



DEPARTMENT OF AQUATIC BIOLOGY AND FISHERIES

UNIVERSITY OF KERALA

(UGC-SAP, COSIST, CAS and DST-FIST Supported Department)

M. Sc. (CSS) AQUATIC BIOLOGY & FISHERIES

SYLLABUS
(2013 onwards)

DEPARTMENT OF AQUATIC BIOLOGY AND FISHERIES
UNIVERSITY OF KERALA
M. Sc. (CSS) Aquatic Biology and Fisheries

CORE COURSES

| Course No. | Course Title | Credits | Hours/wk. | |
|---------------------|---|---------|-----------|---|
| | | | L | P |
| SEMESTER-I | | | | |
| AQB-511 | Freshwater Biology | 2 + 1 | 2 | 2 |
| AQB-512 | Marine Biology | 2 + 1 | 2 | 2 |
| AQB-513 | Oceanography | 2 + 1 | 2 | 2 |
| AQB-514 | Aquatic Biodiversity and Taxonomy | 2 + 1 | 2 | 2 |
| AQB-515 | Biology of Fish and Shellfish | 2 + 1 | 2 | 2 |
| AQB-516 | Biostatistics and Computer Application in Fisheries | 2 + 1 | 2 | 2 |
| SEMESTER-II | | | | |
| AQB-521 | Fish Physiology | 2 + 1 | 2 | 2 |
| AQB-522 | Biochemistry and Biotechnology | 2 + 1 | 2 | 2 |
| AQB-523 | Cytology and Genetics | 2 + 1 | 2 | 2 |
| AQB-524 | Aquatic Microbiology | 2 + 1 | 1 | 2 |
| AQB-525 | Inland Fisheries | 2 + 1 | 2 | 2 |
| AQB-526 | Freshwater Aquaculture | 2 + 1 | 2 | 2 |
| SEMESTER-III | | | | |
| AQB-531 | Marine Fisheries | 2 + 1 | 2 | 2 |
| AQB-532 | Coastal Aquaculture and Mariculture | 2 + 1 | 2 | 2 |
| AQB-533 | Aquarium Management and Ornamental fish culture | 2 + 1 | 2 | 2 |
| AQB-534 | Fish Nutrition | 2 + 1 | 2 | 2 |
| AQB-535 | Fish Health Management | 2 + 1 | 2 | 2 |
| AQB-536 | Fishing Technology and Sustainable Fisheries Management | 1 + 1 | 1 | 2 |
| SEMESTER-IV | | | | |
| AQB-541 | Fish Processing Technology | 3 + 1 | 2 | 2 |
| AQB-542 | Fishery Economics, Fishery Export and Marketing | 2 + 1 | 2 | 2 |
| AQB-543 | Laws and Policies in Fisheries and Fisheries Extension | 2 + 1 | 2 | 2 |
| AQB-544 | Project Work | 6 | | |

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ELECTIVE COURSES

| Course No. | Course Title | Credits | Hours/wk. | |
|------------|---|---------|-----------|---|
| | | | L | P |
| AQB-51A** | Environmental Education and Sustainable Development | 2 + 0 | 2 | 0 |
| AQB-52A** | Harmful Algae | 2 + 0 | 2 | 0 |
| AQB-52B* | Trade Agreements and Indian Fisheries | 1 + 0 | 1 | 0 |
| AQB-53A* | Biosecurity in Shrimp Aquaculture | 1 + 0 | 1 | 0 |
| AQB-53B** | Histological Techniques | 2+ 0 | 2 | 0 |
| AQB-54A** | Research Methodology and Project Formulation | 2 + 0 | 2 | 0 |

* Internal

** Internal & Extra-departmental

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-511
COURSE TITLE : FRESHWATER BIOLOGY
CREDITS : (2+1); HOURS (32+32)
SEMESTER : I
PRE-REQUISITS, IF ANY: NIL

AIM:

- To introduce various freshwater ecosystems and its components.
- To understand the biodiversity and productivity of freshwater environments.
- To impart knowledge on various threats and conservation strategies.

COURSE DESCRIPTION:

This course comprehensive knowledge on life in freshwater; Lentic and lotic environments, freshwater wetlands; Water cycle and weather; Stream flora and fauna, food webs, adaptations of organism, watershed management; Ponds, swamps and marshes, nutrient cycling; Lakes and reservoirs, Ramsar sites in Kerala; Major threats to freshwater systems, pollution and eutrophication, impact of climate change; Conservation of freshwater ecosystems and restoration ecology. Opportunity is available for understanding basic lab equipments, and practice water quality analysis, to study of aquatic plants and ecological characteristics of various freshwater ecosystems.

COURSE CONTENT:

Theory

Unit 1

Objectives of freshwater biology. General account of life in freshwater.

Unit 2

Limnology: Introduction. History. Present status of limnology. Definition of limnology. Essential nature of limnology. Freshwater environments: Extent and distribution of fresh waters. Lentic and lotic environments. Freshwater wetlands. Definition and classification. Ideological classification of freshwater biota. Freshwater communities, population dynamics, energy flow, metabolism.

Unit 3

Introduction to water cycle, climate, weather, groundwater contamination, depletion, remediation.

Unit 4

Stream flora and fauna, community structure, food webs. Adaptations of organisms in streams. Rivers: Origin and characteristics of river. Functions. Biological productivity. Concept of watershed and watershed management.

Unit 5

Ponds: Classification of ponds. Origin. Physicochemical properties of pond water. Primary production. Swamps and marshes: Types of swamps. Permanent and seasonal swamps. Physicochemical conditions. Nutrient cycling. Biotic components.

Unit 6

Lakes and reservoirs: Origin. Characteristics. Classification. Vertical distribution of oxygen in lakes. Eutrophication and pollution of lakes. Ramsar sites (lakes) in Kerala.

Unit 7

Major threats to freshwater systems, including pollution and sand mining. Impact of large dams and fragmentation on river ecology and fishery. River continuum concept. Environmental flow. Pollution and eutrophication. Climate change implications on freshwater systems. Biomonitoring. Future of freshwater ecosystems. Cultural history of freshwater ecosystems.

Unit 8

Conservation of freshwater ecosystems. Restoration ecology. Ecological concepts of restoration ecology. Application. Restoration of freshwater wetlands.

Practical

1. Introduction of basic lab equipments in freshwater biology.
2. Water quality analysis - Estimation of pH, dissolved oxygen, alkalinity, hardness, carbon dioxide and nutrients.
3. Collection and study of aquatic plants
4. Determination of flow rate.
5. Study of ecological characteristics of a stream, pond, lake, reservoir and marsh.
4. Visit to any one of the Ramsar wetland site in Kerala and preparation of field report.
5. Mapping of a wetland/stream

ASSESSMENT

Continuous Assessment: (40%)

- Attendance : 5%
- Two class tests, one presentation, one laboratory record: 10%
- Two assignments: 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment (60%)

Three hour written exam with one word, short and descriptive questions with choices.

References

1. Allan, J.D. and Castillo, M.M. 2009. Stream Ecology (Second Ed.). Springer, Netherlands.
2. Barnes, R.S.K. 1974. Fundamentals of Aquatic Ecosystems, (R.S.K. Barnes & K.H. Mann ,eds.), Blackwell Sci. Publ., London, 229 pp.
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4. Binoda, C.S. & M.P. Nayar 1995. River Pollution in India. APH Publ. Corpn., New Delhi, 565 pp.
5. Bronmark, C. and L. Hansson. 1998. The Biology of Lakes and Ponds. Oxford University Press, New York.
6. Cole, G.A. 1979. Textbook of Limnology. The C.V. Mosby Co., St. Louis, London, 426 pp.
7. Edmondson, W.T. 1959. Freshwater Biology. Wiley Publ., NY, 1248 pp.
8. Ellis, K.V. 1989. Surface Water Pollution and Its Control. MacMillan, London, 380 pp.
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10. Giller, P.S. and B. Malmquist. 1998. The Biology of Streams and Rivers. Oxford University Press, New York.
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13. Haslam, S.M. 1978. River Plants. Cambridge Univ. Press, London, 680 pp.
14. Hutchinson, G.E. 1967. A Treatise on Limnology. Vols. 1 & 2. John Wiley & Sons, NY, 1015 pp.
15. Hynes, H.B.N. 1970. The Ecology of Running Waters. Univ. Toronto Press, Toronto, 555 pp.
16. Karr, J.R. and E.W. Chu. 1999. Restoring Life in Running Waters: Better Biological Monitoring. Island Press, Washington DC.
17. Keddy, P.A. 2000. Wetland Ecology. Principles and Conservation. Cambridge University Press, Cambridge.
18. Laenen, A. & D.A. Dunetle 1997. River Quality: Dynamics and Restoration, Lewis Publ., NY, 463 pp.
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20. Maitland, P.S. 1990. Biology of Freshwaters (2nd Ed.). Chapman and Hall, New York.
21. Miller, W. 2004. Life on Earth. An Encyclopedia of Biodiversity, Ecology and Evolution, (W. Eldredge, ed.), Acad. Press, London, 793 pp.

22. Needham, J.H. & P.R. Needham 1962. A Guide to the Study of Freshwater Biology. Holder Day Inc., San Francisco, 107 pp.
23. Odum, E.P. 1971. Ecology. Holt Riehart & Winston Inc., USA, 152 pp.
24. Pielou, E.C. 1998. Freshwater. University Press, Chicago.
25. Thomas, W.A. 1972. Indicators of Environmental Quality. Plenum Press, NY, 100 pp.
26. Thorp, J.H. and Covich, AP. (eds). 1991. Ecology and Classification of North American Freshwater Invertebrates. Academic Press, New York.
27. Tonapi, G.T. 1980. Freshwater Animals of India. Oxford & IBH Publ. Co., New Delhi, 341 pp.
28. Walton, W.C. 1970. The World of Water, (Richard Carrington, ed.), Weidenfield & Necolson Publ., London, 318 pp.
29. Ward, H.B. & G.C. Whipple 1918. Freshwater Biology. 1111 pp.
30. Ward, J.V. 1992. Aquatic Insect Ecology. 1. Biology and Habitat. John Wiley, New York.
31. Welch, P.S. 1952. Limnology. McGraw Hill Publ. Co., Inc., NY, 538 pp.
32. Wetzel, R.G. 2001. Limnology. Lake and Reservoir Ecosystems (3rd Ed.). Academic Press, San Diego, 1006pp.
33. Williams, DD. And B.W. Feltmate. 1992. Aquatic Insects. CAB International, Wallingford.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-512
COURSE TITLE : MARINE BIOLOGY
CREDITS : (2+1); HOURS (32+32)
SEMESTER : I
PRE-REQUISITS, IF ANY: NIL

AIM:

- To inculcate basic knowledge on marine ecosystem and its importance.
- Create awareness on the ecology, biology and biodiversity of various marine organisms.
- Prepare a biologist to specialise on marine biology.

COURSE DESCRIPTION:

This core course encompasses of various marine ecosystems and aspects on the biology of marine organisms, especially: Intertidal ecology with specific thrust on rocky, sandy, muddy shores environment and organisms; Marine Plankton, productivity and impact on fisheries; Seaweeds and seagrasses, diversity, distribution and its uses; Estuaries, characteristics and estuaries and backwaters in India; Mangrove ecosystem, mangroves of in India, conservation; Coral reefs, distribution, biology and ecology of coral reef organisms, reef conservation; Deep Sea Environment, characteristics, adaptations; Marine Reptiles, Birds and Mammals; Animal associations; Harmful Algal blooms, seafood poisoning, management and mitigation. Hands on training on Quantitative and qualitative study of intertidal organisms; Collection, enumeration, and identification Phytoplankton, Seaweeds, Seagrasses, Mangroves; Coral reef organisms.

COURSE CONTENT:

Theory

Unit 1

Intertidal ecology: Environmental factors. Adaptations. Intertidal community – Rocky, Sandy, Muddy shores: Environmental factors, Zonation, Feeding Biology, Community structure, Trophic structure. Tide pools.

Unit 2

Plankton: Classification. Methods of sampling, preservation, analysis and estimation of Biomass. Productivity. Phytoplankton-Zooplankton relationship. Indicator species. Plankton and fisheries.

Unit 3

Seaweeds and seagrasses: Structure and Types of Seaweeds. Indian Seaweed Resources. Seagrasses: Diversity, Distribution and Importance. Economic importance of seaweeds.

Unit 4

Estuaries: Definition. Classification. Characteristics. Estuarine Biology. Estuaries and backwaters in India

Unit 5

Mangrove ecosystems: Distribution. Structure and adaptations. Environmental condition. Zonations. Fauna. Major mangrove ecosystems in India. Conservation.

Unit 6

Coral reefs: Origin. Global Reef distribution. Status of coral reefs. Environmental factors. Structure of corals. Reef zonation and composition. Biology of hermatypic corals. Octocorals. Species infraction. Reef conservation.

Unit 7

Deep Sea Biology: Environmental characteristics. Adaptations. Sampling strategy. Midwater community. Ecology. Zonation. Hydrothermal vents.

Unit 8

Marine Reptiles, Birds and Mammals: Diversity. Distribution. Conservation.

Unit 9

Animal association: Types of associations. Composition. Value of association.

Unit 10

Harmful Algal blooms: Harmful Algae. Ecology of Algal Bloom. Monitoring Algal Bloom. Seafood poisoning. Management and Mitigation.

Unit 11

Marine Biodiversity: Status of Global Marine Biodiversity. Gradients of Marine Biodiversity. Census of Marine Life. Status of Marine Biodiversity in India. Threats. Protected areas. Marine Biosphere Reserves.

Practical

1. Quantitative and qualitative study of the fauna of rocky, sandy and muddy shores.
2. Phytoplankton: methods of collection, enumeration, identification of common phytoplankton and zooplankton.
3. Collection and identification of locally available seaweeds, seagrasses, mangroves and preparation of herbarium.
4. Coral reef and associated organisms.
5. Study tour/field visits to oceanographic institutions, intertidal environments, estuaries and Mangroves.

ASSESSMENT

Continuous Assessment: (40%)

- Attendance : 5%
- Two class tests, one presentation, records: 10%
- Two assignments: 10%

- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment (60%)

Three hour written exam with one word, short and descriptive questions with choices.

References

1. Balakrishnan Nair, N. and D.M. Thampy, 1980. A Text Book of Marine Ecology. The Macmillan Co. of India Ltd., New Delhi.
2. Boney, A.D., 1975. Phytoplankton. Edward, Arnold, London.
3. Castro, P. and M.E. Huber, 1997. Marine Biology, Second Edition. Mc-Graw Hill Company.
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5. Chapman, V.J., 1976. Mangrove Vegetation. J. Gramer, Berlin.
6. Clark, R.B., 2000. Marine Pollution. Clavendon Press, Oxford, 237 pp.
7. Dawes, C.J. 1988. Marine Botany. John Willey & Sons, New York.
8. Duxbury, A.C., A.B. Duxbury and K.A. Sverdrup, 2000. An Introduction to the World's Oceans. 6th Edition. McGraw Hill Companies Inc.
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10. Falconer, I.R. 1993. Algal Toxins in Seafood and Drinking Water. Acad. Press, NY,
11. Fish, J.D & S. Fish. 2010. *A Students Guide to the Seashore*. Cambridge University Press, 527pp.
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17. Jeffrey S. Levinton, 2001. CD Marine Biology: Function, Biodiversity, Ecology pp. 515.
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19. Laws, E.A., 2000. Aquatic pollution, an introductory text. John Wiley and Sons, Inc., New York, 639 pp.
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22. McCutcheon, S. and B. McCutcheon. 2003. The Facts on File. Marine Science Handbook. Facts on File, Inc., New York, 266pp.

