP, AFLP, TRFLP
- DGGE, TGGE, SSCP
- ISSR

2. Agrobiodiversity and livestock diversity

a. Origin and development (4)

- History of domestication of plant and animal diversity
- Centers of diversity of cultivated plants and captive bred animals

b. Cultivation and breeding techniques (12)

- Recent methods of cultivation /agriculture/animal breeding
- Traditional methods of plant and animal breeding (selection, breeding strategies)
- Case Studies

c. Management of agro-biodiversity (4)

- Documenting information in field and laboratory
- Experimental cultivation and commercial cultivation
- Ex-situ and In-situ conservation centers (e.g. Rice, Wheat, Timber etc.)
- Referencing methods using literature, collection centers, culture collections and databases.

3. Plant tissue culture: (17)

a. Modern methods of plant breeding (selection, hybridization, genetic manipulation)

b. Introduction: Concept of pleuripotency, nutrient media and growth factor requirements, propagation and preservation of plant tissues.

c. Callus culture: Significance and culturing techniques.

d. Regeneration: Shoot regeneration, somatic embryogenesis

e. Types of plant tissue culture:

f. Somatic hybridization

g. Large scale culture of plant cells

h. Transgenic plants: applications of transgenic plants

4. Introduction to (4)

a. Animal tissue culture
b. Transgenic Animals

Suggested Readings:

1. Arun Katyayan,(2011), *Fundamentals of Agriculture, 6th Ed*
2. G. C. Banerjee,(2008), *A Textbook of Animal Husbandary, 8th Ed,* Oxford and IBH Publishing Co., New Delhi
3. Puri et al., (2007), *Agroforestry: Systems and Practices*
4. Rajdhan M. K.,(2003), *Introdction to Plant Tissue Culture, 2nd Ed,* Science Publlishers
5. Bhojwani S. S., Razdan M. K.,(1996) *Revised ed. Plant Tissue Culture: Theory and Practice, Revised Ed,* Elsevier Publication (India)
6. Kalyan Kumar De, (1997) *An Introduction to Plant Tissue Culture,* New Central Book Agency
7. Freshney, (2005), *Culture of Animal Cells, 5th Ed,* Wiley-Liss Publication
8. Ramadass P., (2008), *Animal Biotechnilogy: Recent Concepts and Developments,* MJP Publishers, Chennai

BD – 303: Genomics, Proteomics and Bioinformatics

Approach:

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. On the other hand, natural sources as well as products are often modified to get qualitatively or quantitatively better compounds. This can be done even at molecular level and lead to a greater diversity of compounds The course intends to impart training in the concepts as well as techniques in molecular biology.

a. Introduction to Molecular Biology (8)

- Structure of DNA, RNA and Protein
- Transcription, Translation
- Gene Expression, Structure of Operon

b. Genomics (20)

- Restriction endonulease and DNA modifying enzymes
- PCR, RT PCR, Real Time PCR
- cDNA libraries
- Gene cloning and overexpression: Cloning and expression vectors
- DNA sequencing method: Maxam Gilbert's method, Sanger's Method, Big dye Terminator
- NGS (next generation sequencing) : Pyro sequencing, Solid ,Illumina, Ion Torrent
- Directed Evolution and Error prone PCR
- Applications of RDT

(8)

c. **Proteomics**

- Protein structure-, Ramachandran Plot

- Tools: Isoelectric focusing, PAGE, 2D PAGE, X-ray crystallography, Mass spectrometry & Maldi-Tof, Protein Microarray

d. Bioinformatics: (12)

- Introduction to Bioinformatics,
- Nucleic acid databases, sequence homology, gene finding
- Protein databases, Protein modeling and structure prediction
- Sequence alignment & homology searching- BLAST, ClustalW

Suggested Readings:

1. Sandy Primrose, Richard Twyman, Bob Old (2001), *Principles of Gene Manipulation, 9th Ed*, Blackwell Science Ltd.
2. Strickberger M.,(1996), *Genetics, 3rd Ed*, Prentice-Hall of India Pvt.Ld.
3. Benjamin Lewin. (2008), *Genes IX*, Jones and Bartelett Publishers Inc.
4. James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Loswick (2004) *Molecular Biology of the Gene, 5th Ed*, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.
5. Weaver R., (2007) *Molecular Biology, 4th Edition*, McGrew Hill Science.
6. Khanna P., (2008) *Cell and Molecular Biology*, I.K. International Publishing House Pvt. Ltd.
7. Ausubel et. al, (2002) *Short protocols in Molecular Biology 5th Ed*, Wiley-Liss Publication

BD – 311: Bioprospecting and Bioanalytical Chemistry

1. Isolation of secondary metabolites from a natural source.

2. Methods of extraction :
   Single step and Multi step Extractions; Hot and Cold Extractions,

3. Purification of extracts using separation techniques
   (TLC, Column Chromatography etc.)

4. Spot tests of Secondary metabolites

5. Interpretation of spectroscopy results

6. Screening for antimicrobial compounds from natural sources

7. Random and targeted screening for antibiotics

8. Quantitative assays of antimicrobials.

9. Animal toxicity tests

10. In vitro assays of teratogenicity, mutagenicity and carcinogenicity

BD – 312: Molecular Tools in Biology

1. Isolation of Genomic (bacterial/animal/ plant) and plasmid DNA & Agarose gel electrophoresis.
2. PCR amplification of DNA, Southern blot and RFLP
3. Restriction digestion, ligation and Transformation
4. Isolation of cellular protein, PAGE and Western blotting
5. Gene/ Protein finding from Entrez
6. Visit to a national level Molecular Biology/ Bioinformtics research lab
7. Construction of Evolutionary tree e.g.-beta-lactamases

