

BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY
Department of Zoology
Syllabus of M.Sc. Zoology as per UGC Guidelines on CBCS
Course Structure

Semester – I					
Sl. No.	Paper Code	Paper Title	Type	L+T+P	Total Credits
1.	AS-101	Biosystematics and Taxonomy	Core Course	3+1+0	04
2.	AS-102	Comparative Anatomy of Vertebrates	Core Course	3+1+0	04
3.	AS-103	Sericulture-I(General sericulture, Mulberry Pathology and Silkworm Rearing)	Core Course	3+1+0	04
4.	AS-104	Sericulture-II(Silkworm Pathology, Grainage Management & Post Cocoon Technology)	Core Course	3+1+0	04
5.	AS-105	Laboratory Course	Core Course	0+0+4	04
Any two from following					
1.	AS-106	Population Ecology	Elective Course	2+0+0	02
2.	AS-107	Biodiversity Conservation	Elective Course	2+0+0	02
3.	AS-108	Biochemistry	Elective Course	2+0+0	02
4.	AS-109	Vermiculture and Vermicomposting	Elective Course	2+0+0	02
Compulsory Course					
*	MPDC-105	Remedial Language Course (English/Hindi)	Foundation Course	-	01
Semester – II					
Sl. No.	Paper Code	Paper Title	Type	L+T+P	Total Credits
1.	AS-201	Comparative Animal Physiology	Core Course	3+1+0	04
2.	AS-202	Animal Behaviour	Core Course	3+1+0	04
3.	AS-203	Biology of Parasitism –I(Protozoology & Helminthology-I)	Core Course	3+1+0	04
4.	AS-204	Biology of Parasitism–II(Helminthology – II and Nematology)	Core Course	3+1+0	04
5.	AS-205	Laboratory Course	Core Course	0+0+4	04
Any two from following					
1.	AS-206	Population Genetics and Evolution	Elective Course	2+0+0	02
2.	AS-207	Principles of Parasitology	Elective Course	2+0+0	02
3.	AS-208	Medical and Veterinary Entomology	Elective Course	2+0+0	02
4.	AS-209	Apiculture	Elective Course	2+0+0	02
Compulsory Course					
*	MPDC-205	Moral Studies	Foundation Course	-	01
Semester – III					
Sl. No.	Paper Code	Paper Title	Type	L+T+P	Total Credits
1.	AS-301	Molecular Cell Biology	Core Course	3+1+0	04
2.	AS-302	Wildlife and Conservation Biology	Core Course	3+1+0	04
3.	AS-303	Aquaculture and Fisheries - I	Core Course	3+1+0	04
4.	AS-304	Aquaculture and Fisheries - II	Core Course	3+1+0	04
5.	AS-305	Laboratory Course	Core Course	0+0+4	04
Any two from following					
1.	AS-306	Aquarium Management	Elective Course	2+0+0	02
2.	AS-307	Fish Processing Technology	Elective Course	2+0+0	02
3.	AS-308	Conservation of Exploited Fisheries resources	Elective Course	2+0+0	02
4.	AS-309	Pearl Culture	Elective Course	2+0+0	02
Compulsory Course					
*	MPDC-305	Community Service	Foundation Course	1+0	01
Semester – IV					
Sl. No.	Paper Code	Paper Title	Type	L+T+P	Total Credits
1.	AS-401	Dissertation and Viva-voce	Core Course	2+2+8	12
2.	AS-402	Study Tour/Field Attachment and Viva-voce	Core Course	-	08
Any two from following					
1.	AS-403	Techniques and Tools for Biology	Elective Course	2+0+0	02
2.	AS-404	Biostatistics and Bioinformatics	Elective Course	2+0+0	02
3.	AS-405	Good Laboratory Practices and Research Methodology	Elective Course	2+0+0	02
Compulsory Course					
*	MPDC 405	Ambedkar Studies	Foundation Course	1+0	01

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Scheme of Examination

Semester – I					
Course Code	Course Title	Max Marks		Total Max	
		End Sem	Sessional	Marks	Credit
AS-101	Biosystematics and Taxonomy	70	30	100	4
AS-102	Comparative Anatomy of Vertebrates	70	30	100	4
AS-103	Sericulture-I (General sericulture, Mulberry Pathology and Silkworm Rearing)	70	30	100	4
AS-104	Sericulture-II (Silkworm Pathology, Grainage Management & Post Cocoon Technology)	70	30	100	4
AS-105	Laboratory Course	70	30	100	4
Any two from following					
AS-106	Population Ecology	35	15	50	2
AS-107	Biodiversity Conservation	35	15	50	2
AS-108	Biochemistry	35	15	50	2
AS-109	Vermiculture and Vermicomposting	35	15	50	2
Compulsory Course					
MPDC-105	Remedial Language Course (English/Hindi)			25	1
Semester – II					
Course Code	Course Title	Max Marks		Total Max	
		End Sem	Sessional	Marks	Credit
AS-201	Comparative Animal Physiology	70	30	100	4
AS-202	Animal Behaviour	70	30	100	4
AS-203	Biology of Parasitism –I (Protozoology & Helminthology-I)	70	30	100	4
AS-204	Biology of Parasitism–II (Helminthology – II and Nematology)	70	30	100	4
AS-205	Laboratory Course	70	30	100	4
Any two from following					
AS-206	Population Genetics and Evolution	35	15	50	2
AS-207	Principles of Parasitology	35	15	50	2
AS-208	Medical and Veterinary Entomology	35	15	50	2
AS-209	Apiculture	35	15	50	2
Compulsory Course					
MPDC-205	Moral Studies			25	1
Semester – III					
Course Code	Course Title	Max Marks		Total Max	
		End Sem	Sessional	Marks	Credit
AS-301	Molecular Cell Biology	70	30	100	4
AS-302	Wildlife and Conservation Biology	70	30	100	4
AS-303	Aquaculture and Fisheries - I	70	30	100	4
AS-304	Aquaculture and Fisheries - II	70	30	100	4
AS-305	Laboratory Course	70	30	100	4
Any two from following					
AS-306	Aquarium Management	35	15	50	2
AS-307	Fish Processing Technology	35	15	50	2
AS-308	Conservation of Exploited Fisheries resources	35	15	50	2
AS-309	Pearl Culture	35	15	50	2
Compulsory Course					
MPDC-305	Community Service			25	1

Semester – IV					
Course Code	Course Title	Max Marks		Total Max	
		End Sem	Sessional	Marks	Credit
AS-401	Dissertation and Viva-voce	210	90	300	12
AS-402	Study Tour/Field Attachment and Viva-voce	140	60	200	8
Any two from following					
AS-403	Techniques and Tools for Biology	35	15	50	2
AS-404	Biostatistics and Bioinformatics	35	15	50	2
AS-405	Good Laboratory Practices and Research Methodology	35	15	50	2
Compulsory Course					
MPDC-405	Ambedkar Studies			25	1

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Syllabus of M. Sc. Zoology as per UGC Guidelines on CBCS

The syllabus for M. Sc. Zoology based on semester with credit based pattern comprises of four semesters. The examination shall be of 04 core theory papers, each with 4 credits (4x4=16 credits), 2 elective papers of 2 credits each (2x2=4 credits), 1 laboratory course of 4 credits (1x4=4 credits) and 1 moral/remedial/community service paper of 1 credit (1x1=1 credit). The fourth semester consists of 2 core papers for 12 and 8 credits and 2 elective papers of 2 credits each (2x2=4 credits) and one compulsory paper with 1 credit (1x1=1 credit). Thus, each semester offers 24 credits (4x24=96 credits). Each 4 credit theory paper is equivalent to 100 marks and the laboratory course consists of four modules (i.e. one module from each core paper). The Examination in each theory paper and laboratory course shall be of three hours duration.

Eligibility: Graduate degree with 50% marks (40% SC/ST/PH) in Zoology or any other examination considered to be equivalent will be eligible for admission to M.Sc. Course in Zoology.