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24. Morris, I. 1967. An Introduction to Algae. Hutchinson & Co., London, 189 pp.
25. Morrissey, J.F. and J.L. Sumich. 2012. *Introduction to the Biology of Marine Life*. Jones & Bartlett learning, U.K., 467pp.
26. Newell, R.C., Biology of intertidal animals, Lagos Press, 1970.
27. Nybakken, J.W., and M.D. Bertness. 2004. Marine Biology - An Ecological Approach. Sixth Edition. Benjamin Cummings.
28. Raymont, J.E.G., 1973. Plankton and Productivity in the Oceans. Pergamon Press, London.
29. Qasim, S.Z. 2004. *Handbook of Tropical Estuarine Biology*. Narendra Publishing House, Delhi, 131pp.
30. Round, F.E. 1981. The Ecology of Algae. Cambridge Univ. Press, London, 653 pp.
31. Spoel S. Vander and R.P. Heyman, 1983. Comparative Atlas of Zooplankton Biological Patterns in the Oceans. Springer - Verlag, Berlin.
32. Tomas, C.R. 1997. Identifying Marine Phytoplankton. Acad. Press, NY, 858 pp.
33. Tomilson, P.B., 1986. The Botany of Mangroves. Cambridge University Press.
34. Venkataraman, K., C. Raghunathan. R. Raghuraman and C.R. Sreeraj. 2012. Marine Biodiversity in India, *Zoological Surv. India*, Kolkata, 164pp.
35. Wimpenny, R.S., 1966. Plankton of the Sea. Feber and Feber Limited, London.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-513
COURSE TITLE : OCEANOGRAPHY
CREDITS : (2+1); HOURS (32+32)
SEMESTER : I
PRE-REQUISITS, IF ANY: NIL

AIM:

- To create awareness on the Physics, Chemistry and Biology of coastal and oceanic environment.
- To give an understanding of various processes properties of marine environment
- Prepare a biologist to specialise on oceanography.

COURSE DESCRIPTION:

This course provides an opportunity to gain knowledge on various Physiographic features of ocean, classification of marine environment; Physical properties of sea water; Ocean circulation, upwelling and downwelling, TS diagram, OTEC; Waves, characteristic, tsunami, wave energy; Tide generating forces, types of tides, tides and marine organisms, power from tides; Mud banks of Kerala coast; Composition of sea water, major, minor, and trace elements, dissolved gases; Nutrients such as Nitrogen, Phosphorous and Silicon in sea water and cycle of nutrients; Organic matter, sources, classification, dissolved, particulate and colloidal forms; Marine pollution, mitigation, costs of pollution. This course is designed to impart on hand experience in the familiarization of oceanographic equipments and analysis of various physico-chemical properties of seawater.

Theory

Unit 1

Earth and ocean floor: Origin. Structure of earth. Continental Drift. Paleomagnetism. Plate tectonics. Classification of marine environment: Continental shelves, slopes, rises. Submarine canyons. Abyssal plains and hills. Ocean trenches. Island arcs. Ocean Ridges. Seamounts. Gyots.

Unit 2

Properties of sea water: Temperature. Salinity. Density. Light. Pressure. Colour. Surface tension and viscosity. Sound. Distribution of Temperature, salinity and density. Heat budget.

Unit 3

Ocean circulation: Wind-driven currents. Ekman Motion. Geostrophic Currents. Surface ocean circulation. Upwelling and Downwelling. Eddies. Inertial currents. Longmuir circulation. Thermohaline circulation. Deep ocean circulation. Tracers, TS diagram. OTEC.

Unit 4

Waves: Characteristics. Classification. Forces. Wave refraction. Breakers. Tsunami. Seiches. Internal wave. Storm surges, Wave energy.

Unit 5

Tides: Generating forces. Equilibrium theory. Dynamic theory. Characteristics. Tides and marine organisms. Power generation.

Unit 6

Mud banks of Kerala coast: Classification. Terminology. History. Locations. Natural Environmental factors. Theories.

Unit 7

Composition of sea water: Uniqueness of earth. Dissolving properties of water. Constancy of composition. Residence time. Major, minor, and trace elements. Dissolved gases.

Unit 8

Nutrient in Sea water: Nitrogen, Phosphorous and Silicon in the sea- distribution, cycling, regeneration. N: P ratio.

Unit 9

Organic matter: Sources. Classification. Dissolved, particulate and colloidal species. Distribution and seasonal variation. Ecological significance.

Unit: 10

Marine Pollution: Definition. Categories of Pollution – Oil, Heavy Metals, Pesticides, Sewage, Radionuclides, Thermal, Synthetic organic chemicals. Antifouling paints. Plastics and Trash. Toxicity. Costs of pollution.

Practical

1. Familiarization with oceanographic instruments.
2. Analyses of Physico-chemical properties of seawater, i.e., Transparency, Currents, Salinity, pH, Chlorophyll, Oxygen Concentration, Nitrite, Nitrate, Phosphate, Silicate.

ASSESSMENT

Continuous Assessment: (40%)

- Attendance : 5%
- Two class tests, one presentation, records: 10%
- Two assignments: 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment (60%)

Three hour written exam with one word, short and descriptive questions with choices.

References

1. Barnes, A., 1959. *Oceanography and Biology – A Book of Techniques*. George Allen and Unwin Ltd., London.
2. Blackburn, T.H and J. Sorensen (Eds.). 1985. *Nitrogen Cycling in Coastal Marine Environments – Scope – 33*, John Wiley & Sons.
3. Duxbury, A.C., A.B. Duxbury and K.A. Sverdrup, 2000. *An Introduction to the World's Oceans*. 6th Edition. McGraw Hill Companies Inc.
4. Gross, G., 1993. *Oceanography: A View of the Earth*. Sixth Edition Prentice – Hall Inc., New Jersey.
5. Harold V. Rurman, 1997. *Introductory Oceanography*. Prentice Hall Inc, New Jersey.
6. McCormick, J.M. and J.V. Thiruvathaakal. 1976. *Elements of Oceanography*. W.B. Saunders Company, Philadelphia.
7. McCormick, J.M. and J.V. Thiruvathakal. 1976. *Elements of Oceanography*. W.B. Saunders, Philadelphia.
8. Pickard, G.L. and W.J. Emery. 1995. *Descriptive Physical Oceanography – an Introduction (fifth edition)*. Pergamon Press, London.
9. Pilson, M.E.Q. 1990. *An Introduction to the Chemistry of the Sea*. Prentice Hall, New Jersey.
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11. Riley, J.P. and R. Chester, 1971. *Introduction to Marine Chemistry*. Academic Press, London.
12. Stowe, K. 1996. *Exploring Ocean Science*. John Wiley Sons Inc.
13. Strickland, J.D.H. and T.R. Parsons, 1972. *A Practical Handbook of Seawater Analysis*. Fisheries Board of Canada, Ottawa, Bulletin, 167.
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**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-514
COURSE TITLE : AQUATIC BIODIVERSITY AND TAXONOMY
CREDITS : (2+1); HOURS (32+32)
SEMESTER : I
PRE-REQUISITS, IF ANY: NIL

AIM:

- To introduce the concept of taxonomy and biodiversity.
- To provide information on the theory and practice of taxonomy and biodiversity documentation.
- To impart practical training on the practice on taxonomy and biodiversity documentation.

COURSE DESCRIPTION:

The course aims to provide basic and advanced information on systematics and taxonomy, including taxonomy and its importance; Taxa and species concepts; keys and methods of taxonomy; New approaches in taxonomy; collection and preservation of various taxa, International Code for Zoological Nomenclature, taxonomic publications, biodiversity informatics and databases; taxonomic characters and classification of fish and shellfish; levels of biodiversity, biodiversity hotspots; threats to biodiversity; RET species; national and international initiatives on biodiversity conservation; legal aspects of biodiversity conservation; biodiversity targets and UN Decade on biodiversity. The focus of the course will be to impart skills on the procedure of taxonomy.

COURSE CONTENT:

Theory

Unit 1

Systematics and Taxonomy. Taxonomy and its importance. Taxonomic Impediment. Global Taxonomy Initiative. Current status of aquatic taxonomic research in India.

Unit 2

Taxa and species concepts. Phylogenetic groups: monophyly, polyphyly and paraphyly. Cladistics. Cladogram. Parsimony.

Unit 3

Taxonomic characters. Identification using keys. Dichotomous key. Types of Keys: Simple dichotomous, Bracket, Indented, Serial, Branching, Circular, Box, Pictorial keys. Single access and multi-access keys. Key construction. Computerized Key Construction.

Unit 4

New approaches in taxonomy: Numerical, Phenetic, Cladistic and Molecular. Molecular markers – PCR, RAPD, RFLP, microsatellites, mini satellites and Mitochondrial DNA, and their application in fish phylogenetic studies.

Unit 5

Collection, preservation, labeling and curation of aquatic phyla. Collection and preservation methods of major phyla: Sponges, annelids, molluscs, arthropods, echinoderms, fishes and amphibians. Role of museums in taxonomic research.

Unit 6

International Code for Zoological Nomenclature. Principle of Binominal Nomenclature, Principle of Priority, Principle of Coordination, Principle of the First Reviser, Principle of Homonymy, Principle of Typification. Nomen dubium, nomen nudum, nomen oblitum. The law of priority. Kinds of types.

Unit 7

Taxonomic publications. Preparation of taxonomic papers. Integrated Taxonomic Information System. World Register of Marine Species, Encyclopedia of Life, Catalogue of Life (CoL), Species 2000, Wikispecies, Archive, Macroscopic Observatory, Global Biodiversity Information Facility (GBIF), FishBase

Unit 8

Taxonomic characters of molluscs, decapod crustaceans (prawns and crabs) and fishes. Classical taxonomy – morphometrics – meristics. Classification of fishes up to families. Classification of prawns. Classification of crabs.

Unit 9

Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity. Alpha, Beta and Gamma diversity. Consumptive use, productive use, social, ethical, aesthetic and option values of biodiversity.

Unit 10

Levels and Measures of Biodiversity. Biodiversity at global, National and local levels. Mega Biodiversity Countries. Concept of endemism. Biodiversity hotspots of the world. Western Ghats Biodiversity Hotspot. Aquatic Biodiversity of the Western Ghats.

Unit 11

Threats to biodiversity. Habitat loss and fragmentation, over exploitation, pollution, invasive alien species, climate change. Problem of Genetic diversity loss over time : Bottlenecks, Genetic drifts, Inbreeding depression. Extinction vortex. Sixth extinction. RET species. IUCN classification of threatened species. Red Data Book. Biodiversity conservation strategies. Endangered and endemic species of India. Indian efforts for biodiversity conservation.

Unit 12

Convention on Biological Diversity. Biological Diversity Act and Rules of India. Biodiversity and biopiracy. Biodiversity Target. Aichi Target. UN Decade on Biodiversity.

Practical

1. Collection and preservation of crustaceans, molluscs and fishes
2. Identification of common finfishes using dichotomous keys (Selected orders).
3. Drawing specimens using camera lucida
4. Construction of phylogenetic tree
5. Extraction and isolation of DNA and quantification
6. PAGE – Muscle myogen, eyelens proteins, enzymes of different species of finfishes
7. Fish chromosomes preparation and identification.

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- One assignment and one presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

READING LIST

1. Agarwal, S.K., Swarnalatha Tiwari, P.S. Dubey 2002. Biodiversity and Environment. A.P.H. Publ. Corpn., New Delhi, India.
2. Arvind Kumar 2005. Biodiversity and Conservation. APH Publ., New Delhi, 314 pp.
3. Avise, J. C. 1994. Molecular Markers, Natural History and Evolution. Chapman & Hall, New York.
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5. Clark, A.B. & A.L. Panchen 1974. Synopsis of Animal Classification. John Wiley & Sons Inc., NY.
6. Datta Munshi, J.S & M.P. Srivastava 1988. Natural History of Fishes: Systematics of Freshwater Fishes of India. Narendra Publishing Co., New Delhi, 403 pp.
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DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA

COURSE CODE : AQB-515
COURSE TITLE : BIOLOGY OF FISH AND SHELLFISH
CREDITS : (2+1); Hours (32+32)
SEMESTER : I
PRE-REQUISITS, IF ANY: Nil.

AIM:

- To introduce the immensely fascinating world of fish biology
- To give advanced information on the unique adaptations of various biological systems of fish and shellfish
- To impart basic practical skills in different aspects of biology

COURSE DESCRIPTION:

A comprehensive overview of the scope and utility of fish biology including natural history, diversity and classification of fishes. Emphasis will be given on various biological parameters like morphometry, food and feeding, breeding biology, endocrine system, excretory system, nervous system, circulatory system, respiratory system and sense organs. An overview of age determination in fishes as well as their migratory behaviour. Basic information on the biology of crustaceans and molluscs. The practicals in the field are intended to provide basic skills on fish and shell fish biology. Visit to fish landing centres and aquarium trips were also included.

COURSE CONTENT

Unit 1

Scope and utility. Natural history and diversity of fishes. General classification of fishes. Classification of selected orders.

Unit 2

Morphology and anatomy: Body forms, fins, scales, colouration. Meristic and morphometric studies; truss morphometry.

Unit 3

Digestive system. Food and feeding: Natural fish food. Types of feeding. Structural modifications in relation to feeding habit. Fullness of stomach and feeding intensity. Relative gut length. Gut content analysis.

Unit 4

Air bladders in fishes. Weberian ossicles. Gas exchange, blood and circulatory system. Excretory system. Endocrine system. Nervous system and sense organs. Osmoregulation and ion balance. Electric organs and luminous organs.

Unit 5

Reproductive system. Sex determination. Maturity stages and preparation of maturity keys. Maturity index. Ova diameter study. Estimation of fecundity. Life histories of fish.

Unit 6

Age and growth: Principles of age determination. Scale method. Otolith method. Other skeletal parts as age indicators. Length-frequency method.

Unit 7

Behaviour and cognition. Schooling, orientation and migration. Symbiosis.”

Unit 7

Biology of Crustacea: General organization of decapod crustaceans, with special emphasis on crabs, prawns and lobsters. Morphology and anatomy of crabs, prawns and lobsters. Digestive system of crabs and shrimps. Feeding and breeding biology of shrimps. Larval development in crabs, prawns and lobsters.

Unit 8

Biology of Mollusca: General organization of Mollusca. Morphology and anatomy of bivalves, gastropods and cephalopods. Digestive system of gastropods and bivalves. Feeding and breeding biology of molluscs. Larval development of bivalves, gastropods and cephalopods.

Practical

1. Demonstration of practical laboratory skills for sampling of fish and shellfish, quantitative meristics and morphometrics.
2. Comparative studies on gills, scales, pharyngeal teeth and brain of fishes.
3. Gut content analysis of fishes and molluscs.
4. Digestive system and glands of crustaceans and molluscs- comparative studies
5. Determination of maturity stages, fecundity, GSI and ova diameter.
6. Demonstration of Weberian ossicles, accessory respiratory organs, air bladder and skeletal system (Alizarin preparation).

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- One assignment and one presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

READING LIST

1. Alcock, A., 1968. Materials for a carcinological fauna of India. *Verlag Von J.Cramer, New York*.
2. Bashford, D. 1895. Fishes – Living and Fossil. Narendra Publ. Hse., India, 300 pp.
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18. Jayachandran, K.V. 2001. *Palaemonid prawns. Biodiversity, Taxonomy, Biology and Management*, Oxford and IBH Publ. Co.Pvt. Ltd. New Delhi
19. Misra, K.S. An Aid to the Identification of the Common Commercial Fishes of India and Pakistan. Narendra Publ. Hse., India, 320 pp.
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21. Nelson, J.S. 2006. (4th Ed.). Fishes of the World. John Wiley & Sons, Inc., New Jersey.
22. Nikolski, G.V. 1963. Ecology of Fishes. Acad. Press, London, 351 pp.