SEMESTER IV

BD 401: Research Methodology and Scientific Communication

Approach:

Biodiversity management requires contributions from various fields like science, humanities and economics. Hence, it is essential for students of biodiversity, *for that matter any science student,* to look critically at different aspects of the process of the scientific enquiry. The important aspects of this are research methodology and scientific communication. This paper is aimed at introducing key concepts and their logic to *the* masters' level students. The immediate application of the concepts learned during this paper will be student's dissertation project. Hence, hands-on activities based on students's disseration itself will be included while introducing key concepts of this paper.

I. Research Methodology -

A. History and Philosophy of science (8)
   a. History of Science
      i. What is Science?
      ii. Origin of Science
      iii. Trends in Natural Sciences (Physics, Chemistry and Biology)
      iv. Transition from Natural History to Enquiry based study in biology

   b. Philosophy of Science
      i. General introduction to Philosophy of Science
      ii. The differences in discipline specific philosophies (e.g. how philosophy of biology might differ from that of the physics etc, *Organismism*)

B. Phases of Scientific Enquiry (5)
   a. *Problem identification/ beginning of scientific approach.*
   b. Choosing an *appropriate* system/s (Species, Ecosystem, Forest Type etc.)
   c. Design of a study
   d. Data Collection (Questionnaires, Surveys, PBR, PRA/RRA and Literature review)
   e. Data Analysis

C. Types of research methodologies (10)
   a. Observation based
   b. Hypothesis based
   c. Meta-analysis based
   d. Theoretical

D. Sampling (3)
   a. Importance of sampling in research
   b. Role of the study design in the choice of sampling technique
   c. Sampling effort in context of statistical analysis
   d. Limitations of sampling natural systems

E. Research Ethics (4)
   a. Social implications of research
   b. Animal experimentation ethics, wild-life ethics and human experimentation ethics
   c. Data fudging and plagiarism

II. Scientific Communication

A. Theory behind scientific communication (5)
   a. Importance of scientific communication
   b. Types of scientific communications – traditional and modern
   c. Logical organization of scientific data
   d. Ethics in Scientific communication

B. Different modes of scientific communication (13)
   a. Proposal writing
      i. Statement of Purpose (SOP) and Concept note
      ii. Proposal for funding
      iii. Report Writing
   b. Research paper writing
      i. Different types of research articles -Reviews, articles etc.
      ii. Concept of peer reviewing
      iii. Standard components of research communication
   c. Thesis writing
   d. Oral forms of scientific communication
      i. Transformation of written content to oral form
      ii. Poster presentation
      iii. Oral presentations
   e. Scientific journalism (Print/media)
      i. Science issues in public domain (explanation with case studies)

   f. Legal forms of communication of science
      IPR, patents submissions etc.

Suggested readings:

1. Anthony M. Graziano, Michael,L. Raulin, *Research Methods: A Process of Inquiry 6th Ed*
2. Martha Davis (2005) *Scientific Papers and Presentations*
3. Strunk, Jr., W.,White, E.B., (1979) *The Elements of Style, 3rd Ed.,*
4. Yatendra Joshi, *Communicating in Style*
5. P. B. Medawar, *Advice to a young Scientist*
6. Grafen, A. and Ridley, M., (2006) *Richard Dawkins: How a scientist changed the way we think*. Oxford University Press.
7. Dawkins, R. (1998). *Unweaving the Rainbow*,Penguin Publication, London.
8. Medawar, P. B. and Medawar, J. S. (1977). *The Life Science: Current Ideas of Biology,* Wildwood House, London
9. Barrow and Tipler (1988) *The Anthropic Principle,* Oxford University press
10. Bowles, K. L. (1977) *Problem Solving using Pascal,* Berlin: Springer- Verlag.
11. Maynard Smith, J. (1986) *The Problems of Biology,*Oxford: Oxford University Press.

BD 402: Dissertation

Guidelines for dissertation evaluation :

Criteria	Max. Marks
Project Concept / Defining scope of work / Hypothesis generation (at the start of 2nd Semester)	20 *
Project proposal presentation (at the end of 2nd Semester)	10
Presentation at the end of 3rd Semester	20 *
Literature review	25
Inputs of students in development of work plan, ideas, implementation etc.	20
Actual field work / experimentation / data generation	50
Systematic organization of the data, data processing, Data analysis and data interpretation	50
Motivation – punctuality, perseverance, meeting deadlines,	10
Submission of bimonthly progress reports through faculty coordinator	20*
Ability to work with others	5
Communication skill : Oral Written	10 20
Field book or lab diary	20 *
Presentation at National / International Symposia	10
Potential for publication (decided by TAC)	20
Developing independent proposal for funding	10
Evaluation by External referee	80
Total	**400**

* Internal Assessment