Semester –I

Core Courses

AS-101: Biosystematics and Taxonomy

Unit 1

- Definition and basic concepts of biosystematics taxonomy and classification.
- History of Classification
- Trends in biosystematics : Chemotaxonomy, cytotaxonomy and molecular taxonomy
- Dimensions of speciation and taxonomic characters.
- Species concepts: species category, different species concepts, subspecies and other infra-specific categories.
- Theories of biological classification: hierarchy of categories.

Unit 2

- Taxonomic Characters and different kinds.
- Origin of reproductive isolation, biological mechanism of genetic incompatibility.
- Taxonomic procedures: Taxonomic collections, preservation, curation, process of identification.

Unit 3

- Taxonomic keys, different types of keys, their merits and demerits.
- International code of Zoological Nomenclature (ICZN):
- Operative principles, interpretation and application of important rules: Formation of Scientific names of various Taxa.
- Taxonomic categories.

Unit 4

- Evaluation of biodiversity indices.
- Evaluation of Shannon Weiner Index.
- Evaluation of Dominance Index.
- Similarity and Dissimilarity Index.

Suggested Reading Materials (All latest editions):

- M.Kato. The Biology of Biodiversity, Springer.
- J.C. Avise. Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.
- E.O. Wilson. Biodiversity, Academic Press, Washington.
- G.G. Simpson. Principle of animal taxonomy, Oxford IBH Publishing Company.

- E. Mayer. Elements of Taxonomy.
- E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northem& Co.
- B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.

AS-102: Comparative Anatomy of Vertebrates

Unit 1

- Origin of Chordata: Concept of Protochordata
- Development, structure and functions of integument and its derivatives (glands, scales, feathers and hairs)
- Respiratory system: Characters of respiratory tissue, external and internal respiration.
- Comparative account of respiratory organs.
- Comparative account of Digestive System.

Unit 2

- Evolution of heart.
- Evolution of aortic arches and portal systems.
- Blood circulation in various vertebrates groups.
- Comparative account of jaw suspensorium and vertebral column.

Unit 3

- Evolution of urinogenital system in vertebrates.
- Comparative account of organs of olfactory and taste.
- Comparative anatomy of brain and spinal cord (CNS).
- Comparative account of peripheral and autonomous nervous system.

Unit 4

- Comparative account of lateral line system.
- Comparative account of electroreception.
- Flight adaptations in vertebrates.
- Aquatic adaptations in birds and mammals.
- Origin, evolution general organization and affinities of Ostracoderms .
- General organization, specialized, generalized and degenerated characters of Cyclostomes.
- Origin, evolution general organization of early Gnathostomes .
- General account of Elasmobranchi, Holocephali, Dipnoi and Crossoptergii.

Suggested Reading Materials:

- Alexander, R.M. The Chordata. Cambridge University Press, London.
- Barrington, E.J.W. The Biology of Hemichordata and Protochordata. Oliver and Boyd, Edinburgh.
- Bourne, G.H. The structure and functions of nervous tissue. Academic Press, New York.
- Carter, G.S. Structure and habit in vertebrate evolution - Sedgwick and Jackson, London.
- Eccles, J.C. The understanding of the brain. McGraw Hill Co., New York and London.
- Kingsley, J.S. Outlines of Comparative Autonomy of Vertebrates. Central Book Depot, Allahabad.
- Kent, C.G. Comparative anatomy of vertebrates.
- MalcomJollie, Chordata morphology. East-West Press Pvt. Ltd., New Delhi.
- Milton Hilderbrand. Analysis of vertebrate structure. IV. Ed. John Wiley and Sons Inc., New York.
- Monielli, A.A. The chordates. Cambridge University Press, London.
- Smith, H.S. Evolution of chordata structure. Hold Rinehart andWinstoin Inc., New York.
- Sedgwick, A. A Students Text Book of Zoology, Vol.II.
- Tansley, K. Vision in vertebrate. Chapman and Hall Ltd., London.
- Torrey, T.W. Morphogenesis of vertebrates. John Wiley and Sons Inc., New York and London.
- Walters, H.E and Sayles, L.D. Biology of vertebrates. MacMillan & Co., New York.
- Wolstenholnf, EW. and Knight, J. (Ed.). Taste and Smell in vertebrates, J&A Churchill, London.
- Romer, A.S. Vertebrate Body, Illrd Ed. W.B. Saunders Co., Philadelphia.

- Young, J.Z. Life of vertebrates. The Oxford University Press, London.
- Young, J.Z. Life of mammals, Oxford University Press, London.
- Colbert, E.H. Evolution of the vertebrates, John Wiley and Sons Inc., New York.
- Romer, A.S. Vertebrate Paleontology, 3rd Edn. University of Chicago Press, Chicago.
- Clark, W.E. History of the Primates IV Edn. University of Chicago Press, Chicago.
- Weichert, C.K. and Presch, W. Elements of chordate anatomy, 4th Edn. McGraw Hall Book Co., New York.
- Messers, H.M. An introduction of vertebrates anatomy.
- Montagna, W. Comparative anatomy. John Wiley and Sons Inc.
- de Deer, S.G. Embryos and Ancestors. Clarendon Press, Oxford.
- Andrews, S.M. Problems in vertebrate evolution. Academic Press, New York.
- Waterman, A.J. Chordata structure and function. Macmillan Co., New York.
- Joysey, K.A. and T.S. Kemp. Vertebrate evolution. Oliver and Boyd, Edinburgh.
- Lovtrup, S. The phylogeny of vertebrate, John Wiley and Sons, London.
- Barbiur, T. Reptiles and Amphibians: Their habits and adaptations. Hongton Miffin Co., New York.
- Kingsely Noble, G. The biology of the Amphibia. Dover Publications, New York.
- Smyth. Amphibia and their ways. The McMillan Co., New York.
- Andrevos, S.M., Miles, R.S. and Walker, A.D. Problems in vertebrate evolution. Academic Press, New York.

AS-103: Sericulture –I
(General sericulture and Silkworm Rearing)

Unit 1

- Origin and History of Sericulture.
- Silk Industry in India and World.
- Types of mulberry and non-mulb
- erry silkworms.
- Food plants of Non Mulberry Silkworms.

Unit 2

- Origin, distribution and taxonomy of mulberry
- Soil and water management related to Mulberry fields.
- Mulberry plant Nutrient management: Kinds of manures and chemical fertilizers.
- Nursery management.
- Different types of Plantation Patterns in Mulberry.
- Pruning methods and importance for mulberry.
- Mulberry pathology: Diseases and pests of mulberry.
- Weeds in mulberry garden and their management.

Unit 3

- Life cycle of *Bombyxmori*.
- Morphological features of egg, larva, pupa and adult.
- Morphology and Anatomical features of Digestive, Circulatory, Respiratory and Excretory System of Larvae and Adult.
- Morphology and Anatomical Features of Nervous, Glandular, Muscular and Reproductive System of Larva and adult.

Unit 4

- Rearing Plan.
- Rearing and Environment.
- Disinfections and hygiene-principle of disinfection, types of disinfectants, disinfecting methods-preparation of solution-maintenance of hygienic conditions in the rearing house.
- Incubation technology and its requirements.
- Rearing technology for young and late age silkworms

- Leaf Storage and preservation technology for different scales of rearing.
- Cocoon harvest technology.

AS 104- Sericulture-II **(Silkworm Pathology, Grainage Management & Post Cocoon Technology)**

Unit 1

- Disease management, diagnosis of disease in larva, pupa and moth, moth examination, principle and method.
- Microsporidians, classification and biology of microsporidians infecting lepidopterans and silkworm, causal agent, symptoms, mode of transmission, pathogenicity, cross infectivity, alternate host, diagnosis & control method.
- Viral Diseases, in silkworm; Nuclear Polyhedrosis, Cytoplasmic Polyhedrosis, Infectious Flacherie and Densonucleosis, causal agent, symptoms, mode of infection, transmission, multiplication and pathogenicity. Diagnosis of viral diseases, Control.