23. Peter K. L. Ng, Danièle Guinot & Peter J. F. Davie (2008). "Systema Brachyurorum: Part I. An annotated checklist of extant Brachyuran crabs of the world" (PDF). *Raffles Bulletin of Zoology* 17: 1–286.
24. Sethuramalingam, S. and Ajmal Khan, S. (1991). Brachyuran crabs of Parangipettai coast, CAS in Marine Biology publication, Annamalai University, India, 92pp.
25. Singh, H.R. 2006. Advances in Fish Research. Vol. 1. Narendra Publ. Hse., India, 400 pp.
26. Sakai, T., 1976. Crabs of Japan and adjacent seas. *Publ. Kodansha Tokyo, Japan (1976)* 461pp.
27. Srivastava, C.B.L. 2008. Fish Biology. Narendra Publ. Hse., India, 329 pp.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-516
COURSE TITLE : BIostatISTICS AND COMPUTER APPLICATION IN FISHERIES
CREDITS : (2+1); HOURS (32+32)
SEMESTER : I
PRE-REQUISITS, IF ANY: NIL

AIM:

- To introduce basic concepts of statistics essential for a biologist
- To introduce common tools for statistical analysis
- To introduce programs developed for fisheries data analysis
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COURSE DESCRIPTION: A comprehensive introduction to the important concepts in statistics is provided in the course. It covers the principles of sampling methods, measure of central tendencies and variability in data. Theoretical basis of commonly used statistical tools in analysis of biological data is also introduced. Concepts of hypothesis testing using parametric and non-parametric tests are also introduced. The computational elements are minimal, the emphasis of the course is on understanding the concepts and interpretation of the results. Commonly used statistical software programs specifically developed for fisheries data analysis are also introduced.

COURSE CONTENT

Theory

I. Biostatistics

Unit 1

Types of Biological Data - Organisation of Biological data- Frequency tables- Diagrammatic representations of Biological data- Measures of Central tendencies and its applications for Biological Variables. Measures of Dispersion and its applications- coefficient of variation- Application of Skewness in Biological Data

Unit 2

Correlation and Regression analysis in Biological Data - Probability- Addition and Multiplication. Theorems-Bayes's Theorem-Simple application in Biological data- Sampling Biological Populations-Parameter-Statistic-Sampling Distributions-Standard Error-Binomial, Poisson and Normal Distributions-applications in Biological Data.

Unit 3

Hypothesis testing and its applications in Biological data-Null and Alternate Hypotheses-Errors in Hypothesis testing-Critical Region-Level of Significance-One Tailed and Two Tailed tests-Application of Significance Tests in Biological Data-Large and small sample tests in Biological Data-Z, 't, and F tests- Chi Square Tests-Analysis of Variance applications in

Biological Data-One and Two way ANOVA. Likelihood Methods; Concept of Principal component analysis; Canonical correlation and Path coefficients; Discriminant analysis; Factor analysis and Cluster analysis; Transformations; Analysis of Covariance.

Unit 4

Non parametric test: Wilcoxon test, Mann-Whitney U-test, Kruskal and Wallis test and Friedman's test; Use of computer software for data analysis; Survival analysis.

II. Computer Application in Fisheries

Unit 5

Common software for data analysis in fisheries. Introduction to computer software: SPSS, SAS, SYSTAT, R and STATISTICA for analysis and presentation of fisheries data; Basic concepts of database management systems; Introduction to MS-ACCESS, ORACLE (RDBMS).

Unit 6

Modeling studies using computer. FISAT. ECOPATH. Geographical Information Systems: Applications to Marine Fisheries. Remote sensing for fisheries and coastal zone management.

Practical

1. Preparation of tables and graphs from the given data.
2. Calculation of Standard Deviation, ANOVA and Correlation using EXCEL
3. Application of different statistical tools on data collected in the areas of aquatic biology and fisheries.
4. Length-weight relationship and other applications using FISAT.
5. Exercises on analysis of data using SPSS, SAS, FISAT, SYSTAT and STATISTICA

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- One assignment and one presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

READING LIST

1. Aitken, Mike, Braadhurst, Bill, Hladky, Steve. 2009. *Mathematics for Biological Scientists*. Garland Science Publishing, New York, 208pp.
2. Anderson TW. 1984. *An Introduction to Multivariate Statistical Analysis*. Wiley Series in Probability and Statistics, Singapore.

3. Bailey, N.T.J. 1973. *Statistical Methods in Biology*. The English Univ. Press Ltd., London, 160 pp.
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5. Butler, M.J.A., M.C. Mouchot, V. Barale and C. LeBlanc. 1988. *The application of remote sensing technology to marine fisheries: an introductory manual*. FAO Fish. Tech.Pap. 295, 165 pp.
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7. Elhance, D.N. & V. Elhanle 1983. *Fundamentals of Statistics*. Kitab Mahal Publ., India, pp.
8. Finney, D.J. 1978. *Statistical Methods in Biology Assay*. Charles Griffith Co. Ltd., England, 508 pp.
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10. Grafen, A. & R. Hails 2008. *Modern Statistics for the Life Sciences*. Oxford Univ. Press, NY, 351 pp.
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13. Kothari, C.R. 2011. *Research Methodology: Methods & Techniques*. New Age International Publishers, New Delhi, 401pp.
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20. Steven F. 2001. *Oracle PL / SQL Best Practices: Optimising Oracle Code*. SPD/O'Reilly Reprints.
21. Subramanian, N. 1986. *Introduction to Computers*. Tata McGraw-Hill Publ. Co. Ltd., New Delhi, 239 pp.
22. *Systat 8.0: Getting Started Manual*.
23. Walpole, R.E. 1968. *Introduction to Statistics*. The MacMillan Co., NY, 365 pp.
24. William RD & Matthew G. 1984. *Multivariate Analysis, Methods and Applications*. John Wiley & Sons.
25. Yamane, T. 1973. *Statistics. An Introductory Analysis*. Harpir Internat.
26. Zar, J.H. 1974. *Biostatistical Analysis*. Prentice-Hall, Inc., NJ, 620 pp.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE: AQB-521
COURSE TITLE: FISH PHYSIOLOGY
CREDITS: (2+1); Hours (32+32)
SEMESTER : II
PRE-REQUISITS, IF ANY: Nil

AIM:

- To provide knowledge on physiology of various systems of fish
- To impart knowledge in neuroendocrine mechanism in fish reproduction
- To impart practical training on various fish physiology experiments.

COURSE DESCRIPTION:

A comprehensive descriptive overview of various aspects of muscle physiology, gas exchange in air bladder, role of hormones and factors affecting digestion, metabolism, physiology of respiration, osmoregulation and acoustico lateralis system. Emphasis is given on neuroendocrine mechanism in fish reproduction and various behavioural aspects. The course also provides practical training on fish physiology experiments and analysis.

COURSE CONTENT

Theory

Unit 1

Swimming and buoyancy in fishes. Muscle physiology: body waves, energetics. Physiological aspects of dynamic and static lift. Mechanism of gas exchange in air bladder.

Unit 2

Food and feeding biology: Components of balanced food, Ingestion of food and feeding mechanism. Digestive system and glands. Physiology of Digestion: Digestion of carbohydrates, lipid and proteins. Digestive enzymes and regulation of their secretions, Absorption and assimilation of nutrients, Role of hormones in the regulation of digestion, Factors affecting digestion and transport of nutrients.

Unit 3

Concept of growth, Growth curve. Correlation of growth with body weight and length, Metabolism (anabolism and catabolism) and growth, Biotic and abiotic factors affecting growth, Role of minerals, vitamins and hormones in the regulation of growth, Influence of nutrients in growth stimulation.

Unit 4

Physiology of respiration, mechanism of gas exchange. Branchial pump. Gill ventilation. Composition of fish blood and respiratory pigments. Aerial respiration. Ammonia quotient, Chloride cells and role in respiration, Respiratory metabolism, energy budget.

Unit 5

Osmoregulation and ion balance: salt balance in marine and freshwater fishes. Chloride cells. Osmoregulation in elasmobranchs. Excretory organs in fish and shell fish and their function, urea cycle, endocrine control of osmoregulation.

Unit 6

Sense organs in fishes: lateral line system, acoustic system, vision, electro-receptors, electric organs. Physical nature and chemical basis of bioluminescence, chromatophores, sense organs in shell fish.

Unit 7

Physiology of fish migration and behavior: Behavioral response to the environment. Circadian rhythm. Parental care in fishes. Hormones in communications, pheromones, concept on fish behavior and regulatory mechanism, Adaptive mechanism to altered environment adaptation of fish and shell fish to temperature, pressure etc. Stress response, stress hormone, stress adaptation.

Unit 8

Sexual dimorphism, primary and secondary sex characters, bisexual reproduction, inter-exes, hermaphroditism, Sex differentiation and factors affecting sex differentiation. Sex reversal in fish, factors affecting sex reversal. Development of gonad, oogenesis; spermatogenesis, metabolic changes during oogenesis and spermatogenesis, vitellogenesis and gonadal steroidogenesis. Annual reproductive cycle and breeding patterns in male and female.

Unit 9

Pheromones and reproductive behaviour, parental care. Regulation of seasonal reproduction: Role of environment (photoperiod, temperature, rainfall), Role of hypothalamo-hypophyseal system and pineal gland, role of peripheral endocrine system, role of nutrition.

Practical

1. Dissection and display of reproductive system (male and female).
2. Identification of primary and secondary sex characters.
3. Estimation of amylase, AST and ALT
4. Estimations of pH in different parts of GI tract.
5. Estimation of carbohydrate, protein and lipid splitting enzymes.
6. Differential count of blood cells and estimation of Haemoglobin concentration, Haematocrit value
7. Chromatophores response in relation to eye stalk ablation
8. Determination of growth and age by otolith and fish scale analysis
9. Identification of primary and secondary sex characteristics of fishes
10. Hormonal assay (RIA), ELISA
11. Dissection of fish and shell fish to study endocrine glands
12. Identification of moult stages in crustaceans
13. Application of electrocardiogram and respirometer

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- One assignment and one presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

READING LIST

1. Biswas, S.P. 1993. Manual of Methods in Fish Biology. South Asian Publ. Pvt. Ltd., New Delhi, 157 pp.
2. Bone, Q and R.H. Moore. 2008 (Third Ed.). Biology of fishes. Taylor & Francis Group, New York.
3. Evans, D.H. 1998. The Physiology of Fishes. 2nd ed. CRC Press, NY, 519 pp.
4. Farrell & Anthony. *Encyclopedia of Fish Physiology*. Elsevier, New York, 2163pp
5. Hoar, W.S. and D.J. Randall. 1971. Fish Physiology. Vols. I to V. Academic Press, New York.
6. Hoar, W.S. 1993. General and Comparative Physiology. Prentice Hall of India Pvt. Ltd., New Delhi, 851 pp.
7. Ian AJ & Hoar WS. 2001. *Muscle Development and Growth*. Academic Press, New York.
8. Prosser CL. 1950. *Comparative Animal Physiology*. WB Saunders.
9. Scharrer E. 1963. *Neuroendocrinology*. Columbia University Press
10. Shadwick RE & Lauder GV. 2006. *Fish Biomechanics*. Academic Press.
11. Smyth & Lynwood. 2003. *Introduction to Fish Physiology*. Narendra Publishing House, Delhi, 352pp.
12. Thomas PC, Rath SC & Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ. House.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-522
COURSE TITLE : BIOCHEMISTRY AND BIOTECHNOLOGY
CREDITS : (2+1); HOURS (32+32)
SEMESTER : II
PRE-REQUISITS, IF ANY: NIL

AIM:

- To sensitize the candidates with various aspects on the biochemistry of aquatic organisms.
- To provide modern knowledge on the biotechnological application of marine organisms.

COURSE DESCRIPTION:

This comprehensive course is designed to provide knowledge to biologists on the characteristics of hormones, growth and reproductive hormones in fish and shellfish; Marine toxins, molecular mechanisms; Marine Biomaterials; Marine Nutraceuticals, biological and biomedical applications; Drugs from the Sea; Microbes as tools in marine biotechnology; Genetic Engineering, Tools for genome analysis, Genome sequencing of microbes, plants and animals, molecular markers, phylogenetics, metagenomics; Fouling and corrosion, antifouling treatments.

COURSE CONTENT:

Theory

Unit 1

General characteristics of hormones. Chemistry and function of growth and reproductive hormones in fish and shellfish.

Unit 2

Marine Toxins: Toxins from Cyanobacteria, Dinoflagellates, Macroalgae, Cnidarians, Annelids, Molluscs. Molecular mechanisms.

Unit 3

Marine Biomaterials. Biominerals. Biocomposites. Non-mineralized structures. Biopolymers

Unit 4

Marine Nutraceuticals: Marine Microbes. Algal products. Chitin-Chitosan. Collagens. Omega-3 Polyunsaturated fatty acids. Antioxidants. Biological and Biomedical Applications.

Unit 5

Drugs from the Sea: Antibiotics. Anticancer compounds. Antimalarials. Analgesics. Immunomodulators. Cosmeceuticals.

Unit 6

Microbes as tools in marine biotechnology. Marine bacteria. Screening of marine bacteria for metabolites. Biopolymers. Bioremediation, Genetically modified microbes in bioremediation. Marine nanotechnology. Biofuels from Algae.

Unit 7

Genetic Engineering: Introduction of Genomics; Recognition of coding and non-coding regions and annotation of genes; Tools for genome analysis –RFLP, DNA fingerprinting, RAPD, PCR and Automated DNA sequencing.

Unit 8

Genome Sequencing: Genome sequencing – Microbes, plants and animals; Taxonomic classification of organisms using molecular markers – 16S rRNA typing/sequencing; Phylogenetics; Toxicogenomics; Pharmacogenomics and metagenomics.

Unit 9

Fouling and corrosion. Biofilm formation; Marine fouling and boring organisms - their biology, adaptation; Factors influencing the settlement of macrofoulers; Antifouling treatments; Corrosion process and control of marine structures.

Practical

1. Demonstration of: Motility test. Gas and acid formation from carbohydrates. Hydrolysis of starch. Hydrolysis of casein. Hydrolysis of Tween 80.
2. Antimicrobial screening test
3. Extraction of bioactive compounds from seaweeds, microalgae, sponges and test their efficiency microbiology, biochemistry and molecular assays.

ASSESSMENT

Continuous Assessment: (40%)

- Attendance : 5%
- Two class tests, one presentation, records: 10%
- Two assignments: 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment (60%)

Three hour written exam with one word, short and descriptive questions with choices.

References

1. Campbell, AM and Heyer LJ. 2007. Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, Benjamin Cummings.

2. Ehrlich, H. 2010. *Biological Materials of Marine Origin: Invertebrates (Biologically-Inspired Systems)*, Springer.
3. Feng Chen and Yue Jiang 2001. *Algae and their Biotechnological Potential*, Springer.
4. Fingermann, Milton, Nagabhushanam & Rachakonda. 2000. *Recent Advances in Marine Biotechnology*. Oxford & IBH publishing Co. Pvt. Ltd., Delhi, 382pp
5. Fusetani, Nobuhiro; Kem, William (Eds.). 2009. *Marine Toxins as Research Tools*. Progress in Molecular and Subcellular Biology, Volume 46, Springer.
6. Gina Smith, 2005. *The genomics Age*, American Management Association, New York.
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9. Muralidharan, V.S. & A. Subramania. 2009. *Nanosciences & technology*. Ane Books Pvt. Ltd., New Delhi, 150pp.
10. Pennington. S. R and M.J. Dunn, 2002. *Proteomics from Protein Sequences to Function*, Vova Books private limited, India.
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14. Voet, V. and J.G. Voet, *Biochemistry*, 3rd edition, John Wiley, New York, 2004.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-523
COURSE TITLE : CYTOLOGY AND GENETICS
CREDITS : (2+1); HOURS (32+32)
SEMESTER : II
PRE-REQUISITS, IF ANY: NIL

AIM:

- To impart knowledge on advances in cell biology
- To provide basic and advanced information on genetic principles
- To impart practical skills on basis experiments in cytology and genetics.