Unit 2

- Bacterial Diseases, of silkworm, Bacterial diseases of digestive organs, Septicemia and Sototo disease, causal agent, symptoms, mode of infection and pathogenicity, diagnosis of disease, and their control.
- Fungal diseases of silkworm, types of muscardine and aspergillosis; causal agent, mode of infection, symptoms, multiplication and pathogenicity, diagnosis of disease, and their control.
- Silkworm Pests and their Management.

Unit 3

- Silkworm seed organisation, significance of seed organization; Basic seed multiplication centres P4, P3, P2 and P1
- Types of seed - industrial and reproductive seed, loose eggs, sheet eggs.
- Seed Production Process – disinfection methods, sorting, seed cocoon preservation, pupae sexing, emergence of moths, isolation, Pairing and depairing, egg laying, moth examination, surface disinfection, quality control.
- Acid Treatment – hot acid and cold acid, short term chilling and acid treatment, Long term chilling and acid treatment.
- Transportation of eggs, methods of transportation.

Unit 4

- Assessment of cocoon properties, and study of different type of defective cocoons.
- Different types of Cocoon Stifling, Cooking, and Brushing Methods.
- Reeling- definition of reeling, principle involved – direct system and indirect system of reeling & study of different type of Silk reeling machines.
- Silk Re-reeling, purpose, Structure of Re-Reeling Machine.

AS 105 – Laboratory Course

Module – I

- Composition assessment of the taxonomic diversity/biodiversity in a habitat (eg: grass land, arid land, wet land, etc.).
- Influence of climatic conditions on taxonomic diversity in a given habitat.
- Preparation of models showing the status of certain taxa or species in a particular habitat.

Module – II

- Museum specimens and slides
- Protochordates - Salpa-sexual, Salpa-asexual, Botryllus, Herdmania.
- Rhinobatus, Chimaera, Acipenser, Amia, Periophthalmus, Triacanthus, Notopterusnotopterus, Scatophagusargus, Trichurus, Mastacembalusarmatus, Exocoetus (flying fish), Diodonhysterix, Echeneisneucrates.

- Amphibians -Ichthyophis, Geganophis, Rhacophorus, Ranatigrina, Amblystoma. Reptiles -Sitana, Chameleon, Phynosoma, Chelonemydas.
- Birds - Indian Oriole, Indian koel (male), Indian koel (female), Indian tailor bird, Kite, Jungle fowl.
- Mammals - Indian Otter, Marmoset, Loris, Bat (Megadermalyra), Pangolin.
- Skull and lower jaw of Chelonia, Chrocodile, Bird, Carnivoremammal (dog), Herbivore mammal (horse).
- Types of vertebrae of Procoelus, Opisthocoelous, Amphicoelous, Amphiplatian, Heterocoelous, Axis and atlas vertebrae.

Module – III

- Sericulture maps (a) World maps and Silk Road. (b) Sericulture map of India and Uttar Pradesh
- Study of different food plants of mulberry and non-mulberry by preparation of herbarium.
- Preparation of nursery bed.
- Pruning of mulberry plants.
- Soil analysis related to mulberry crop.
- Study of powdery mildew, leaf spot and leaf rust through sectioning, staining and temporary mounting.
- Collection, mounting/preservation of insect pests of mulberry (field work).
- Identification of mulberry pests. Study of nature of damage of the following pests: Leaf roller, Bihar hairy caterpillar, scale insect, mealy bug, thrips, beetles, jassids and grasshoppers.
- Study of different weeds of mulberry garden, their management and herbarium preparation.
- Study of different garden equipments.
- Dissection of the larvae of *Bombyxmori*: Digestive system, Nervous system, excretory system, Respiratory system and Silk Gland. Permanent preparation and study of different parts of larvae: Mouth parts, spiracle and trachea.
- Preparation of different disinfectants and their application.
- Study of different rearing equipments.
- Incubation of silkworm eggs, blackboxing and hatching.
- Brushing, cleaning and chopping of leaves.
- Individual rearing
- Cocoon Harvesting.

Module – IV

- Handling of grainage cocoons.
- Preparation of different types of silkworm eggs.
- Cocoon Assessment.
- Cocoon cooking by open pan and three pans methods.
- Reeling Techniques viz. Improved Charkha, Multi ends reeling machine.
- Re-reeling.

Elective Courses

AS-106: Population Ecology

Unit 1

- Population Growth: Growth of organisms with non-overlapping generations, exponential growth, Verhulst – Pearl logistic growth model.
- Case studies (field and laboratory), Stochastic and time lag models of population growth, stable age distribution, population growth projection using Leslie Matrix

Unit 2

- Competition and Niche Theory: intraspecific and interspecific competition, history of niche concepts, theory of limiting similarity
- Mutualism: Evolution of mutualism, Plant – pollinator and animal – animal interactions basic models

Unit 3

- Population Regulation: Extrinsic and Intrinsic Mechanisms
- Case studies in population dynamics: one or two examples from areas such as fisheries, wildlife, and biological control of agricultural pests.
- Ecological Modeling: Fundamentals of constructing models and testing them

Unit 4

- Life history strategies: Evolution of life history traits, longevity and theories of ageing, energy apportionment between somatic growth and reproduction.
- Parental investment and offspring, reproductive strategies – ecology and evolution of sex and mating systems, optimal body size, r and k selection

Suggested Reading Materials:

- Begon, M., J.L. Harper and C.R. Townsend. Ecology, Individuals, Populations and Communities. Blackwell Science, Oxford, UK.
- Cherrett, J.M. Ecological concepts. Blackwell Sci. Publi. Oxford, UK.
- Elseth, B.D. and K.M. Baumgartner. Population biology. Van Nostrand Co., New York.
- Jorgensen, S.E. Fundamentals of ecological modeling. Elsevier, New York.
- Krebs, C.J. Ecology. Harper & Row, New York.
- Krebs, C.J. Ecological methodology. Harper & Row, New York.
- Ludwig, J.A. and J.F. Reynolds, 1988. Statistical ecology. John Wiley & Sons, New York.
- Pianka, E.R. Evolutionary ecology. Harper & Row, New York.
- Ricklefs, R.E. and G. Miller. Ecology, W.H. Freeman & Co., New York.
- Roughgarden, J., Ecological methods. Southwood, T.R.E.
- Swartzman, G.L. and S.P. Kaluzny. Ecological simulation primer. MacMillan, New York.
- Roff, O.A. The evolution of life histories. Theory and Analysis. Chapman & Hall, London, UK.

AS-107: Biodiversity Conservation

Unit 1

- Concept of Biodiversity introduction, evolution, factors promoting biodiversity, Brief account on the diversity of unicellular & multicellular animal.
- High biodiversity, global biodiversity, biodiversity value, use and importance of biodiversity.

Unit 2

- Cellular and molecular aspects of biodiversity. Rise of biological diversity – photosynthetic prokaryotes, Microbial diversity in soil marine prokaryotic diversity genetic species & ecosystem diversity.
- Terrestrial & aquatic biodiversity.

Unit 3

- Threats to biological diversity, loss of biodiversity & its courses, listing of threatened biodiversity including vulnerable, rare, threatened, endangered & extinct plant & animal species.

Unit 4

- Concept of conservation, conservation values & ethics, inventorisation of biological resources, Action plan of conservation, conservation of rare & endangered species, conservation through network of protected areas, Role of NGO's in conservation activities & conservation & sustainable development.

Suggested Reading Materials:

- Hickman C.P.Jr., F.M. Hickman and L.S. Roberts, Integrated Principles of Zoology, Mosby College Publication. St.Louis.
- Ayyar, E.K. and T.N. Ananthakrishnan, Manual of Zoology, Vol. I (Invertebrata), Parts I & II. S. Viswanathan (Printers and Publishers) Pvt. Ltd., Madras.