COURSE DESCRIPTION:

Membrane structure and function; organization of genes and chromosomes; cell division and cell cycle; DNA replication, repair and recombination; protein synthesis and processing, animal cell culture; Mendelian principles; concept of gene and genetic variation; regulation of gene expression; population genetics, Hardy Weinberg Equilibrium; application of selection for performance improvement, breeding, genetic drift; genetic code, mutation. The basic experiments in cell biology and molecular biology included in the syllabus will provide practical skills for the students.

COURSE CONTENT

Theory

I. Cytology

Unit 1

Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

Unit 2

Organization of genes and chromosomes: Operon, interrupted genes, gene families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons.

Unit 3

Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle. cancer and the cell cycle. Apoptosis.

Unit 4

DNA replication, repair and recombination: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms. RNA synthesis.

Unit 5

Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post- translational modification of proteins.

Unit 6

Animal cell culture: Primary culture, cell lines. Media culture systems. Fish cell lines. Hybridoma technology. Diagnosis of genetic disorders. DNA probes. Gene therapy (brief account).

II. Genetics

Unit 7

Mendelian principles: Dominance, segregation, independent assortment, deviation from Mendelian inheritance.

Unit 8

Concept of gene: Allele, multiple alleles, complementation tests. Sex determination in fish. Chromosome manipulation: Ploidy induction, sex reversal, gynogenesis and androgenesis. Cryopreservation.

Unit 9

Genetic variation: Causes and measurement; Chromosome theory of inheritance: genetic basis of determination of sex.

Unit 10

Modern concept of gene; DNA as genetic material, genetic code and protein synthesis, transfer and regulation of genetic information.

Unit 11

Pleiotropy; Penetrance; Gene and genotypic frequency and factors affecting them. Population genetics, Hardy Weinberg Equilibrium. Application of selection for performance improvement. Inbreeding. Genetic drift.

Unit 12

Mutation: natural and induced, mutagens fate of mutant allele in the population; Cross breeding and genetic drift.

Practical

1. Extraction of DNA.
2. SDS-PAGE separation of proteins.
3. Demonstration of (i) PCR amplification, (ii) Rapid amplification fo polymorphic DNA (RAPD), (iii) Cloning, (iv) Western blotting, (v) ELISA.
4. Familiarization with bio-databases (DDJB, OMIM, NCBI, EMBL).

5. Basic sequence analysis of DNA and amino acid sequences (ORF finding. Gene finding. N-mer analysis. Transmembrane region analysis).
6. Alignment experiments – Dot Plots (Dot-let) and Global alignment (GCG). BLAST searches. MSA using ClustalX.
7. Molecular visualization practical: Simple visualization. Energy minimization. Ramachandran Plot.
8. Phylogenetic analysis. Simple example using Phylip. Molecular docking using Hex.
9. Exercises on Mendelian laws, multiple alleles and epistasis

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- One assignment and one presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

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2. Barnes, D. and P.J. Mathur. 1998. *Methods in Cell Biology*. Vol. 57. *Animal Cell Culture Methods*. Academic Press.
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6. Claverie, J.M. and C. Notredame 2003. *Bioinformatics for Dummies*. Wiley.
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8. De Robertis, E.D.P. and E.M.F. DeRobertis 1981. *Essentials of Cell and Molecular Biology*. Saunders College Publ., NY, 383 pp.
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11. Kirpichnikov VS. 1981. *Genetic Basis of Fish Selection*. Springer-Verlag.
12. Krebs & Jocelyn. 2013. *Lewin's Essential Genes*. Jones & Barlett Learning, 867pp.

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15. Lewin, B. 1980. Gene Expression. Vol. 2. Eukaryotic Chromosomes. John Wiley & Sons, NY, 1139 pp.
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18. Masters RW. 2000. *Animal Cell Culture-Practical Approach*. Oxford University Press
19. Mummery & Christine. 2011. *Stem Cells Scientific Facts & Fiction*. Elsevier, New York, 312pp.
20. Peruski, L.F. and L.H. Peruski. 1997. *The Internet and New Biology: Tools for Genomic and Molecular Research*. ASM Press.
21. Purdom, C.E. 1993. *Genetics and Fish Breeding*. Chapman & Hall.
22. Schena, M. (Ed.).1999. *DNA Microarrays: A Practical Approach*. Oxford University Press.
23. Scott, F.G. 1998. *Developmental Biology*. 2nd Ed. Sunderland Sianuer Associates.
24. Snustad, D.P. and M.J. Simmons. 1999. *Principles of Genetics*. 2nd Ed. John Wiley & Sons.
25. Srinivas, A. 2006. Handbook of Computational Molecular Biology. Chapman & Hall.
26. Stansfield WD. 1991. *Theory and Problems of Genetics*. McGraw-Hill.
27. Watson, J.D. 2004. Molecular Biology of the Gene. 5th ed. Pearson Educat., Delhi, 711 pp
28. Wilson EB. 1900. *The Cell in Development and Inheritance*. 2nd Ed. The MacMillan Co.
29. Wolfe, S.L. 1995. Introduction to Cell and Molecular Biology. Wordsworth Publ. Co., Belmont, 805 pp.
30. Zipursky, L. and Darnell, J. 2004. *Molecular Cell Biology*. 5th Ed. WH Freeman.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-524
COURSE TITLE : AQUATIC MICROBIOLOGY
CREDITS : (2+1); Hours (32+32)
SEMESTER : II
PRE-REQUISITS, IF ANY: Nil

AIM:

- To gain knowledge on theory and practice on Aquatic Microbiology
- To understand microbial diversity and biotechnological application of microbes.

COURSE DESCRIPTION:

The encompasses information on importance and significance of studying Aquatic Microbiology, methods of sampling, enumeration and identification aquatic microorganisms; Diversity of microorganism, structure and classification of various microbes; Microbial nutrition, role of microbes in biogeochemical cycles; Microbes associated with fishes, indicator of aquatic pollution; Biofilms and Biofouling; Microbial biodegradation; Microbes of biotechnological importance; Marine Extremophiles. Training on preparation of media, sterilization, enumeration of microbial population, isolation and identification of bacterial strains will be available.

COURSE CONTENT

Theory

Unit 1

General introduction to microbiology. Aquatic microbiology - importance and significance. Methods of studying the aquatic microorganisms - Collection, Enumeration, Isolation, and Culture. Identification based on Morphological, Physiological and Biochemical characteristics. Preservation of Aquatic microbes. Culture collection Centres.

Unit 2

Diversity of microorganism - Archaea, bacteria, cyanobacteria, fungi, viruses and actinomycetes. Structure of Bacteria, fungi, algae, and viruses; Classification of microbes – conventional and modern methods.

Unit 3

Microbial nutrition. Influence of physicochemical factors on the distribution and abundance of aquatic microorganisms. Microbial nitrogen fixation; Roles of microbes in biogeochemical cycles: Carbon, nitrogen and phosphorus cycle. Decomposition of organic matter.

Unit 4

Microbes associated with fish, food spoilage, fish and human pathogens. Indicator of Aquatic Pollution - Faecal coliforms; Prevention and control.

Unit 5

Microbial communities in the aquatic environment. Biofilms and Biofouling. Biocorrosion. Microbial interactions, symbiosis and antagonism. Microbial Diseases of Aquatic organisms.

Unit 6

Microbial biodegradation - natural and synthetic material in the aquatic environment. Hydrocarbon, Heavy metals, Pesticides, Plastics, Lignin, Cellulose degradation,

Unit 7

Microbes of Biotechnological importance; Primary and secondary metabolites (enzymes, antibiotics, organic acid, toxins etc.)

Unit 8

Marine Extremophiles: Survival at extreme environments, adaptive mechanisms in thermophilic, alkalophilic, asmophilic, barophilic, psychrophilic microorganisms. Hyperthermophiles and Halophiles, importance in biotechnology.

Practicals

1. Sterilization, Preparation of culture media, agar slants.
2. Enumeration of microbial population: Quantification of microbial load in water, sediment and aquatic organisms.
3. Isolation and purification of bacterial cultures.
4. Gram's Staining, morphological, physiological, biochemical characterization of microbes.
5. Demonstration of: Motility test. Gas and acid formation from carbohydrates. Hydrolysis of starch. Hydrolysis of casein. Hydrolysis of Tween 80.
6. Estimation of coliforms from water samples.

ASSESSMENT

Continuous Assessment: (40%)

- Attendance : 5%
- Two class tests, one presentation, records: 10%
- Two assignments: 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment (60%)

Three hour written exam with one word, short and descriptive questions with choices.

REFERENCES

1. Austin, B, and D.A Austin 1999. Bacterial Fish pathogens- Diseases of Farmed and Wild Fish. Springer.
2. Dhevendaran, K. 2008. Aquatic Microbiology. Southern Book Star, TVM, 242 pp.
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4. Ford, T.E., 1993. Aquatic microbiology. An ecological approach. Blackwell scientific publications, London, 518 pp.
5. Kirchman, D.L. 2008. Microbial Ecology of the Oceans John Wiley and Sons.
6. Mitra, A. & K. Banerjee. 2004. *Marine Microbiology*. Narendra Publishing House, Delhi, 159pp.
7. Pelezar, M.J., E.C.S. Cahn & H.R. Krieg 1981. Elements of Microbiology. McGraw Hill Book Co., NY, 692 pp
8. Percival, S.L. 2004. *Microbiology of Waterborne Disease*. Elsevier, Academic Press, New York, 480pp.
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10. Rheinheimer, G. 1971. Aquatic Microbiology. John Wiley & Sons, London.
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DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA

COURSE CODE: AQB-525

COURSE TITLE: INLAND FISHERIES

CREDITS: (2+1); Hours (32+32)

SEMESTER : II

PRE-REQUISITS, IF ANY: Nil

AIM:

- To impart knowledge on the role and relevance of inland fisheries.
- To provide information on management of inland fisheries.
- To impart basic practical skills in fisheries data collection and field work.

COURSE DESCRIPTION:

Major inland waters of the world and of India, their fish fauna; global inland fish production trends; major inland fish producing countries and ecosystems; theories of distribution of freshwater fishes in various inland water bodies of India; inland fisheries development in India and research institutions; detailed account on riverine, lacustrine, reservoir and estuarine fisheries, including crafts and gears; cold water fisheries of India and sport fishing; wetland and fisheries management; fishery management- rules and regulations.

COURSE CONTENT

Theory

Unit 1

Major inland waters of the world and of India, their fish fauna. Global inland fish production-Trends. Major inland fish producing countries and ecosystems. Theories of distribution of freshwater fishes in India. Categorization of different freshwater fisheries resources: Ponds, lakes, bheels, tanks, estuaries, brackish water lagoons, wetlands, biosphere reserves and mangroves and derelict water bodies.

Unit 2

Inland fisheries development in India, Freshwater fisheries research institutions in India (CIFRI, CIFA, NRCCWF).

Unit 3

Riverine fisheries: Ecology of river fisheries: fish fauna - size, abundance, subpopulation, migration, movements, feeding and reproduction. Major river systems of India and their fisheries. Development of inland fisheries Characteristics of fisheries: use, types of crafts and gear, preservation of fish, effects of other uses of river basins on fisheries. Assessment:

fishery potential, fishery and fish stock. Direct and Indirect effects of human intervention in rivers, habitat modification and improvement (rehabilitation of channels and flood plains), 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. Impacts of dams in riverine fisheries. Management of river systems for fisheries.

Unit 4

Reservoir fisheries: Introduction. Ecology and classification of reservoir fish fauna. Crafts and gears. Cage and pen culture. Pollution in reservoirs. Exotic fishes and their role in reservoir fisheries of India. Reservoir fisheries of Kerala. Management of reservoir fisheries. Culture based capture fisheries.

Unit 5

Lacustrine fisheries: Fish fauna of natural lakes. Management and conservation of fisheries of lakes.

Unit 6

Cold water fisheries of India. Management of cold water fishery. Development of sport fishing in India.

Unit 7

Estuarine fisheries: Introduction. Estuarine fishery resources of India in general and their management. Fisheries of major estuarine systems in India (short account). Fisheries of Hooghly-Matlah estuary. Brackishwater fishery resources of Kerala.

Unit 8

Swamps, marshes and rice fields fishery potential with special reference to mangroves. Importance of wetlands in fisheries resource management.

Unit 9

Brief history of Inland fishery management. Management and conservation of inland fishery resources. Fisheries legislation. Kerala inland fisheries bill. Government projects for enhancing Inland fish production

Practical

1. Collection and identification of fishes from rivers, reservoirs, lakes, estuaries and ponds.
2. Study of crafts and gear used in inland fishing.
3. Field visits to different types of inland aquatic habitats.
4. Catch data analysis on major freshwater resources

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- One assignment and one presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

READING LIST

1. Blaber, J.M. 1997. *Fish and Fisheries in Tropical Estuaries*. Chapman & Hall.
2. Cowx, I.G. 1996. Stock assessment in Inland Fisheries. Fishing News Books, Oxford, 513pp.
3. FAO 1999. Fish and Fisheries at Higher Altitudes: Asia FAO Fisheries Technical paper No. 385.
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22. Templeton. R. 1995. Freshwater Fisheries Management. Fishing News Books, Oxford, 241 pp.

23. Wanganeo & Ashwani. 2006. *Trends in Biodiversity & Aquaculture*. Daya publishing house, Delhi, 472pp.
24. Welcomme, R.L. 1979. *Fisheries Ecology of Floodplain Rivers*. Longman Inc., NY, 315 pp.
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DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA

COURSE CODE : AQB-526
COURSE TITLE : FRESHWATER AQUACULTURE
CREDITS : (2+1); HOURS (32+32)
SEMESTER : II
PRE-REQUISITS, IF ANY: NIL

AIM:

- To provide knowledge on Inland Aquaculture, a fast developing industry for the production of high protein rich food.
- To open avenues to the students as entrepreneurs in both self employment and also to support the economy of the country through export.
- To impart practical training on culture of fresh water organisms.

COURSE DESCRIPTION:

The students will be introduced to topics such as development of aquaculture, procedures for construction and management of aquaculture systems, effluent management system and role of export inspection agency, traditional aquacultural practices, culture of Indian major carps, fin fishes, waste water aquaculture, seed production of Indian Major carps, induced breeding, seed production of freshwater prawns and culture of cat fishes and air breathing fishes, modern concepts in integrated farming and its techno-economic feasibility, collection and transportation of feed. hypophysation, brood stock maintenance, and agencies promoting aquaculture. The course also include visit to fish farms and on hand training on fish culture and aquaculture practices.

Theory

Unit 1

Introduction to aquaculture. History of aquaculture. Objectives and scope of aquaculture. Comparative efficiency of aquaculture as a means of protein. Aquaculture systems: Extensive, semi-intensive and intensive culture of fish, Pen and cage culture in lentic and lotic water bodies, polyculture, composite fish culture. Need for aquaculture development Aquaculture – Global Scenario. Status of aquaculture in India.

Unit 2

Selection of site for aquaculture. Farm engineering: Surveying- leveling-trapezoidal and Simpson's rule, Calculation of earthwork for the construction of pond, soil sampling. Project formulation and layout for the construction of a fish pond. Design and construction of farm and hatcheries. Equipments in farm and hatchery. Water intake system, pumping - total head, discharge head, components of a pumping system. Reservoir and distribution of water to various systems.