- Ayyar, E.K. and T.N. Ananthkrishnan, Manual of Zoology, VoLII (Chordata), S. Viswanathan (Printers and Publishers) Pvt. Ltd., Madras.
- Jordan, E.L. and P.S. Verma, Invertebrate Zoology, S. Chand & Co. Ltd., Ram Nagar, New Delhi.
- Jordan, E.L. and P.S. Verma, Chordate Zoology and Elements of Animal Physiology, S. Chand & Co. Ltd., Ram Nagar, New Delhi.
- Nigam, H.C., Zoology of Chordates, Vishal Publications, Jalandhar - 144008.
- Parker and Haswell, Text Book of Zoology, Vol.I, (Invertebrata), A.Z.T.B.S. Publishers and Distributors, New Delhi - 110 051.
- Parker and Haswell, Text Book of Zoology, VoLII (Chordata), A.Z.T.B.S. Publishers and Distributors, New Delhi - 110051.
- Waterman, Allyn J. et.al., Chordate Structure and Function, Mac Millan & Co., New York.
- Ismail, S.A., Vermiculture: The Biology of Earthworms, Orient Longman, India.

AS-108: Biochemistry

Unit 1

- Scope of biochemistry: Biological processes of living systems. Water and its functions
- Dissolved gases and their properties. pH, buffer, acids and bases.
- Bioenergetics - Laws of thermodynamics and its relevance to biological systems. High-energy phosphate bonds and its role in energy capture and transfer

Unit 2

- Proteins – Biomedical importance. Structure and functions of proteins. Amino acid structure and properties. Primary and higher orders of protein. Protein folding. Nitrogenase system.
- Enzymes - Classification and general properties. Kinetics. Mechanisms of enzyme action (chymotrypsin). Regulation of enzyme activities.
- Lipids - Lipids of physiologic significance, membrane lipids, cholesterol. Synthesis and Oxidation of fatty acids. Ketogenesis

Unit 4

- Carbohydrates- Carbohydrates of physiologic significance. Metabolism. Glycolysis & Krebs cycle: Pathway & regulation. Oxidative metabolism: electron transport chain, oxidative phosphorylation. Gluconeogenesis. Hexose monophosphate Shunt.
- Minerals: Classifications, properties and biological significance.
- Vitamins: Classifications, properties and biological significance.

Suggested Reading Materials:

- Stryer, L: Biochemistry (Freeman)
- Conn et al: Outlines of Biochemistry (Wiley)
- Watson, J.D. et al: Molecular Biology of the Gene (Benzamin/Cummings)

AS-109 Vermiculture And Vermicomposting

Unit 1

- Vermiculture: Definition, scope and importance; Local and exotic species for culture; Environmental requirements; Culture methods; wormery, breeding techniques; indoor and outdoor cultures, monoculture and polyculture.

Unit 2

- Earthworms : Taxonomic position and diversity; Types: Morphological and ecological grouping; Epigeic, Anecic and Endogeic species; Ecological role and economic importance of earthworms.

Unit 3

- Marketing the products of Vermiculture: Quality control, market research; marketing techniques, creating the demand by awareness and demonstration, advertisements, packaging and transport.

Future perspectives: Predator/pathogen control in wormeries; Potentials and constraints for vermiculture in India.

Unit 4

- Practical:
 - a) *Internal and External Anatomy*
 - b) *Identification of species on the basis of Vermicast.*
 - c) *Preparation of pit*
 - d) *Preparation of sludge*
 - e) *Elements of Media (soil, moisture, humidity)*

Suggested Reading Materials:

- Edwards CA, Hendrix P and Arancon N (2014) *Biology and Ecology of Earthworms*, Springer Publishers.
- Karaca A (2011) *Soil Biology: Biology of Earthworms*. Springer Publishers.
- Edwards CA, Arancon NQ and Sherman RL (2011) *Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management*, CRC Press, USA.
- Ranganathan LS (2006) *Vermibiotechnology– From Soil Health to Human Health*. Agrobios, India.
- Ismail SA (2005) *The Earthworm Book*. Edition, Other India Press, Apusa, Goa, India.
- Ismail SA (1997) *Vermicology: The Biology of Earthworms*. Orient Longman, India.

MPDC-105: Remedial Language Course (English/Hindi)

Semester -II

Core Courses

AS-201: Comparative Animal Physiology

Unit 1

- Principles of Animal Physiology-Idea of mechanistic and Evolutionary physiology. Homeostasis in different forms.
- Size and Scale of organisms-Size and Surface area to volume ratio. Metabolic scope (Scaling relationship) between BMR and Body mass. Metabolic rates as a function of body mass in mammals and arthropods. Metabolic rate as a function of animal locomotor speed in locust and migratory butterfly, rainbow trouts, and speedy cheetah.

Unit 2

- Thermal Physiology- Heat Transfer between animal and environment. Poikilothermy and Homeothermy. Physiological adjustments in extreme environmental conditions.
- Sensory Physiology-Lateral Inhibition and enhanced edge effect in invertebrates under different Illumination. Receptor system and sensory perception in phytophagous insects. Phototransduction in compound and vertebrate eye.

Unit 3

- Physiology of Excretion- Physiology of ultrafiltration, Reabsorption, tubular secretion. Counter current theory of urine concentration, Regulation of urine formation. Method of Urine formation, Nitrogenous wastes. Renal regulation of acid-base balance.
- Physiology of blood and body fluids -Comparative structure of cells in circulation of invertebrate and vertebrates. Composition of blood, Plasma and blood Corpuscles, in vertebrates, Functions. Haemopoiesis.

Unit 4

- Physiology of Respiration- Respiratory pigments in animals. Physiology of aerial and aquatic respiration in invertebrates and vertebrate examples. Respiratory adaptations in animals living in O₂ deficient environment.
- Physiology of behavior- Pheromones in colonial interactions, foraging and mating. Allelochemicals in plant-Insect interaction. Chemotaxis.

Suggested Reading Materials:

- Conn, Stumpi RK, Bruening and Doc: Outlines of Biochemistry (Wiley)
- Ganong: Review of Medical Physiology (Lange)
- Eckert, R: Animal Physiology (W.H. Freeman).

AS-202: Animal Behaviour

Unit 1

- Behaviour: Definition - Innate behaviour, learning, reasoning, motivation, conflict and sexual behaviour.
- Migration and homing with special reference to birds.
- Communication in animals: Visual, olfactory, auditory and tactile.
- Camouflage and Mimicry – types of mimicry

Unit 2

- Ecological Aspects of Behaviour: Habitat selection, food selection and optimal foraging theory, anti-predator defense mechanisms, aggression, territoriality and dispersal.
- Social Behaviour: Aggregations – Schooling in fishes, flocking in birds, herding in mammals; group selection, kin selection, altruism, inclusive fitness, and social organization in insects and primates.

Unit 3

- Reproductive Behaviour: Evolution of sex, reproductive strategies, mating systems, courtship, sperm competition, sexual selection and parental care.
- Hormones and behaviour, pheromones and behaviour.

Unit 4

- Biological rhythms: Circadian, circannual, tidal/lunar, ultradian, infradian rhythms, synchronization of biological rhythms, phase shift.
- Photoperiodism with reference to birds and mammals - human circadian rhythms.