Unit 3

Management of aquafarms: eradication of pests and predators, weeds and their control. Liming. Manuring. Water quality management and monitoring. Effluent treatment system. Environment impact assessment (EIA).

Unit 4

Culture practices. Selection of species for aquaculture. Exotic species and indigenous species under culture. Types of aquaculture: monospecies culture, polyculture, monosex culture, composite fish culture, integrated fish farming; cage and pen culture, cage aquaculture in Indian reservoirs; recirculatory systems. Sustainable aquaculture.

Unit 5

Traditional aquaculture practices in India - Pokkali culture. Culture of carps in India: Composite fish culture, recent advances in carp culture. Culture practice of important finfish species of the world and India. Breeding programs. Culture of freshwater prawns, monosex culture, advances in prawn culture. Wastewater-fed aquaculture. Biofloc technology. Impact of exotic fish species on Indian aquaculture.

Unit 6

Integrated farming systems: Design, farming practices, constraints and economics of IFS of fish with paddy, cattle, pig, poultry, duck, rabbit, etc.

Unit 7

Seed production and culture of Carps: Wild collection and transportation. Bundh Breeding. Brood stock maintenance. Chinese Hatchery. Hypophysation. Ovulating agents like Ovaprim, Ovotide, etc. Seed production of exotic carps. Design of carp hatchery. Composite fish culture. Seed production of freshwater prawns: water quality requirements, feeding, health management, design of prawn hatchery. Freshwater prawn culture and farm management. Seed production and culture of catfishes and air breathing fishes: Magur, Singhi, Channa, Pangasius.

Unit 8

All India Coordinated Research Project on Aquaculture of ICAR. Agencies promoting aquaculture: ADAK, Matsyafed, FFDA's and BFFDA's, FIRMA, KSCADC Ltd. (Kerala State Coastal Development Corporation).

Practical

1. Identification of aquatic weeds, pests and predators.
2. Measurement of water quality parameters.
3. Identification of culturable species.
4. Field visit to "Chemmeen Kettu".
5. Field visit to shrimp hatchery and farm.
6. Field visit to fish hatchery and farm.
7. Identification of carps brooders and seeds
8. Model Carp hatchery
9. Economics of carp hatchery and farm

10. Identification of freshwater prawn
11. Model prawn hatchery
12. Assessment of seed quality- stress test
13. Calculating carrying capacity of
14. pond and stocking density
15. Check tray assessment and feed ration calculation
16. Lime and fertilizer requirement calculations

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- One assignment and one presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

READING LIST

1. Agrarwal, S.C. 2007. A Handbook of Fish Farming. Narendra Publ. Hse., New Delhi, 133 pp.
2. Badapanda, K.C. 2012. *Aquaculture Vol.1* . Narendra Publishing House, Delhi, 496pp.
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24. Meehan, W.E. 2002. Fish Culture in Ponds and Other Inland Waters. H.R. Publ. Hse., Piliiani, 287 pp.
21. Midlen and TA Redding. 1998. *Environmental Management for Aquaculture*. Kluwer Publ.
22. New, M.B. 1982. Giant Prawn Farming. Elsevier Sci. Publ. Co., NY, 532 pp.
23. New, M.B. & S. Singholka 1985. Freshwater Prawn Farming. A manual for the culture of *Macrobrachium rosenbergii*. FAO Fisheries Technical Paper, 225 pp.
24. New M.B. & W.C. Valenti 2000. Freshwater Prawn Culture: The Farming of *Macrobrachium rosenbergii*. Blackwell Sci. Ltd. Oxford, UK, 443 pp.
25. Pandey, B.N., S. Deshpandey & P.N. Pandey. 2007. Aquaculture. APH Publ. Corpn., New Delhi, 236 pp.
26. Pillay, T.V.R. & Kutty, M.N. 2005. Aquaculture-Principles and Practices. 2nd ed. Blackwell Publ. Ltd., UK, 624 pp.
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**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE: AQB-531

COURSE TITLE: MARINE FISHERIES

CREDITS: (2+1); Hours (32+32)

SEMESTER : III

PRE-REQUISITS, IF ANY: Nil.

AIM:

- To introduce the nature and scope of marine fisheries, both at global and national levels
- To provide an overview on the principles of population dynamics and marine fisheries management.
- To impart practical training on marine fish and shellfish identification and fishery related research.

COURSE DESCRIPTION:

The course introduced the basics of marine fisheries of the world, common marine fisheries (both pelagic and demersal) resources of India (with special emphasis on fish, crustaceans and molluscs) and the scope for its management, socio-economic potentials of marine fisheries, impact of fishing on marine ecosystem, the need for conservation of marine resources, deep sea fishing, oceanic and deep sea fisheries of India, marine fishery regulations and policies in India, principles of fish population dynamics, including assessment of fish stocks. The students will get practical training on collection and identification of marine fishery resources, demonstration of craft and gears and biometric studies through the visits to fish landing centres.

COURSE CONTENT:

Theory

Unit 1

Introduction to marine fisheries of the world. Major fishing zones of world and India. Trends in fish production. Introduction to marine fisheries of India. Pelagic and demersal fishery resources of India. Marine capture fishery of Kerala. Mud bank fishery- wedge bank fishery.

Unit 2

Pelagic fisheries of India: sardines, mackerels, anchovies, white baits, tuna, seer fish, carangids, ribbonfish, shads and other clupeids, barracudas, Bombay duck, pomfrets, mullets. Features and trends in the production of pelagic fisheries. Conservation of pelagic fish stocks.

Unit 3

Demersal fisheries of India: sharks, major perches, threadfin, breams, sciaenids, silver belly. Features and trends in production of demersal fisheries. Impact of trawling. Conservation of demersal fish stocks.

Unit 4

History of deep sea fishing. Oceanic and deep sea fisheries of India. Potential resources. Deep scattering layer fish biomass. Deep sea fishing policy of India.

Unit 5

Crustacean fishery of India: Penaeid and non-penaeid shrimp fisheries. Stock assessment and management options. Lobster fishery. Crab fishery.

Unit 6

Molluscan fishery of India: Mussel fishery. Clam fishery. Cephalopod fishery. chank fishery.

Unit 7

Principles of fish population dynamics: Recruitment. Growth. Mortality. Catch per unit effort. Population studies and stock assessments: Population structure: Age-length and sex composition. Estimation of population size. Marking and tagging. Population dynamics. Population models. Stability of exploited population – Maximum Sustainable Yield. Assessment of fish stocks.

Practical

1. Collection and identification of marine food fishes.
2. Collection and identification of commercially important shellfishes.
3. Biometric studies on fin- and shellfishes.
4. Visits to landing centres (Reports).
5. Demonstration of crafts and gear

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- One assignment and one presentation; one class test/practicals: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

READING LIST

1. Aravind Kumar, 2004. Fishery Management. APH Publ. Corpn., New Delhi, 371 pp.
2. Bal, D.V. & K.V. Rao 1984. Marine Fisheries. Tata McGraw Hill Publ. Co. Ltd., New Delhi, 470 pp.
3. Belgrano & Andrea. 2011. *Ecosystem Based Management for Marine Fisheries*. Cambridge University Press, Cambridge, 402pp.
4. Dholakia, A.D. 2004. Fisheries and Aquatic Resources of India. Daya Publ. Hse., Delhi.
5. FAO (2012). The State of World Fisheries and Aquaculture. FAO Fisheries and Aquaculture Department, FAO, Rome
(<http://www.fao.org/docrep/016/i2727e/i2727e00.htm>)
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7. Gulland, J.A. 1983. Manual of Methods for Fish Stock Assessment part 1. Fish Population Analysis, FAO Manuals in Fisheries Science No. 4.
8. ICAR 2011. Handbook of Fisheries and Aquaculture. ICAR, New Delhi, 1116 pp.
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11. Kurian CV and V.O Sebastian VO. 1986. *Prawns and Prawn Fisheries of India*. Hindustan Publ. Corp.
12. Misra, K.S. 2003. An Aid to Identification of the Common Commercial Fishes of India and Pakistan. Narendra Publ. Hse., New Delhi, pp.
13. Modayil, M.J. & N.G.K. Pillai. 2007. *Status & Perspective in Marine Fisheries in India*. CMFRI, Kochi, 404pp.
14. Pillai, NGK. 2011. Marine Fisheries and Mariculture in India. Narendra Publishing House, Delhi.
15. Rounstill, G.A. 1985. Fishery Science. Methods and Application. Internat. Books Periodicals Suppl.
16. Sparre & Venema Introduction to tropical fish stock assessment Part-1 Manual, Food & Agriculture Organisation of UN, Rome.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-532
COURSE TITLE : COASTAL AQUACULTURE AND MARICULTURE
CREDITS : (2+1); HOURS (32+32)
SEMESTER : III
PRE-REQUISITS, IF ANY: NIL

AIM:

- To provide state of the art knowledge on coastal aquaculture and mariculture
- To open avenues to students as entrepreneurs in both self-employment and also to support the economy of the country through export.
- To impart practical training on culture of marine organisms.

COURSE DESCRIPTION:

The course introduces the topics such as status of coastal aquaculture and mariculture, different farming systems and principles of aquaculture and mariculture, design and construction of shrimp and fish hatchery, water quality management. Culture and seed production of crustaceans, echinoderms and fish, species diversification, positive and negative impacts of introduced species, and management of mariculture. Practical training on identification of fish and shellfish and their larvae, culture of live feed, model shrimp hatcheries and field visit to culture systems and hatcheries are part of the course.

COURSE CONTENT

Theory

Unit 1

Overview of status of coastal aquaculture and mariculture- global and Indian perspective; scope, potential and emerging trends. Different farming systems, Traditional, extensive, modified extensive, semi intensive and intensive. Satellite farming. Culture of marine fin and shell fishes. Distribution and biology of culturable species. Principles of coastal aquaculture and mariculture. Aquaranching.

Unit 2

Site selection, design and project preparation for the establishment of a shrimp hatchery. Culture of shrimps: stocking, water quality, feeding, health management, harvesting. Selection of site and selection of materials for pen/cage culture. Important fishes cultured in the open seas and culture systems.

Unit 3

Seed production and culture of brackishwater fishes pearl spot, sea bream, groupers, yellow tail, eel, cobia, pompano. Shrimp seed production: brood stock maintenance, larval stages, feeding, water quality requirements, health management, packing and transportation, design of shrimp hatchery.

Unit 4

Seed production and culture of crabs and lobsters.

Unit 5

Seed production and culture of mussels, oysters and clams. Pearl production.

Unit 6

Culture of sea cucumbers. Seed production technology. Culture of sea urchins.

Unit 7

Species diversification in aquaculture. Positive and negative impacts of introduced species

Practical

1. Identification of Mullet, Milkfish, Seabass
2. Identification of cultured shrimps and different larval stages.
3. Model shrimp hatchery
4. Economics of shrimp hatchery and farm
5. Identification of crabs and lobsters
6. Identification of culturable sea weeds and products extracted from them
7. Culture of live feed organisms: Artemia, Skeletonema
8. Controlled rate freezer and its use in cryopreservation

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- One assignment and one presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

READING LIST

1. Bardach, J.E. J.H. Rhyther and W.O. McLarney 1972. *Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms*. Wiley Intersci., NY, 868 pp.
2. Biswas, K.P. 2011. *Marine Prawns & Shrimps*. Daya Publishing House, Delhi, 329pp.
3. Bensam, P. and P. Vasudeva. 1993. *Hand Book on Aquafarming: Seafishes Oceanic Cage culture*. Manual. MPEDA, Cochin, Kerala.
4. Felix, S. 2009. *Advances in shrimp Aquaculture Management*. Daya Publishing House, Delhi, 192pp.

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6. Huet, M. 1972. *Text book of fish culture: Breeding and cultivation of fish*. Fishing News (Books) Ltd. Farnham, Surrey, U.K. 436 pp.
7. ICAR 2011. *Handbook of Fisheries and Aquaculture*. ICAR, New Delhi, 1116 pp.
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9. Jhingran, V.G. 1983. *Fish and Fisheries of India*. Hindustan Publ. Corpn. (India), Delhi, 666 pp.
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15. Philipose, KK, L. Jayasree, S.R. Krupesha and D. Damodaran eds. 2012. *Handbook on Opensea Cage Culture*. Central Marine Fisheries Research Institute, Karwar, 143pp.
16. Pillai, N.G.K. 2011. *Marine Fisheries & Mariculture in India*. Narendra Publishing House, Delhi, 352pp.
17. Pillay, T.V.R. & M.N. Kutty 2005. *Aquaculture: Principles and Practices*. Blackwell Publ. Ltd., Oxford, UK, 624 pp.
18. Purdom & Colin. 2009. *Genetics & Fish Breeding*. Chapman & Hall Ltd., London 277pp.
19. Radhakrishnan, E.V. 2011. *Handbook of Prawns*. CMFRI, Cochin. 125pp.
20. Rao, G Syda and Imelda, Joseph and Philippose, K K and Mojjada, Suresh Kumar. 2013. *Cage Aquaculture in India*. Central Marine Fisheries Research Institute, Kochi.
21. Shagufta. 2012. *Fisheries Aquaculture & Biotechnology*. APH Publishing Corporation. New Delhi, 259pp.
22. Stickney, R. R. 1979. *Principles of warmwater aquaculture*. John Wiley & Sons, New York, Wiley Interscience, 376 pp.
23. Wheaton, F.W. 1977. *Aquaculture Engineering*. Wiley Interscience, New York, 708 pp.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-533
COURSE TITLE : AQUARIUM MANAGEMENT AND ORNAMENTAL FISH CULTURE
CREDITS : (2+1); HOURS (32+32)
SEMESTER : III
PRE-REQUISITS, IF ANY: NIL.

AIM:

- To introduce the nature and scope of aquarium management and ornamental fish culture
- To impart knowledge on self-employment opportunities in ornamental fish culture and aquarium management.
- To impart practical skills to students on aquarium management and ornamental fish culture.

COURSE DESCRIPTION:

Course provides knowledge on diversity of ornamental fish and plants, history and development of aquarium keeping and ornamental fish culture, principles of setting up and management of aquaria, breeding biology of various ornamental fishes, commercial farming techniques, seed production, packing and transportation of ornamental fishes, feeding and nutrition of ornamental fishes, prophylaxis and quarantine and disease management, live feed culture and formulation of feeds, water quality management, preparation of artificial sea water and diseases and health management, and application of modern biological and biotechnological tools for genetic improvement. Besides this, practical training imparted on aquarium keeping and ornamental fish culture would provide them with opportunities for seeking self-employment in this sector.

COURSE CONTENT:

Theory

Unit 1

Diversity of ornamental fish. Major hotspots of ornamental fish- global and Indian perspective. Ornamental fish trade- global and Indian perspective. Preferred species in trade. Contribution of marine and freshwater fishes. Major ornamental fish species of India. Ornamental plants. Ornamental invertebrates.

Unit 2

History of aquarium fish keeping. Etiology of aquarium. Biotope aquarium. Vivarium, insectarium, terrarium, paludarium, oceanarium, dolphinarium. Reef aquarium. Nano aquariums. Role of public aquaria. Aquarium keeping as a hobby.

Unit 3

Principles of setting up and maintenance of aquaria: Construction of aquarium. Aquarium accessories- aerators, filters, skimmers, chillers, lighting, decorates, etc. Latest trends in aquarium tanks.

Unit 4

Reproductive biology. Sex determination in ornamental fish. Breeding and seed production of common ornamental fishes: Construction of breeding tanks. Larval rearing. Commercial farming technologies. Indigenous ornamental fishes and their culture, propagation and trade. Ornamental aquatic plants: Propagation methods, nutrient and environmental requirement, cropping methods, packing and transport.

Unit 5

Packaging, transportation and marketing of aquarium fishes. Anaesthetics used in the trade. Problems in ornamental fish export. Prophylaxis and quarantine.

Unit 6

Feeding and nutrition of ornamental fishes. Nutritional requirements of aquarium fish. Larval feeding. Live feed culture. Artemia culture, infusoria, brachionus culture, development of livefeed culture lab. Formulated feeds. Preparation of aquarium fish food. Colour enhancement techniques.

Unit 7

Water quality management. Preparation of artificial sea water. Acclimatization of marine ornamentals to fresh water. Common diseases and parasites of freshwater and marine ornamental fish. Health management of aquarium fishes.

Unit 8

Genetic improvement in ornamental fishes. Genetic manipulation and production of new strains; hybrids. Pedigree maintenance. Ornamental fishes as a biotechnological tool. Green certification. Regulations in ornamental fish trade in India.

Practical

1. Identification of common ornamental fishes and ornamental aquarium plants.
2. Preparation of feeds and practicing feeding schedules.
3. Aquarium fabrication and maintenance
4. Breeding trials on selected aquarium fishes.
5. Culture of live feed organisms.
6. Therapeutic methods applicable to aquarium fishes.
7. Identification of common diseases and parasites of fish
8. Induced breeding and hypophysation.

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- One assignment and one presentation; one class test/Practicals: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

READING LIST

1. Alappat, H.J. & A. Biju Kumar 1996. Aquarium Fishes (A Colourful Profile). B.R. Publ., Delhi, 106 pp.
2. Atz, W. 1971. Aquarium Fishes. Pelham Books Ltd., London, 110 pp.
3. Axelrod, H.R. & W. Vorderwinkler 1962. Encyclopedia of Tropical Fishes with Special Emphasis on Techniques of Breeding. TFH. Publ., Inc., NJ, 763 pp.
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6. Faulkner, D. & J.W. Atz 1971. Aquarium Fishes, Their Beauty, History and Care. Pelham Books, London, 110 pp.
7. Favre, H. 1977. Dictionary of the Freshwater Aquarium. Wardlock Ltd., London, 160 pp.
8. Frey, H. 1961. Illustrated Dictionary of Tropical Fish. TFH. Publ. Inc., NJ, 768 pp.
9. Gohm, D. 1984. Tropical Fish. Hamlyn Publ. Group Ltd., London, 143 pp.
10. Gopakumar G. 2011. *Marine Ornamental fish Culture: Package of Practices*. CMFRI Cochin. 100pp.
11. ICAR 2011. Handbook of Fisheries and Aquaculture. ICAR, New Delhi, 1116 pp.
12. Innes, W.T. 1953. Exotic Aquarium Fishes. Innes Publ. Co., Philadelphia, 533 pp.
13. Kurup, M.B. 2008. Ornamental Fish Farming, Breeding and Trade. Dept. Fish., Govt. Kerala, 280 pp.
14. Meenakshi, J., N.K. Yadava & R.K. Gupta. 2010. *Freshwater Ornamental Fishes*. Mangalam Publications, Delhi, 397pp.
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17. Mills, D. 1987. The Practical Encyclopedia of the Marine Aquarium. Salamander Books Limited, London.
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22. Santhanam, R., N. Sukumaran & P. Natarajan 1984. *A Manual of Freshwater Aquaculture*. Oxford & IBH Publ. Co. Pvt. Ltd., New Delhi, 193 pp.
23. Talwar, P.K. & A.G. Jhingran 1991. *Inland Fishes of India and Adjacent Countries*, Vols. I & II. Oxford & IBH Publ. Co., Pvt. Ltd., New Delhi, 1158 pp.
24. Thabrow De WV. 1981. *Popular Aquarium Plants*. Thornbill Press.
25. Wabnitz, C., M. Taylor, E. Green & T. Raza From Ocean to Aquarium. *Global trade in Marine Ornamental Species*. UNEP World Conservation Monitoring Centre, Cambridge, U.K., 64 pp.
26. Wilkie, D. 1971. *Aquarium Fish*. Pelham Books Ltd., London, 214 pp.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-534

COURSE TITLE : FISH NUTRITION

CREDITS : (2+1); HOURS (32+32)

SEMESTER : III

PRE-REQUISITS, IF ANY: PRINCIPLES OF AQUACULTURE IN AQB526

AIM:

- To impart knowledge on major nutrients and their importance in the diet
- To introduce the concept of nutrition and metabolism of fish in aquaculture.
- To provide practical skills for the formulation of feed for aquaculture.

COURSE DESCRIPTION:

The course is designed to provide a comprehensive overview of fish nutrition and feed industry. The focus of the paper is to familiarise students to major nutrients, feed formulation, feed ingredients, various aquaculture feeds, feeding practices and their evaluation. Emphasis is also on nutritional requirement and bioenergetics of cultured fishes. A descriptive overview of digestion, absorption and assimilation of major nutrients are additives. Field trips to feed mill/fish meal plant and aquaculture facilities to gain practical exposure is also included.

COURSE CONTENT:

Theory

Unit 1

Major nutrients: Proteins, Lipids, Carbohydrates, Vitamins, Minerals; Feed additives. Antimetabolites, antinutritional factors.

Unit 2

Feed formulation: common ingredients, importance of protein source, methods of feed formulation. Farm made feeds

Unit 3

Types of feed in aquaculture; Parts of feed mill; Water stability; Storage; Spoilage. Feeding devices, feed ration, feeding frequency, Live feeds

Unit 4

Evaluation of feed: FCR, PER, NPU, Chemical score, Biological value. Growth: absolute growth, relative growth, SGR, Percentage weight gain

Unit 5

Bioenergetics: Energy budget; Gross energy, Digestive energy, metabolizable energy

Unit 6

Digestive organs of fish and shell fishes. Digestive enzymes. Digestion, absorption and assimilation of major nutrients. Digestibility

Unit 7

Metabolism: Carbohydrates, lipids, proteins

Unit 8

Nutritional requirement. Experimental diet, reference diet, purified and semi-purified diet. Nutrient requirement in different life stages.

Practical

1. Identification of different feed ingredients
2. Visit to feed mill/fish meal plant
3. Proximate composition of feed ingredients
4. Formulation of feed using locally available ingredients.

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation: 5%
- One assignment and one presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions: 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

READING LIST

1. Bardach, J.E. 1972. *Aquaculture: The Farming and Husbandary of Freshwater and Marine Organisms*. Wiley-Interscience, London.
2. Chandrasekhar, Y.S. 2013. *Fish Nutrition in Aquaculture*. Swastick Publications, Delhi.
3. Cowey, C.B. et al. 1985. *Nutrition and Feeding in Fish*. Academic Press, New York
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5. Halver, J.E. 1972. *Fish Nutrition*. Academic Press, London.
6. Hasan, M.R. 2007. *Economics of Aquaculture Feeding Practices in selected Asian countries*. FAO of the UN, Rome
7. Hasan, M.R. 2007. *Study and analysis of feeds and fertilizers for sustainable aquaculture development*. FAO of the UN, Rome
8. Holt, G.J. 2011. *Larval Fish Nutrition*. Springer-Verlag, New York
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10. Leiwes, E.W. 1984. *Culture, Feeding and Diseases of Commercial flatfish species*. Oxford and IBH Publishing Company Pvt. Ltd., New Delhi.

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12. Long, A.C. 2012. *Fish feeding and integrated fish farming*. Cybertech Publications, Delhi.
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15. Paulraj, R. *Aquaculture Feed*, MPEDA, Cochin.
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17. Raghunath, M.R. 2013. *Nutrition and Feeding of Fishes*. Swastik Publishing House, Delhi.
18. Stickney, R.R. 1979. *Principles of warm water aquaculture*. John Wiley & Sons, New York
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**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-535
COURSE TITLE : FISH HEALTH MANAGEMENT
CREDITS : (2+1); HOURS (32+32)
SEMESTER : III
PRE-REQUISITS, IF ANY: AQB515, AQB521 AND AQB526

AIM:

- To provide an overview of pathological processes in fish
- To introduce different fish and shell fish diseases of both pathogenic and non-pathogenic origin and their management
- To provide an overview of the immune system of fish and shell fish.

COURSE DESCRIPTION:

The course provides equal focus on three aspects of health management; pathological processes, diseases of pathogenic and non-pathogenic origin and immunology of fin fishes and shell fishes. Major diseases in Indian aquaculture are dealt in detail along with diseases of economic significance elsewhere. Prophylaxis, treatments and management options for ensuring success in aquaculture is discussed. The pathological changes are discussed in detail. An overview of fish and shell fish immunology is also covered.

COURSE CONTENT:

Theory

Unit 1

General principles: Concepts of health, stress and disease. Theories on diseases. Classification of diseases. Fish diseases – An overview. Retrospect. Importance.

Unit 2

Finfish diseases: Viral. Bacterial. Fungal. Protozoal. Parasitic. Non-communicable diseases (Environmental. Nutritional. Genetic). Neoplasia.

Unit 3

Shellfish diseases: Major microbial and parasitic diseases of shrimps and prawns. crabs and molluscs of culture importance.

Unit 4

General Principles of Immunology. Types and nature of immune mechanisms. Non-specific Defence. Endocytosis and phagocytosis. Inflammation. Cellular transformations.

Cellular non-specific defence: Neutrophils and phagocytosis. MPS. Humoural non-specific defence: Humoural factors in non-specific defence (Lysozyme. Complement. Interferon. CRP. Transferrins. Lectins. Properdins. Other humoural factors)

Specific Defence Mechanisms in Vertebrates: Cellular specific defence: Lymphocytes. Humoural specific defence: Antigens (Essential features. Epitopes. Cross reactivity). Antibodies (Properties. Structure of immunoglobulins. Immunoglobulin classes.

Unit 5

Vaccines and vaccination. Vaccines in fish disease control. Adjuvants. Immuno stimulants, probiotics in fish health.

Unit 6

Drugs used in aquaculture, action of drugs and chemicals used in aquaculture, antibiotic resistance, Regulations on the use of drugs in aquaculture

Unit 7

Disease diagnosis: PCR, Histopathology, ELISA. Screening of broodstock and juveniles for aquaculture,

Unit 8

Management of fish and shellfish diseases: Prophylaxis and therapy. Quarantine. Biosecurity. Emerging diseases in Indian aquaculture.

Practicals

1. Identification fish and shellfish pathogens/parasites
2. Diagnosis for viral diseases in shrimps by PCR
3. Histopathology

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- One assignment and one presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

References

1. Amlacher, E. 1997. Textbook of Fish Diseases. (Transl. D.A. Conroy & R.L. Herman), Narendra Publ. Hse., Delhi, 302 pp.
2. Anderson & Douglas. 2003. *Fish Immunology: Diseases of fishes*. Narendra Publishing House, Delhi, 239pp.
3. Archana, P. 2010. *Fish Immunology & Biotechnology*. Swastik Publications, Delhi, 311pp.
4. Biswas, K.P. 1992. Prevention and Control of Fish and Prawn Diseases. Narendra Publ. Hse., Delhi, 144 pp.
5. Chakrabarti, N.M. 1994. Diseases of Cultivable Freshwater Fishes and Their Control. Internat. Books Periodicals Supply Serv., Delhi, 149 pp.
6. Egusa, S. 1991. Infectious Diseases of Fish. Oxonian Press, New Delhi, India, 696 pp.

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23. Woo, P.T.K. 2006. Fish Diseases and Disorders: Protozoan and Metazoan Infections. Fish Diseases and Disorders. Vol. 1. 2nd ed. CABI Publ., Wallingford, UK, 791 pp
24. Woo, P.T.K. & D.W. Bruno 1999. Viral, Bacterial and Fungal Infections. Fish Diseases and Disorders. Vol. 3. CABI Publ., Wallingford, UK, pp.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-536
**COURSE TITLE : FISHING TECHNOLOGY AND SUSTAINABLE FISHERIES
MANAGEMENT**
CREDITS : (2+1); HOURS (32+32)
SEMESTER : III
PRE-REQUISITS, IF ANY: NIL

AIM:

- To introduce the materials used for the construction of fishing gears
- To introduce different fish catching methods of the world, their classifications and concepts of sustainable fisheries management
- To introduce fishing vessels of India and the world

COURSE DESCRIPTION:

The course is aimed at providing a practical understanding of the capture fisheries sector. Fishing methods of the world and its classification is introduced with focus on techniques widely followed in India. Different gear materials and their properties are also introduced. Fishing vessel designs along with equipment for various fishing operations is discussed. Fish finding devices and navigational devices used in fishing vessels are also introduced. The course also examines sustainability issues capture fisheries and discuss management options based on FAO-CCRF.

COURSE CONTENT:

Theory

Unit 1

ISSCFG classification of fishing gears. Detailed account.

Unit 2

Design, fabrication and operation of major fishing gears in India: trawls, purse seines, gill nets, trammel nets, dol nets.

Unit 3

Important fishing boats of India; classification.

Unit 4

Sea safety equipments, communication devices, navigational devices, fish finding equipments.

Unit 5

Bycatch reduction methods; prohibited fishing practices; turtle excluder device; Vessel monitoring system (VMS); catch certification

Unit 6

CCRF Article 8: Fishing operations.

Practical

1. Drawing gear designs
2. Visit to fishing vessel and report preparation
3. Visit to fishing harbours to observe the layout and design

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- One assignment and one presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

References

1. Aravind Kumar, 2004. Fishery Management. APH Publ. Corp., New Delhi, 371 pp.
2. Belgrano & Andrea. 2011. *Ecosystem Based Management for Marine Fisheries*. Cambridge University Press, Cambridge, 402pp.
3. Charles, AT. Sustainable Fishery Systems. Blackwell Science Ltd., Oxford.
4. Gillett, R. 2008. *Global Study of Shrimp fisheries*. FAO, London, 208pp.
5. Gulland, J.A. 1983. Manual of Methods for Fish Stock Assessment part 1. Fish Population Analysis, FAO Manuals in Fisheries Science No. 4.
6. James Hindson, Daniel D. Hoggarth, Mohan Krishna, Christopher C. Mees, Catherine O'Neill. 2005. How to Manage a Fishery. Marine Resources Assessment Group (MRAG), London, Centre for Environment Education, Ahmedabad and Scales Consulting Ltd, London.
7. ICAR 2011. Handbook of Fisheries and Aquaculture. ICAR, New Delhi, 1116 pp.
8. Jhingran, V.G. 2007. Fish and Fisheries of India. 3rd ed. Hindusthan Publ. Corp., New Delhi, 727 pp.
9. McLeod, Karen and Leslie. Heather (Eds.) (2009) *Ecosystem-Based Management for the Oceans* Island Press
10. Modayil, M.J. & N.G.K. Pillai. 2007. *Status & Perspective in Marine Fisheries in India*. CMFRI, Kochi, 404pp.

11. Norse, Elliott A. and Crowder, Larry B. (Eds.) (2005) *Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity*, Island Press
12. Pillai, NGK. 2011. *Marine Fisheries and Mariculture in India*. Narendra Publishing House, Delhi.
13. Sharma A.P. 2012. *Management issues in Inland Fisheries and Aquaculture*. Narendra Publishing House, Delhi, 243pp.
14. UNEP 2009. *Certification and sustainable fisheries*. UNEP, Nairobi
15. Winter, Gerd (Ed). 2009. *Towards Sustainable Fisheries Law. A Comparative Analysis*. IUCN, Gland, Switzerland. xiv + 340 pp

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-541
COURSE TITLE : FISH PROCESSING TECHNOLOGY
CREDITS : (3+1); HOURS (48+32)
SEMESTER : IV
PRE-REQUISITS, IF ANY: NIL

AIM:

- To understand in detail the spoilage of fish along with associated factors
- To understand the principles and practices associated with various methods of fish preservation
- To introduce the bacterial quality of fish with an overview of the current quality assurance regimen

COURSE DESCRIPTION:

The coursework is aimed at imparting sufficient theoretical knowledge for managing the production and quality assurance sections on fish processing factories. It provides understanding of the post mortem spoilage of fish emphasizing the need for preservation. Common methods of preservation are dealt in detail with added focus on techniques of economic importance to our region. Spoilage and pathogenic bacterial populations in fish is examined. Quality assurance systems like HACCP currently in practice are understood. Visits to fish processing factories will aid in better understanding of the theoretical aspects.