Suggested Reading Materials:

- Drickamer&Vessey: Animal Behaviour, Concepts, Processes and Methods (Wadsworth)
- Grier: Bi~logy of Animal Behaviour (Mosby College)
- Immelmann: Introduction to Ethology (Plenum Press)
- Lorenz: The Foundation of Ethology (Springer-Verlag)
- Manning: An Introduction to Animal Behaviour (Addison - Wesley)
- McFarland: Animal Behaviour, Psychology, Ethology and Evolution (Pitman)
- Price & Stoker: Animal behaviour in laboratory and field (Freeman)
- Wood-Gush: Elements of Ethology (Chapman and Hall)

AS-203: Biology of Parasitism – I (Protozoology & Helminthology-1)

Unit 1

- General features and Classification of parasitic Sarcomastigophora and Ciliphora.
- General organization, life cycle and pathogenesis of following parasites:
 - a) Amoebae-*Entamoebahistolytica*, *Naegleriafowleri*, *Acanthamoeba*.
 - b) Intestinal and genital flagellates- *Giardia lamblia*, *Trichomonasvaginalis*,
 - c) Blood and tissue flagellates-*Trypanosoma*, *Leishmania*.

Unit 2

- General Features and Classification of Apicomplexa
- General organization, life cycle and pathogenesis of following parasites:
 - a) *Plasmodium spp.*
 - b) *Toxoplasma gondii*
 - c) *Cryptosporidium parvum*,
 - d) *Cyclosporacayetanensis*

Unit 3

- General organization and classification of Phylum Platyhelminthes.
- Monogenea: General organization, Morphology, life history and economic importance of following parasites:
 - a) *Gyrodactylus*

- b) *Polystoma*
- c) *Diplozoon*
- Aspidobothria: General organization and classification of Aspidobothria
- General organization, Morphology, life history and economic importance of *Aspidogasterconchicola*

Unit 4

- Digenea: General morphology, Functional anatomy of Male and Female reproductive system. Egg formation and types of eggs. Larval forms and types of cercariae.
- General organization, life cycle and pathogenesis of following parasites:
 - a) *Fasciola hepatica*
 - b) *Fasciolopsisbuski*
 - c) *Schistosomamansoni*, *Scistosomajaponicum* and *Schistosomahaematobium*
 - d) *Clonorchissinensis*
 - e) *Paragonimuswetermani*.

AS 204 – Biology of Parasitism - II (Helminthology-2 and Nematology)

Unit 1

- General organization of Cestodes and its classification upto order level.
- Cestodaria: Structural organization and life cycle of *Amphilina*, *Gyrocotyle*
- Cestoda: General morphology, Ultrastructure of tegument, Hold fast organs. Functional anatomy of Male and Female reproductive system and larval forms.

Unit 2

- General organization, life cycle and pathogenesis of following parasites:
 - a) *TaeniaSolium*
 - b) *Echinococcusgranulosus*
 - c) *Diphyllobothriumlatum*
 - d) *Hymenolepis nana*
 - e) *Dipylidiumcaninum*
- Acanthocephala: General organisation and classification of the groups. Morphology and life cycle of *Moniliformisdubius*

Unit 3

- Classification of parasitic nematodes, Diagnostic features of various orders, super families and families.
- General morphology and anatomy: Body wall, Ultra structure of Cuticle, Cuticular specializations, Chemical Composition.
- Digestive system, Feeding and Nutrition in Nematodes.
- Excretory System, Nervous System and sense organs.

Unit 4

- Functional anatomy of reproductive system of Nematodes.
- Nematode egg, oviposition, Development, Hatching, Moulting, Larval forms with special reference to pathogenicity.
- Morphology, Life-cycle and Pathogenesis of following parasites:
 - a) *Ancylostomaduodenale*
 - b) *Wuchereriabancrofti*
 - c) *Dracunculusmedinensis*

- d) *Trichinellaspiralis*,
- e) *Strongyloidesstercoralis*.
- f) *Enterobiusvermicularis*.

AS 205: Laboratory Course

Module – I

- Haemoglobin estimation
- Blood cell count - haemocytometer
- Blood coagulation experiments
- Qualitative tests for sugars, proteins, lipids

Module – II

- Sleep - wake rhythm of human.
- Activity - rest budget of ungulates.
- Population estimation: Diversity, abundance, density, species richness and composition of birds.
- Habituation in earthworms.
- Study of individual patterns of behaviour, Study of social patterns of behaviour
- Interspecific association - cattle and egrets
- Flocking behaviour in pigeons.
- Film shows on animal behaviour.

Module – III

- Examination of locally available different hosts animal hosts (Poultry, sheep, goat, Cattles, Fishes.) for collection, preservation, mounting and identification of protozoan parasites and trematodes
- Study of permanent mount specimens of protozoan parasites
- Collection, Preparation and identification of protozoan/Trematode parasites
- Study of permanent mount specimens of Trematode parasites
- Microscopical examination of blood smears for protozoan parasites and isolation and identification of protozoan cysts and eggs of Helminth parasites from faecal samples.

Module – IV

- General principles of Collection, Preservation, Staining and Mounting of Cestodes and animal parasitic nematodes.
- Examination of locally available different animal hosts (Poultry, sheep, goat, Cattles, Fishes.) for collection, preservation, and identification of different helminth parasites.
- Study of permanent slides of cestodes and animal parasitic nematodes
- Microscopical Examination of blood smears for microfilariae.
- Examination of faecal samples for the cestode and nematode eggs.

Elective Courses

AS-206: Population Genetics and Evolution

Unit 1

- Concepts of Evolution and theories of organic evolution with an emphasis on Darwinism.
- Neo-Darwinism: Hardy-Weinberg law of genetic equilibrium, detailed account of destabilizing forces, natural selection, mutation, genetic drift, migration, meiotic drive.
- Quantifying genetic variability: Genetic structure of natural populations, phenotypic variation, models explaining changes in genetic structure of populations, factors affecting human disease frequency.

Unit 2

- Genetics of quantitative traits in populations: Analysis of quantitative traits, quantitative traits and natural selection, estimation or heritability, genotype environmental interactions, inbreeding depression and heterosis, molecular analysis of quantitative traits, phenotypic plasticity.
- Genetics of speciation: phylogenetic and biological concept of species, patterns and mechanisms of reproductive isolation, models of speciation (allopatric, sympatric, parapatric).

Unit 3

- Molecular Evolution: Gene evolution, evolution of gene families, molecular drive, assessment of molecular variation.
- Origin and evolution of economically important microbes and animals.
- Population and genetics and ecology: Metapopulations, monitoring natural populations, why small populations become extinct, loss of genetic variations, conservation of genetic resources in diverse taxa.

Unit 4

- Different types of evolution, evolutionary trends in animals, theories of evolution including modern synthetic theory, laws of evolutions, evolution of horse, elephant and man.
- Biogenetic law, evidences of organic evolution, mutation including modern concept, genetic drift.

Suggested Reading Materials:

- Dobzhansky, Th. Genetics and Origin of Species. Columbia University Press.
- Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.M. Valentine. Evolution. Surjeet Publication, Delhi.
- Futuyama, D.J. Evolutionary Biology, Sinauer Associates, INC Publishers, Sunderland.
- Hartl, D.L. A Primer of Population Genetics. Sinauer Associates, Inc, Massachusetts.
- Jha, A.P. Genes and Evolution. John Publication, New Delhi.
- King, M. Species Evolution-The role of chromosomal change. The Cambridge University Press, Cambridge.
- Merrel, D.J. Evolution and Genetics. Holt, Rinehart and Winston, Inc.
- Smith, J.M. Evolutionary Genetics. Oxford University Press, New York.
- Strickberger, M.W. Evolution. Jones and Bartlett Publishers, Boston London.

AS-207: Principles of Parasitology

Unit 1

- Nature of parasitism, Scope of the subject, definitions and concept of parasitism and parasites. Animal associations. Hyper-parasitism. Origin of parasite. Modes of parasitic invasion and escape.

Unit 2

- Consequences of parasitism: Parasitic adaptations (morphological, anatomical, embryonic and larval). Various types of life histories of parasites. Origin of imermediate hosts and paratenic hosts.

Unit 3

- Factors influencing parasitic fauna: Influence of age of the host on parasite fauna; Food of the host and its mode of life. Migration of the hosts, Effects of geographical distribution on parasitic fauna. Influence of human activity on parasite.

Unit 4

- Host-parasite relationship: Influence of parasites on host. Mechanical action; Withdrawal of substances necessary for the normal metabolism of the host. Effects of the parasites on the host. Host's reaction to parasite. Host specificity.

AS-208: Medical and Veterinary Entomology

Unit 1

- Introduction to medical entomology. General features, life cycle patterns and classification of Diptera. Morphological peculiarities, life cycle and disease relationship of mosquitoes belonging to family Culicidae of Orthorrhapha.

Unit 2

- Morphology, life cycle and disease relationship of *Phlebotomus*, *Simulium* and *Tabanus* of suborder Orthorrhapha. Brief account of non blood sucking flies of suborder Cyclorrhapha (i.e. Eye flies, blow flies and flesh flies). Flies as mechanical vector of disease. Different types of Myiasis.

Unit 3

- Morphology, life cycle and disease relationship of Cyclorrhapha blood sucking flies (i.e. *Stomoxys*, *Glossina* and *Phippobosca*). Morphology of Lice, Bugs and fleas and their disease relationship.

Unit 4

- General account of Acarina. Morphology, life cycle and disease relationship of different genera belonging to the families Ixodidae and the Argasidae. Brief account of Mites (*Trombicula*, *Dermanyssus*, *Liponyssus*, *Pediculoides*, *Tyroglyphus*, *Sarcoptes*) and their disease relations.

AS-209 Apiculture

Unit 1

- History, Classification and Biology of Honey Bees, Social Organization of Bee Colony.

Unit 2

- Rearing of Bees, Artificial Bee rearing (Apiary) and appliances, Beehives – Newton and Langstroth, Bee Pasturage, Selection of Bee Species for Apiculture, Bee Keeping Equipment, Methods of Extraction of Honey (Indigenous and Modern)

Unit 3

- Diseases (Galleria and Mites) and Enemies, Control and Preventive measures, Conservation of Honey Bees.

Unit 4

- Practical:
 - f) *Preparation of honey bee boxes*
 - g) *Extraction of honey and venom*
 - h) *Purification of honey*
 - i) *Sting Apparatus of honey bee*
 - j) *Identification of components of life cycle of honey bee (Social Organization-larva, worker, drone, queen)*
 - k) *Mouth Parts*
 - l) *Pollen Basket preparation*
 - m) *Extraction of Galleria and mites*

Suggested Reading Materials:

- Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
- Bisht D.S., Apiculture, ICAR Publication.
- Singh S., Beekeeping in India, Indian council of Agricultural Research, NewDelhi.

MPDC-205: Moral Studies

Semester -III

Core Courses

AS – 301: Molecular Cell Biology

Unit 1

Nuclear Compartment:

- Nucleus – EM Structure.
- Nuclear envelope – structure & function.
- Chromosomes – Packaging of genome, chromosome structure, genetic maps, nucleolus.
- Information networks – Internet, HTTP, HTML URLs, E M B net, NCBI, Japan net. Protein information – databases.
- Genovne information – databases also).

Unit 2

Secretary Pathway:

- ER-structure (SER, RER), transport.
- Ribosomes, polysomes, free ribosomes, membrane associated ribosomes & secretary pathway.
- Vesicles involved in intracellular transport.
- Assembly of cell organelles.

Unit 3

Cellular respiration & degradation:

- Mitochondria structure, assembly components.
- Peroxisomes – structure and functions.
- Endosomes – late and early – structure, formation, assembly components.
- Lysosomes – structure & polymorphism.
- Proteosomes – types structures, assembly & functions.

Unit 4

Cell cycle division and signal transduction:

- Cell cycle – cyclines&cyclin dependent kinases & check points.
- Cytoskeleton & intracellular movement – microtubule, MTO C.
- Micro filaments & intermediate filaments.
- Meiosis.
- Mitosis – role of mitotic apparatus in cell division.
- Signal transduction. Receptor mediated.
- G proteins (adenylcyclase& ion channels phospholipasec).
- Non-receptor mediated.

Suggested Reading Materials:

- Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc., USA.
- Molecular Biology of the Cell, B.Alberts, D. Bray, J. Lewis, M. Raft, K. Roberts, and J.D. Watson. Garland Publishing Inc., New York.

- Molecular Biology of the Gene, J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. The Benjamin/Cummings PUB. Co., Inc., California.
- Gene VI, Benjamin Lewin, Oxford University Press, U.K.
- Molecular Biology and Biotechnology. A comprehensive desk reference, R.A. Meyers (Ed.), VCH Publishers, Inc., New York.
- Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York.
- Introduction to Practical Molecular Biology, P.O. Dabre, John Wiley & Sons Ltd., New York.
- Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford.

AS-302: Wildlife and Conservation Biology

Unit 1

- Wildlife in India- Wildlife wealth of India & threatened wildlife. Reasons for wildlife depletion in India. Wildlife conservation approaches and limitations. National and State mammals and birds of India.
- Wild life Habitat- Characteristic, Fauna and Adaptation with special reference to Tropical forest. Protected Area concept: National Parks, Sanctuaries and Biosphere Reserves, cores and Buffers, Nodes and corridors. Community Reserve and conservation Reserves

Unit 2

- Management of Wildlife- Red Data Book and Conservation status (endangered, vulnerable, rare, threatened and near threatened species)-definitions. Distribution, status. Habitat utilization pattern, threats to survival of Slender Loris, Musk deer, Great Indian Bustard, Olive Ridley turtle.
- Wild life Trade & legislation- Assessment, documentation, Prevention of trade. Policies and laws in Wild life management (national) and ethics.

Unit 3

- Biodiversity extinction and conservation approaches- Perspectives and Expressions. Identification and prioritization of Ecologically sensitive area (ESA). Coarse filter and fine filter approaches. Regional and National approaches for biodiversity conservation.
- Theory and analysis of Conservation of populations- Stochastic perturbations - Environmental, Demographic, spatial and genetic stochasticity. Population viability analysis- conceptual foundation, uses of PVA models. Management Decisions for small populations using PVA models. Minimum viable populations & recovery strategies for threatened species

Unit 4

- National and International efforts for conservation- Information on CITES, IUCN, CBD International agreements for conserving marine life. Convention on wetlands of International Importance (Ramsar convention). Important projects for the conservation of endangered species in India.
- Conservation of Natural Resources- Resources: Types and Degradations. Human impact on Terrestrial and Aquatic resources. Conservation of invertebrates with special reference to corals and butterflies. Overview of conservation of Forest & Grassland resources

Suggested Reading Materials:

- M.Kato. The Biology of Biodiversity, Springer.
- J.C. Avise. Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.
- E.O. Wilson. Biodiversity, Academic Press, Washington.

- G.G. Simpson. Principle of animal taxonomy, Oxford IBH Publishing Company.
- E. Mayer. Elements of Taxonomy.
- E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northem& Co.
- B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.

AS-303: Aquaculture and Fisheries I (General Aquaculture)

Unit 1

- Present Scenario and Problems: Trend in Global & Indian Aquaculture
- Environmental issues related to Aquaculture
- Strategies for Sustainability of Aquaculture
- Economic viability

Unit 2

- Soil and water interaction: Physical and Chemical Properties of soil and water, productivity vs nutrient quality & quantity of soil and water
- Micro Organisms of soil, their role and impact on aquatic habitats and species
- Soil and water quality monitoring and management

Unit 3

- Fish nutrition
- Nutritional biochemistry
- Role of nutrients
- Nutritional biogenetics
- Nutritional Physiology and Pathology
- Feed resources and manufacture

Unit 4

- Basics of Fish Health and Management
- Defense system in Fishes
- Parasitic and mycotic diseases
- Infectious bacterial and viral diseases
- Non Infectious diseases
- Techniques in health management

AS-304: Aquaculture & Fisheries- II (Seed Production, Hatchery Management & Aquaculture Techniques)

Unit 1

- Introduction; History, Constraints and current status of natural seed collection and hatchery seed production.
- Reproductive biology.
- Gamete Maturation & development.
- Environmental & endocrine control of reproduction.
- Induced Spawning.
- Brood stock management.
- Hatchery technology, design & Management.