COURSE CONTENT:

Theory

Unit 1

Importance of fish in human diet. Nutritional quality of Fish. Proximate composition of fish. Spoilage of fish, Rigor mortis.

Unit 2

Drying: Basic principles, natural drying packing and storage of dried fish. Salting: principles, quality of salt, Kench salting, brine sailing. Smoking: Principles of smoking, cold smoking, hot smoking, fuel, packing and storage of smoked fish. Chilling: Manufacture and storage of ice, quality of ice, methods of chilling. Freezing: Basic principles, methods and application of chilling, Block freezing, Individual quick freezing (IQF), storage of chilled and frozen fish. Thermal processing. Canning. Other methods of processing and preservation. Spoilage in preserved seafood.

Unit 3

Fundamental aspects of quality control in sea food. Inspection of sea food quality. Different aspects of sea food quality. National agencies for sea food inspection. HACCP. Hygiene in processing plants.

Unit 4

Miscellaneous fishery products. Fishery by-products.

Unit 5

Bacteriology of fish and shellfish. Spoilage Bacteria. Bacteria of human health significance in seafood.

Practical

1. Visits to fish processing plant, ice plant and fish landing centre.
2. Proximate analysis of fish
3. Preparation of fishery products

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- One assignment and one presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

READING LIST

1. Bremmer, H.A. 2002. Safety and Quality Issues in Fish Processing. Woodhead Publ. Ltd., England, 507 pp.
2. Curting, C.L. 1999. Processing and Preservation. Agro Botanical Publ., Bikaner, India, 372 pp.
3. Gopakumar, K. 2002. Textbook of Fish Processing Technology. Indian Council of Agricultural Research, New Delhi, 491 pp.
4. Hall, G.M.1992 Fish Processing Technology. Chapman & Hall India, Madras, India, 309 pp.
5. ICAR 2006. Handbook of Fisheries and Aquaculture. Directorate of Information and Publication of Agriculture, ICAR, New Delhi, 755 pp.
6. Kulikov, P.I. 1978. Preparation of Meal, Oil and Protein-Vitamin Preparations in the Fishing Industry. Amerind Publ. Co. Pvt. Ltd., New Delhi, 253 pp.
7. Long, A.C. 2008. Fish Processing Technology. Cybertech Publ., New Delhi, 312 pp.
8. Moorjani, M.N. 1984. Fish Processing in India. Publ. Infor. Div., ICAR, New Delhi, 82 pp.
9. Murano, P.S. 2003. Understanding Food Science and Technology. Wordsworth/Thomson Learning, Belmont, USA, 449 pp.

10. Ninawe, A.S. & K. Rathnakumar 2008. Fish Processing Technology and Product Development. Narendra Publ. Hse, New Delhi, 562 pp.
11. Novikov, V.M. 1983. Handbook of Fishery Technology. Vol. 4. Amerind Publ. Co. Pvt. Ltd., New Delhi, 491 pp.
12. Pearson, A.M. & T.R. Dutson 1999. HACCP in Meat, Poultry and Fish Processing. In, Advances in Meat Research Series, Vol.10. Aspen Publication, Maryland, 393 pp.
13. Sen, D.P. 2005. Advances in Fish Processing Technology. Allied Publ. Pvt. Ltd., New Delhi. 818 pp.
14. Stansby, M.E. 1963. Industrial Fishery Technology. Reinhold Publ. Co., NY, 393 pp.
15. Windsor, M. & S. Barlow 1981. Introduction to Fishery By-products. Fishing News Books Ltd, Surrey, England, 187 pp.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-542
**COURSE TITLE : FISHERY ECONOMICS, FISHERY EXPORT AND
MARKETING**
CREDITS : (2+1); HOURS (32+32)
SEMESTER : IV
PRE-REQUISITS, IF ANY: NIL

AIM:

- To understand the basic economic concepts involved in fisheries and aquaculture
- To introduce the global fish trade
- To understand the marketing of fish in India.
-

COURSE DESCRIPTION:

The coursework is aimed at three aspects: imparting knowledge on the economic considerations in fisheries sector and options for management of resources, understanding the global fish trade with emphasis on fish exports from India and to understand the way inland and marine fish marketing channels work in India. Emphasis is also given to different agencies in fisheries export and marketing.

COURSE CONTENT:

Theory

Unit 1

Bio-economic model of the fishery. Cost components in fishing effort.

Unit 2

Population equilibrium analysis, sustainable yield curves, overfishing and under fishing, open access fisheries.

Unit 3

Management of fisheries: regulation of commercial fisheries. Importance of fisheries in the World and Indian economics. Fishery resources of India and production.

Unit 4

Economics of different aquaculture systems. Factors affecting economics of aquaculture. Socio-economic issues in aquaculture development.

Unit 5

International trade of seafood and trade regulations. Seafood Export promotion in India. MPEDA. Status of Indian seafood export. Procedures for seafood export. Quality regulations in Indian seafood export.

Unit 6

Inland and marine fish marketing in India. Role of cooperatives in marketing. Case study of Matsyafed.

Practical

Estimation of costs and returns of different aquaculture systems

Case studies – visit to fish farms, prawn farms and hatcheries – discussion on socioeconomic issues in aquaculture development.

Data collection on cost and returns of different fishing methods

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- One assignment and one presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

READING LIST

1. Badapanda, K.C. 2012. *Fishery Economics & Administration*. Narendra Publishing House, Delhi, 427pp.
2. Chaston I. 1983. *Marketing in Fisheries and Aquaculture*. Fishing News Books.
3. Cunninghams, M., R. Dunn & D. Whilmarsh. 1985. *Fishery Economics - an introduction*. Mansell publishing Ltd. London.
4. Dholakia, A.D. 2004. *Fisheries and Aquatic Resources of India*. Daya Publ. Hse., Delhi,
5. Dunne EB. 1990. *Fisheries Economics - An Introduction*. Mansell Publ.
6. FAO. *Code of Conduct for Responsible Fisheries*. Rome, FAO. 2011. 91 pp.
7. Grafton QR, Kirkley J, Kompas T & Squire D. 2006. *Economics for Fisheries Management*. Ashgate Publ. Co.
8. Ian C. 1984. *Marketing In Fisheries and Aquaculture*. Fishing News Books.
9. Munro GR & Scott A. 1984. *The Economics of Fisheries Management*. University of British Columbia.
10. Palanisamy K, Paramasivam P & Renganathan CR. 2002. *Agricultural Production Economics, Analytical Methods and Applications*. Associated Publ. Co.
11. Rao, P.S. 1983 *Fishery Economics and Management in India*. Pioneer Publ. & Distributors.
12. Sathiadas, R. 2012. *Marine Fishery Marketing in India*. CMFRI, Cochin, 276pp.
13. Shang YC. 1981. *Aquaculture Economics*. Westview Press.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-543
**COURSE TITLE : LAWS AND POLICIES IN FISHERIES AND FISHERIES
EXTENSION**
CREDITS : (2+1); HOURS (32+32)
SEMESTER : IV
PRE-REQUISITS, IF ANY: NIL

AIM:

- To familiarize the laws and regulations enacted for the judicious usage of fish and fisheries in the state.
- To study the need for extension in fisheries and aquaculture.
- To familiarize the philosophy, principles, concepts and practices of fisheries extension system, its scope and importance.

COURSE DESCRIPTION:

The course will introduce the need for policies and regulations, conservation of water wealth and biodiversity, international initiatives such as code of conduct for responsible fisheries, CITES, CMS, etc and Indian acts such as MPEDA act, coastal aquaculture authority act, wildlife (protection) act of India, fisheries policies of Kerala, KMFR act Ban on trawling, Kerala inland fisheries act, extension in fisheries and aquaculture, introduction to extension education and methods, participatory fisheries extension approaches, aquaculture extension systems, market-led extension approaches, importance of information and communication technology in fisheries, aqua-tourism, role of women`s self help groups etc. Students will also conduct participatory surveys, develop manuals, undertake case studies on the use of Information and Communication Technology (ICT) in fisheries extension, besides field visits to established extension projects.

COURSE CONTENT

Theory

Unit 1

Status of global fish production. Key challenges in attaining sustainability. Need for policies and regulations. Global initiatives to conserve marine resources. UNCLOS, United Nations Fish Stocks Agreement (UNFSA), Convention on Biological Diversity (CBD), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), TRAFFIC, Convention on Wetlands (RAMSAR), Convention on Migratory Species of Wild Animals (CMS), The International Convention for the Regulation of Whaling, FAO Code of Conduct for Responsible Fisheries (CCRF). World Trade Organization agreements and fisheries.

Unit 2

Fisheries legislation in India. Marine fishing policy 2004. Marine Fisheries Regulation Act (MFRI). Guidelines for fishing operations in Indian EEZ. Marine fishing regulation and management bill, 2009. The MPEDA Act and Rules 1972. Coastal Zone Management. The Coastal Aquaculture Authority Act 2005. Coastal Regulation Zone (CRZ) Notification, 2011. Island Protection Zone (IPZ) Notification, 2011. Wildlife (Protection) Act of India. Deep Sea Fishing Policy of India.

Unit 3

Fisheries policy of Kerala. Kerala Marine Fisheries Regulation Act (KMFRA) 1980, History and status of ban on trawling during monsoon, The Kerala Inland Fisheries and Aquaculture Act, 2010.

Unit 4

Need for extension in fisheries and aquaculture. Introduction to extension education, research, and service; Review of philosophy, principles, concepts, and practices of fisheries extension systems and approaches; Overview of fisheries research, development and extension systems in India; Scope and importance of fisheries and aquaculture extension. Fisheries co-operatives.

Unit 5

Teaching, learning and co-learning; Epistemology of knowledge in fisheries – ITK *vis-à-vis* lab generated knowledge. Fisheries extension – advantages and limitations of present welfare and subsidy oriented extension systems; Development and extension approaches as practiced by public and private sectors in India; participatory fisheries extension approaches.

Unit 6

Aquaculture extension system - review of extension approach as practiced by fisheries department; Market led extension approaches; Importance of Information and Communication Technology (ICT) in fisheries extension system. Aquatourism. Role of women self-help groups and their role in poverty alleviation. Case study of Kudumbasree.

Practical

1. Exercises on development of extension and field manuals
2. Exercises on participatory learning / co-learning
3. Case study of extension approaches practiced by select State Fisheries Department, ADAK, Matsyafed, etc.
4. Case study on the use of ICT for fisheries development
5. Field exposure by visiting established extension projects.

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- One assignment and one presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

READING LIST

1. Brown D, S. Derek and FS Simon 2005. *Mainstreaming Fisheries Co-Management in the Asia-Pacific*. Asia-Pacific Fishery Comm. Rep.Publ. 2005/24, FAO, United Nations Regional Office for Asia and the Pacific, Bangkok.
2. Chambers R, Arnold P & Thrupp LA. 1989. *Farmers First: Farmer Innovation and Agricultural Research*. Intermediate Technology Publ.
3. Chandrasekhar CS. (Ed.). 2004. *Privatization of Agricultural Extension in India*. MANAGE, Hyderabad.
4. Dholakia, A.D. 2004. *Fisheries and Aquatic Resources of India*. Daya Publ. Hse., Delhi.
5. FAO. *Code of Conduct for Responsible Fisheries*. Rome, FAO. 2011. 91 pp.
6. ICAR 2011. *Handbook of Fisheries and Aquaculture*. ICAR, New Delhi, 1116 pp.
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8. Malhotra SP and VRP Sinha. 2007. *Indian Fisheries and Aquaculture in a Globalizing Economy*. Part II. Narendra Publ. House, Delhi
9. Misra DC. 1990. *New Directions in Extension Training*. Directorate of Extension, Ministry of Agriculture, New Delhi.
10. Phillips JJ. 1998. *Handbook of Training Evaluation and Measurement Methods*. Gulf Publ.
11. Saha, G.S., H.K. De & M. Kumaran. 2010. *New initiatives in Aquaculture extension*. Narendra Publishing House, Delhi, 206pp.
12. Samuel, C.T. 2000. *Marine Fishery Extension*. Discovery Publishing House, Delhi.
13. Saxena & Amit. 2011. *Fisheries Extension*. Daya Publishing House, Delhi, 227pp.
14. Singh RP, Thamtani A & Singh P. 1996. *Training Management*. Jain Publ.
15. Sinha VRP. 1999. *Rural Aquaculture in India*. FAO, United Nations, Thailand. RAP Publ.
16. Ramchandran C. 2004. *Teaching not To F(in)ish: A Constructivist Perspective on inventing a Responsible Marine Fisheries Extension System*. CMFRI, Kochi.
17. Ray GL. 2006. *Extension, Communication and Management*. 6th Ed. Kalyani Publishers.
18. Rivera WM. 2000. *Agricultural Extension: Worldwide Institutional Evolution and Forces for Change*. Elsevier.
19. Robert SP. 2005. *Fisheries Co-Management: A Practical Hand Book*. CABI.
20. Samanta RK. 1990. *Development Communication for Agriculture*. DK Publ., Delhi

21. Shyam, S. Salim and R. Narayanakumar, (2012). *World Trade Agreement and Indian Fisheries Paradigms: A Policy Outlook*. Manual. Central Marine Fisheries Research Institute, Kochi.
22. Singh R. 1993. *Communication Technology for Rural Development*. BR Publ., Delhi
23. Swan, J. and D. Gréboval (eds.). 2005. Overcoming factors of unsustainability and overexploitation in fisheries: selected papers on issues and approaches. International Workshop on the Implementation of the International Fisheries Instruments and Factors of Unsustainability and Overexploitation in Fisheries. Siem Reap, Cambodia, 13–16 September 2004. *FAO Fisheries Report* . No. 782. FAO Rome, 352pp.
24. Van Den Ban AW. 1985. *Communication for Rural Innovation: Rethinking Agricultural Extension*. Blackwell

ELECTIVE COURSES

DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES UNIVERSITY OF KERALA

COURSE CODE : AQB-51 A
COURSE TITLE : ENVIRONMENTAL EDUCATION AND SUSTAINABLE
DEVELOPMENT
CREDITS : (2); **HOURS (32)**
PRE-REQUISITS, IF ANY: NIL

AIM:

- To introduce the scope and need for environmental education, with special focus on higher education.
- To orient the students towards the concept of sustainable development, with the United Nations declaration on Education for Sustainable Development.
- To inculcate the spirit of conservation in students.

COURSE DESCRIPTION:

The course provides an overview of the history of environmentalism and environmental education (EE), the need and scope of EE, development and its impact on environment and global initiatives towards sustainable development, concept, philosophy and practice of sustainable development and education for sustainable development, green charter for higher education and green campus initiatives.

COURSE CONTENT

Unit 1

The relevance on environmental education. Environmental education: concepts and application. History of environmental education. Environmental education in India.

Unit 2

Development and its impact on environment. Development and sustainability. UN conference on environment and development. Earth summit, WSSD.

Unit 3

Sustainable development: origin of concept and philosophy. Principles of Sustainable Development. Concept of Sustainable development in Indian context. History of education for sustainable development. Reorienting education for sustainable development. Green charter for higher education. Green campus initiatives.