Unit 2

- Aquarium Fish trade.
- Aquarium Keeping.
- Value addition.
- Pearl production.
- Bait fish culture.

Unit 3

- Introduction to Coastal aquaculture.
- Different farming systems of coastal aquaculture.
- Important cultivable finfishes.
- Culture of marine molluscs & echinoderms.

Unit 4

- Introduction to fresh water aquaculture.
- Aquaculture Systems.
- Fish Farming.
- Fresh Water Prawn farming.
- Integrated farming Systems.
- Waste water treated aquaculture.

AS – 305: Laboratory Course

Module – I

- Cell structure: prokaryotic and eukaryotic cell types with the operation of light microscope, phase contrast and polarising microscopes: Care and maintenance of the microscopes.
- Phase contrast microscopy-setting, measurements of refractive index, measurement of nuclear and cytoplasmic volume.
- Separation and isolation of cells by sedimentation velocity in unit gravity.
- Study of subcellular organelles: methods of disrupting cells.
- Isolation and identification of subcellular components of rat liver: Isolation of nuclei of rat liver hepatocytes.
- Isolation of mitochondria by differential centrifugation and identification of succinic dehydrogenase in the mitochondrial pellet.
- Isolation and estimation of DNA from rat liver hepatocytes.
- Agarose gel electrophoresis, staining and identification of nucleic acids.
- Chromosome segregation in mitosis and meiosis. Preparation of chromosome squashes from grasshopper/cockroach testes for the observation of the stages of meiosis.

Module – II

- Field work to understand basic ecological concepts.
- Survey of aquatic birds
- Scat analysis of predators
- Prey and predators relationships
- Laboratory experiments wherever possible.

Module – III

- Visit to conventional aquafarm to see the management of used water; Survey on environmental impact nearby aquaculture farms; Setting model for sustainable aquaculture(organic farm, integrated farm);Applications of remote sensing and GIS(Geographical Information System);Economic evaluation of Aquaculture practices.
- Equipment used in soil and water analysis; Soil sampling and determination of soil moisture and bulk density; pond filling, analyses of mud acidity and soil texture; Measurement of Temperature, pH, conductivity, salinity, transparency, turbidity and solids; Analysis of dissolved oxygen, alkalinity and hardness, phosphorus and nitrogen.
- Formulation and preparation of balanced fish feed; Feeding Trials; Estimation of protein and lipid quality; preparation of feeding table.
- General procedures for disease diagnosis; Taxonomy and identification of fish parasites; Sampling and Preparation of media and culture of pathogenic bacteria; Techniques of bacterial classification; Histological techniques for disease diagnosis; molecular and immunological techniques; Biochemical tests; PCR; ELISA; Agglutination test; Challenge tests; Purification of Virus; Stress related study of fish and shellfish; Disease treatments.

Module – IV

- Study of gonadal development in carps and other cultivable finfishes; Identification of carp and catfish seed; Collection and identification of cultivable brackish water finfish seed; Packing and transportation of cultivable finfish seed; Induced breeding of fishes through various inducing agents; Evaluation of carp milt and egg; Design and operation of Chinese hatchery; Preparation of brood and larval feed for different cultivable finfish; Rearing of carp spawn and fry; Visit to different finfish hatcheries.
- Identification of common freshwater aquarium fishes and breeding trials of selected freshwater fishes; Identification of common brackish water and marine aquarium fishes; Aquarium fabrication, setting and maintenance; Preparation of powdered and pelleted feed for ornamental fishes; Visit to ornamental fish farms; Study of bacterial, viral, fungal diseases of ornamental fishes and their control; Prophylactic and quarantine measures; Nuclei implantation in pearl oyster; Identification ornamental aquatic plants.
- Identification of cultivable marine and brackishwater finfish and shellfish; Identification of cultivable seaweeds; Designing of different farming systems- cages, pens, rafts and racks; Visit to coastal aquafarms.
- Identification of commercially important cultivable fish and prawn species; Assessment of seed quality- stress test; Calculating carrying capacity of pond and stocking density; Check tray assessment and feed ration calculation; Sampling procedure and growth assessment; Lime and fertilizer requirement calculation; Modeling of different culture system.

Elective Courses

AS-306: Aquarium Management

Unit 1

- Ornamental fishes: taxonomy, general and identifying character of Fresh water ornamental fish:Catfish,Cichlids,Cyprinids,Live-bearers, Loaches,Neotropical electric fish,Pufferfish,Rainbowfish ,Spiny eels,cypriniforms.
- Marine water ornamental fish:Angelfish, Butterfly fish ,Damsels,Dartfish,Dragonets, Eels, Flatfish, Gobies, Lionfish, Parrotfish, Pipefish, Pseudochromis, Rabbitfish, Rays, Scorpionfish, Seahorse, Squirrelfish, Sharks , Snappers, Tangs, Tilefish, Triggerfish, Wrasse.

Unit 2

- Aquarium types, Infrastructure: filters, heater, refugium, calcium reactor, feed pump, bog-wood, driftwood, air-stone, live rock, substrate, fish-cam, fish feeder, lighting, other accessories.
- Food and feeding, management, Coloration and Pigmentation: category; types; formation; dietary, neuronal, hormonal control. Uses and functions; morphology and physiology of color changes and its significance

Unit 3

- Culture: Gonads (ovary, testis) morphology, histology and physiology, Endocrine and environmental control over gonadal cycle, Reproduction, fertilization, Different developmental stages

Unit 4

- Diseases and treatment: Ectoparasite, endoparasites: protozoan, helminth, arthropods, bacterial, fungal, viral parasites, their symptoms, pathogenicity, treatments and prophylaxis

AS-307: Fish Processing Technology

Unit 1

- Fishing crafts; Principles of design and construction; Corrosion protection; Craft, materials - wood, marine plywood, fibreglass, reinforced plastic, aluminium, steel, ferro-cement; Bio-deterioration and preventive measures; Different types of fishing vessels in India; General arrangements of fishing vessels; Modern navigation equipment, navigation and fishing lights; Life saving devices

Unit 2

- Principles of fish preservation; Preservation of fish, sanitary requirements for maintenance of quality, processing ways of fish, Fish trade and its component,

Unit 3

- Fish craft as secondary earning of the fish trade person. Secondary utilization of fishery waste, as organic fertilizer, composition of fish waste in agriculture benefits, decorative piece as fish crafts, useful conversion of fish waste, different ways and their techniques.

Unit 4

- Economic importance of fish, it's by products and application, their processing ways, Fish market as a big trade, understanding of fish trade, employment types linked with fish trade, gender role in fish trade.

AS-308: Conservation of Exploited Fisheries resources

Unit 1

- Major fisheries resources, Aquaculture: fish, shellfish and molluscs , Target and non-target, Distribution, composition, trends and dynamics of major exploited fishery resources in hill streams, rivers, reservoirs, lakes, lagoons, estuaries, territorial waters, oceanic waters, deep sea oceanic islands; Straddling/shared stocks and non-conventional resources; Sports, game and ornamental fisheries; Major commercially exploited stocks, their potentials, status, bionomics, methods of capture and yields;

Unit 2

- Issues related to capture fisheries; Fish Stock Assessment, Endangered and threatened species, *in-situ* and *ex-situ* conservation; genetic conservation, Fisheries and Biodiversity Acts; Juvenile fishing, destructive gears, by-catch and discards; Status and impact of exotic species, accidental introductions; Guidelines and policies for exotics.