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- Assignment and presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

READING LIST

1. Brown, L.R., Larsen, J. & B. Fischlowitz-Roberts 2002. The Earth Policy Reader. Orient Longman, Hyderabad, 303 pp.
2. CEE 1990. Essential Learnings in Environment Education. A Database for Building Activities and Programmes. Centre for Environment Education, Ahmedabad, 150 pp.
3. Cunningham, W.P & M.A. Cunningham 2004. Principles of Environmental Science. Inquiry and Applications. McGraw Hill Higher Education, New York, 424 pp.
4. Ehrlich, P.R. 1998. Global Change and Biodiversity. World Resources Institute 1998-99. Oxford University Press, NY, pp.
5. Fien, J. & D. Tilbury 1996. Learning for a Sustainable Environment: A New Agenda for Teacher Education, UNESCO-ACEID, Bangkok.
6. IUCN, UNEP & WWF 1991. Caring for the Earth, International Union for the Conservation of Nature, Gland.
7. Kelu, P. 2000. Environmental Education. A Pedagogical Analysis. Publi. Div., Univ. Calicut.
8. Mohan, I. 2007. Environment Education. APH Publ., New Delhi, 300 pp.
9. NCERT 2001. Environmental Orientation to School Education. A Training Module for Southern Region. National Council of Educational Research and Training, New Delhi.
10. NIER 1993. The Final Report of a Regional Seminar: Environmental Education and Teacher Education in Asia and the Pacific, National Institute for Educational Research, Tokyo.
11. NIER1996. Learning for a Sustainable Environment: Teacher Education and Environmental Education in Asia and the Pacific, NIER, Tokyo.
12. Ramachandra, T.V. 2008. Environment Education for Ecosystem Conservation Capital Publishing Company, New Delhi, 214 pp.
13. Satapathy, M.K. 2007. Education, Environment and Sustainable Development. Shipra, Delhi, 324 pp.
14. Shrivastava, K.K. 2004. Environmental Education: Principles, Concepts and Management. Kanishka, New Delhi, 456 pp.
15. World Commission on Environment and Development 1987 Our Common Future. Oxford Univ. Press, Oxford.

Websites

1. www.cseindia.com

2. www.ceeindia.org
3. <http://www.desd.org/> (Education for Sustainable Development)
4. <http://www.earthcharterinaction.org/education/UNDESD.html>
5. www.earthday.net/footprint/info.asp
6. <http://www.iucn.org/themes/cec/education/decade.htm>
7. www.rprogress.org
8. www.sustainable-development.gov.uk
9. <http://www.unep.org/>
10. www.un.org/esa/sustdev/ (United Nations Division for Sustainable Development)
11. www.unesco.org/education/desd
12. <http://portal.unesco.org/education/en/>

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-52A
COURSE TITLE : HARMFUL ALGAE
CREDITS : (2+0); Hours (32+0)
PRE-REQUISITS, IF ANY: Nil

AIM:

- To gain knowledge on the taxonomy of marine microalgae.
- To create awareness on the ecology of harmful algal bloom and seafood poisoning.

COURSE DESCRIPTION:

This course on Harmful Algae provides knowledge on the taxonomy of Marine Diatoms and Dinoflagellates; Sampling techniques and estimation of algal bloom; Seafood Poisoning; Ecology of harmful algal bloom; Monitoring and management of harmful algal bloom.

COURSE CONTENT:

Unit 1. Marine Diatoms: General characteristics. Classification. Morphology. Terminology. Description of taxa.

Unit 2. Marine Dinoflagellates: General characteristics. Terminology and morphology. Classification. Identification of species.

Unit 3. Sampling Techniques and estimation: Equipments. Techniques. Strategies.

Unit 4. Seafood Poisoning: Paralytic shellfish poisoning. Diarrhetic shellfish poisoning. Amnesic shellfish poisoning. Ciguatera poisoning. Toxin analysis. Algal toxins. Bioassay methods.

Unit 5. Ecology of harmful algal bloom: Environmental factors. Aquaculture. Cultural eutrophication. Unusual climatological conditions. Ships ballast water.

Unit 6. Monitoring and management. Environmental monitoring. Monitoring seafood. Seafood safety regulation. Management of fishery resources.

ASSESSMENT

Continuous Assessment: (40%)

- Attendance : 5%
- Two class tests, one presentation: 10%
- Two assignments: 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment (60%)

Three hour written exam with one word, short and descriptive questions with choices.

References

1. Falconer, I.R. 1993. Algal Toxins in Seafood and Drinking Water. Acad. Press, NY.
2. Graneli, E. & J.T. Turner 2006. Ecology of Harmful Algae. Springer, Netherlands, 413 pp.
3. Hallegraeff, G.M., D.M. Anderson & A.D. Cembella 1995. Manual of Harmful Marine Microalgae. IOC Manual 33, UNESCO, Paris, 793 pp.
4. Huisman, J., H.C.P. Matthijs & P.M. Visser 2005. Harmful Cyanobacteria. Springer, The Netherlands, 241 pp.
5. Meinesz, A. 1997. Killer Algae. The Univ. Chicago Press, London, 378 pp.
6. Morris, I. 1967. An Introduction to Algae. Hutchinsen & Co., London, 189 pp.
7. Round, F.E. 1981. The Ecology of Algae. Cambridge Univ. Press, London, 653 pp.
8. Thomas, C.R. 1997. Identification of Marine Phytoplankton. Acad. Press, NY, 858 pp.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-52B
COURSE TITLE : TRADE AGREEMENTS AND INDIAN FISHERIES
CREDITS : (1+0); HOURS (16)
PRE-REQUISITS, IF ANY: NIL

AIM:

- To equip students with understanding on the impact of globalization on Indian fisheries

COURSE DESCRIPTION:

The course provides an overview of the developments in Indian fisheries sector post-globalization. Examines the role of EIA and MPEDA in export promotion of Indian fishery products and the influence of agencies like WTO. Disputes due to trade barriers, IPRs and quality certifications are also discussed with focus on the way forward to make maximum benefit out of the changing scenario.

COURSE CONTENT:

Theory

1. Fisheries Scenario of India: Marine capture fisheries, Aquaculture, Ornamental fish culture
2. Indian seafood trade, EIA, MPEDA
3. History of WTO, Its impact on Fisheries sector, Dispute settlement Experiences
4. Trade barriers and their impacts on Indian fisheries
5. Trade related intellectual property rights
5. Quality certifications and their role in seafood trade
6. Conflicts in Fisheries, Ecolabelling, Sustainable Fisheries

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- Assignment and presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

References

1. FAO 1995. *Code of Conduct for Responsible Fisheries*, FAO, Rome. Available online at <ftp://ftp.fao.org/docrep/fao/005/v9878e/v9878e00.pdf>.
2. ICAR 2011. *Handbook of Fisheries and Aquaculture*. ICAR, New Delhi, 1116 pp.
3. Malhotra SP and VRP Sinha. 2007. *Indian Fisheries and Aquaculture in a Globalizing Economy*. Part II. Narendra Publ. House, Delhi
4. Robert SP. 2005. *Fisheries Co-Management: A Practical Hand Book*. CABI.
5. Shyam, S. Salim and R. Narayanakumar, (2012). *World Trade Agreement and Indian Fisheries Paradigms: A Policy Outlook*. Manual. Central Marine Fisheries Research Institute, Kochi.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-53A
COURSE TITLE : BIOSECURITY IN SHRIMP AQUACULTURE
CREDITS : (1+0); HOURS (16)
PRE-REQUISITS, IF ANY: NIL

AIM:

- To equip students with understanding on the existing biosecurity concerns and appraise them about the possible solutions applicable to local conditions.
- To understand the need for establishing biosecurity in shrimp aquaculture
- To understand the practical considerations while developing a biosecurity protocol for shrimp farms and hatcheries

COURSE DESCRIPTION:

The course provides an overview of shrimp farming industry in the world and India. The frequent outbreaks of pathogenic diseases and subsequent economic losses points to the need for developing a set of practices for maintaining disease free culture environments. Various components of a biosecure system is introduced.

COURSE CONTENT:

Theory

1. History of shrimp culture in the world. Present status of shrimp farming in the world.
2. History of Indian shrimp culture. Present status of Indian shrimp farming
3. Management requirements in shrimp farms
4. Major pathogens and their impacts on shrimp farming
5. Biosecurity requirements in shrimp aquaculture
6. Establishment of biosecurity in shrimp aquaculture

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- Assignment and presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

References

1. FAO 1995. *Code of Conduct for Responsible Fisheries*, FAO, Rome. Available online at <ftp://ftp.fao.org/docrep/fao/005/v9878e/v9878e00.pdf>.
2. ICAR 2011. *Handbook of Fisheries and Aquaculture*. ICAR, New Delhi, 1116 pp.
3. Lotz, J.M. 1997. Viruses, biosecurity and specific pathogen-free stocks in shrimp aquaculture. *World Journal of Microbiology and Biotechnology*, **13**(4): 405-413.
4. Donald V. Lightner. 2005. Biosecurity in Shrimp Farming: Pathogen Exclusion through Use of SPF Stock and Routine Surveillance. *Journal of the World Aquaculture Society*. 36(3): 229–248.
5. Vimala, D.D., Ravichandran, P. and Gopal, C. 2010. *Handbook on Biosecurity Measures for Shrimp Farming*. CIBA Special Publication No. 47. CIBA, Chennai.
6. Gopal, C. and 6 others (Eds). 2012. *Training manual on sustainable shrimp farming through adoption of better management practices and biosecurity*. CIBA Special Publication No. 62. CIBA, Chennai.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-53B
COURSE TITLE : HISTOLOGICAL TECHNIQUES
CREDITS : (1+1); HOURS (16+32)
PRE-REQUISITS, IF ANY: NIL

AIM:

- To provide practical experience in basic histological techniques.

COURSE DESCRIPTION:

The course provides a theoretical overview of various aspects on the preparation of histological sections and permanent slides. Hands on experience is provided for using H&E stain and observing various tissues of fin fish/shrimp.

COURSE CONTENT:

Theory

1. Microscope mounts.
2. Theory of fixation and fixatives.
3. Processing of tissues for paraffin sections – theoretical aspects.
4. Theory of staining and biological stains.
5. Principles of Histochemistry.
6. Frozen sections – principles and procedure.

Practical

1. Preparation of whole mounts, blood smear and imprints.
2. Preparation of paraffin sections.
3. Staining of paraffin sections: Double staining with Iron haematoxylin and eosin.

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- Assignment and presentation; one class test: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

References

1. Anderson, B.G. & D.L. Mitchum 1974. Atlas of Trout Histology. Wyoming Game and Fish Department, Cheyenne, Wyoming. 110 pp.
2. Armed Forces Institute of Pathology 1949. Manual of Histologic and Special Staining Techniques. 2nd ed. The Blackiston Div., McGraw Hill Book co., Inc, NY
3. Conn, H.S. 1961. Biological Stains. A Handbook on the Nature and Uses of the Dyes Employed in the Biological Laboratory. 7th ed. The Williams & Wilkins Co, Baltimore, Maryland, 355 pp.
4. Gray, P. 1954. The Microtomist's Formulary and Guide. The Blackiston Co., Inc, NY, 794 pp.
5. Gray, P. 1973. The Encyclopedia of Microscopy and Microtechnique. van Nostrand Reinhold Co, NY, 638 pp.
6. Grizzle, J.M. & W.A. Rogers 1976. Anatomy and Histology of the Channel Catfish. Auburn Univ. Agric. Exp. Stn. Auburn, Alabama, USA, 94 pp.
7. Groman, D.B. 1982. Histology of the Striped Bass. Am. Fish. Soc. Monogr. No. 3, Bethesda, Maryland, 116 pp.
8. Gurr, E. 1962. Staining Animal tissues. Practical and Theoretical, Leonard Hill (Books) Ltd., London, 631 pp.
9. Madhukumar, G. 2004. The Anatomy and Histology of the Pearl-Spot, *Etroplus Suratensis* (Bloch). Ph. D. Thesis, Univ. Kerala
10. Patt, D.I. & G.R. Patt 1969. Comparative Vertebrate Histology. Harper and Row Publ., New York, 437 pp.

**DEPARTMENT OF AQUATIC BIOLOGY & FISHERIES
UNIVERSITY OF KERALA**

COURSE CODE : AQB-54A
COURSE TITLE : RESEARCH METHODOLOGY AND PROJECT FORMULATION
CREDITS : (2+0); Hours (32)
PRE-REQUISITS, IF ANY: Nil

AIM:

- To introduce the concept and methods of research
- To impart knowledge on scientific procedures on preparing research reports and papers and making presentations.
- To provide information on preparing research projects, research ethics and impact factors of publications.

COURSE DESCRIPTION:

The course include components such as elements of scientific method; ethical issues in research; various categories of research, steps involved in research process, including development of hypothesis and its testing; formats of research report; scientific writing; bibliographic database; impact factors and indices; principles and procedures in formulating a research projects. The topic also provides scope for practicing creating writing and editing.

COURSE CONTENT:

Unit 1

Elements of scientific method; Research - purpose, relevance and scope; Generalization and transferability of research data; Objectivity and value neutrality in scientific research; ethical issues in research.

Unit 2

Types of research - basic, applied, strategic, anticipatory and adaptive research; historical, descriptive and experimental research; Qualitative and quantitative research methods; Experimental and ex-post facto approaches, survey research, action research, participatory research, case study method, content analysis.

Unit 3

Steps involved in research process; Identifying and defining researchable problems; Formulation of research objectives; Hypothesis - meaning, types, development of hypothesis and its testing.

Unit 4

Formats of research report - writing thesis/dissertation, research articles - abstracts, literature review, materials and methods, results and discussion, summary and references.

Unit 5

Bibliographic database. Impact factor, citation index, H index, Ethics in research. Plagiarism and software for checking plagiarism.

Unit 6

Principles in formulating a research projects. Components of a research proposal.

ASSESSMENT

Continuous Assessment: (40%)

- Attendance/Participation : 5%
- Assignment and presentation; one class test involving editing research papers and preparing abstracts: each 10%
- Mid-semester exam with one word and descriptive questions : 15%

End semester assessment

Three hour written exam with one word, short and descriptive questions with choices.

READING LIST

1. Anderson, J., B.H. Durston & M. Poole 1970. Thesis and Assignment Writing. Wiley Eastern Pvt. Ltd., New Delhi, pp.
2. Briscoe, M.H. 1996. Preparing Scientific Illustrations. Springer, NY, 204 pp.
3. *Chicago Manual of Style*. 14th Ed. 1996. Prentice Hall of India
4. Day, R.A. 1979. How to Write and Publish s Scientific Paper. ISI Press, Pennsylvania, 160 pp.
5. Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
6. Kerlinger FN. 1983. *Foundations of Behavioural Research*. Surjeet Publ.
7. Kothari, C.R. 2005. Research Methodology. Methods and Techniques. 2nd ed. New Age Internat. (P) Ltd., Publ., New Delhi, 401 pp.
8. Kumar R. 1996. *Research Methodology: a Step-by-Step Guide for Beginners*. Sage Publ.
9. Rossiter DG. 2003. *Preparation for M.Sc. Thesis Research*. ITC, Netherlands.
10. Sandhu, G.S. 1990. Research Techniques in Biological Sciences. Amol Publ., New Delhi, 388 pp.
11. Sinha VRP. 2005. *Fisheries Research Planning and Management in Developing Countries*. Narendra Publ. House.
12. von Normann, R.W. 1971. Experimental Biology. 2nd ed. Prentice Hall Inc., N.J., 269 pp.
13. Walliman N. 2001. *Your Research Project: a Step-by-Step Guide for the First Time Researcher*. Sage Publ.