Unit 3

- Reasons of over exploitation and results, reasons of extinction of fish species and results, importance of fishery resources, Markets and trade policy, Biodiversity and Conservation, Present trend of dwindling fisheries resources, direct and Indirect effects of human intervention in rivers, habitat modification and improvement (rehabilitation of channels and flood plains),

Unit 4

- Limitation of the environmental impact of fishing, **objectives for sustainable, exploitation of stocks, technical measures** to promote more selective fishing , type of vessels authorised to fish; limiting fishing effort;**recovery plans for stocks, Decision-making and consultation**, protection and restoration of fish movements (different types of fish passes and enhancement of fish migration), management and repair of riverine vegetation, stock enhancement strategies like introduction of new species, pre- and post- stocking management, potential risk of stocking

AS-309 Pearl Culture

Unit 1

- Histology of mantle. Natural and Artificial Process of Pearl formation. Chemical composition of Pearls. Present status, prospects of pearl industry in India.

Unit 2

- Biology of Pearl oyster: Pearl producing molluscs. Morphology and anatomy of Pearl oyster, Life cycle of pearl oyster.

Unit 3

- Problems of Pearl Industry; Diseases and Predators of Pearl oysters, Economic importance of pearls.

Unit 3

- Practical:
 - a) *Identification of freshwater Pearl Oyster*
 - b) *Water quality analysis (DO, Hardness, Nitrate, Nitrite, Sulphate, Chloride, pH, Alkalinity, Acidity, TDS)*
 - c) *Internal Anatomy of Pearl Oyster*
 - d) *Graft Tissue Preparation, Nucleus Insertion*
 - e) *Harvesting and clearing of Pearl*

Suggested Reading Materials:

- Thomas PC, Rath SC & Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ.
- Southgate P. and Lucas J. 2008. The Pearl Oyster 1st Edition. Elsevier Science.
- Economic Zoology. K.S.Mishra

MPDC – 305: Community Service

Semester –IV

Core course

AS-401: Dissertation and Viva-voce

AS-402: Study Tour/Field Attachment and Viva-voce

Elective Courses

AS-403 Techniques and Tools for Biology

Unit: 1

- Principles and uses of analytical instruments: pH meter, colorimeter, UV-Visible spectrophotometer, ultracentrifuge, densitometer, spectrofluorometer, chemiluminometers, radioactivity counters, differential scanning calorimeter, HPLC, and NMR spectrometers.

Unit: 2

- Microscopy: principle of light transmission, electron, phase-contrast, fluorescence, confocal, scanning electron microscopes. Microphotography and image analyzers.
- Microbiological techniques: media preparation and sterilization, inoculation and growth monitoring, use of fermenters, biochemical mutants and their uses, and microbial assays.

Unit: 3

- Cell culture techniques: design and functioning of tissue culture laboratory, cell proliferation measurements, cell viability testing, culture media preparation and cell harvesting methods.
- Cryotechniques: cryopreservation for cells, tissue, organisms, cryotechniques for microscopy, freeze-drying for physiologically active substances.

Unit: 4

- Separation techniques in biology: thin layer chromatography, electrophoresis, and centrifugation and density gradient centrifugation.
- Radioisotope and mass isotope techniques in biology: sample preparation for radioactive counting, autoradiography, metabolic labeling and magnetic resonance imaging.

Suggested Reading Materials (All latest Editions)

- Animal Cell Culture - A practical approach, Ed. John R. W. Masters, IRL Press.
- Introduction to Instrumental Analysis, Robert Braun, McGraw Hill International Editions.
- A Biologists Guide to Principles and Techniques of Practical Biochemistry, K. Wilson & K. H. Goulding, ELBS Edn

AS-404: Biostatistics & Bioinformatics

Unit 1

General Statistics & Probability

- Introduction, scope, applications and uses of statistics, collection and classification of data, census and sampling surveys, graphs and diagrams, central tendency and its measures: arithmetic mean, median, dispersion and its measure: range and its coefficient, variance and standard deviation, coefficient of variation.

- Bivariate data, scatter diagram and interpretation, calculation and interpretation of Karl Pearson's correlation coefficient, equation of the lines of regression and properties of regression lines.
- Probability. Definition, addition and multiplicative laws (without proof). Random variable and its distribution, binomial probability distribution, examples and conditions, means and variance, Poisson probability distribution, examples and conditions, means and variance, continuous variable, normal distribution, use of normal probability table for finding probabilities.

Unit 2

Population Sampling

- Population parameters and sample statistics, sampling techniques: simple random sampling, stratified random sampling, systematic sampling, standard error.
- Estimation: point & interval, Estimators of population mean & proportion (without proof), confidence intervals for population mean & proportion. Data, graphical presentation of data – frequency distribution Sample means and standard deviations.

Unit 3

Experimental design

- Testing of hypothesis and its types, errors, levels of significance, one-tailed, and two-tailed tests, tests for single mean and single proportion, equality of the two population means and two population proportions.
- Chi-square test, Student's test for significance, fishers Z test. Experimental designs completely randomized, randomised block and factorial experimental designs. Analysis of variance for different experimental designs, F distribution. Correlation and regression, linear and non-linear regression, multiple regression. Non-parametric tests.

Unit 4

Bioinformatics Tools

- Introduction to Bioinformatics, Basic concepts of biological databases;
- Access to sequence databases on the Internet,
- Protein and Genome Information Resources,
- Computer tools for sequence analysis: finding and retrieving sequences.

Suggested Reading Materials:

- Jorgensen, S.E. Fundamentals of ecological modeling. Elsevier, New York.
- Lendren, D. Modelling in behavioral ecology. Chapman & Hall, London, UK.
- Sokal, R.R. and F.J. Rohlf. Biometry. Freeman, San Francisco.
- Snedecor, G.W. and W.G. Cochran. Statistical methods. Affiliated East-West Press, New Delhi (Indian ed.).
- Green, R.H. Sampling design and statistical methods for environmental biologists. John Wiley & Sons, New York.
- Murray, J.D. Mathematical biology. Springer-Verlag, Berlin.
- Pielou, E.C. The interpretation of ecological data: A primer on classification and ordination.

AS-405: Good Laboratory Practices & Research Methodology

Unit – I

- Safety in laboratories, Use, Care and Maintenance of common laboratory equipments: Microscope, pH meter, colorimeter/ spectrophotometer, analytical balance, centrifuge, electrophoresis apparatus, glassware; general safety measures; personal protection; chemical hazards; spillage and waste disposal; first aid. Research methodology: Meaning of research; objective of research; motivation in research; types of research; research approaches; significance of research; research methods versus methodology; Research and scientific methods; Importance of knowing how research is done; Research process; Criteria for good research.

Unit – II

- Research problem and research design: Selecting research problem; necessity of defining a problem; techniques involved in defining the problem; meaning of research design; need for research design; important concepts related to research design; different research designs; basic principles of experimental design; important experimental designs. Interpretation and report writing: Meaning of interpretation; technique of interpretation; precautions in interpretation; significance of report writing; layout of research report; types of reports; Presentation of research work- oral, poster and writing research paper; Precautions for writing research report.
- Review of related literature: Understanding the role of review; how to begin a search for related literature- Library reference, recording and indexing, classification of references, internet sites for biological references; downloading the information through internet; requests for reprints through e-mail and post; classification and filing of reprints. Writing research proposal: Characteristics of a proposal; content and organization of a proposal; weakness in proposal seeking funding.

Unit III

- Defining research question, Approaches and Methodology, Documentation and presentation of data, Analysis and Interpretation of Data, Writing of research proposal, report and Research paper: Meaning and types – Structure –Documentation : Footnotes and Bibliography-Editing the final draft –Evaluating the final draft –Checklist for the good proposal /research/report.

Unit IV

- Basic knowledge of organizing conferences, symposia, workshop, exhibition etc.
- A brief idea of funding agencies such DST, DBT, ICMR, CSIR and UGC. Role of Intellectual Property Rights (IPR) in Research and development.
- Ethical, legal, social and scientific issues in biological research.

MPDC 405: Ambedkar Studies