

Veer Narmad South Gujarat University, Surat
Department of Aquatic Biology
M.Sc. (Aquatic Biology)
Syllabus - Semester-I

AQB- 101: Aquatic resources and their management

Total: 60 Hrs

Unit – I:

Inland Environment:

Origin, classification and distribution of rivers, Major River system of India and Gujarat

Origin, classification and distribution of lakes, Thermal stratification and thermal exchange in lakes.

Origin, classification and distribution of ponds

Classification and distribution of reservoir, important reservoir of Gujarat, transitional phases of reservoir

Classification, morphology and distribution of Estuaries, Lagoons and Coastal inlets

Unit – II

Marine Environment:

Introduction, origin and zonation of ocean, sea bottom topography: Abyssal, canyons and trenches

Main physical (density, viscosity, surface tension, temperature) and chemical (major and minor constituents) properties of sea water

Introduction, origin and types of tides, currents and waves

Unit – III

Aquatic resources:

Fin fishes: major carps, catfishes, hilsa, mullet, sardine, mackerel

Sport fishes and Ornamental fishes: Introduction and some important species

Shell fishes: Prawn, shrimp and molluscs

Aquatic plants: freshwater higher vascular plants, sea weeds, sea grasses and mangroves

Unit – IV

Management of Aquatic resources

Aquatic resources management practices with reference to present and future aspect

Concept of Integrated Water Resources Management (IWRM) □ water allocation and water scheduling problem □ equitable manners of water management

Role of regulatory bodies in Management of aquatic resources (Pond, Lake, River, Sea, Estuaries and Reservoirs)

Management of fishery resources

Reference:

1. Barnes R.S.K. (1999). Introduction to Marine Ecology (3rd Edition), Blackwell Science, Oxford UK
2. Edmondson, W.T. (1976). Freshwater Biology 2nd Edn. John Wiley and Sons Inc.
3. Golterman, H.L., Clyno, R.S. and Ohnstad, M.A.M. (1978). Methods for physical and chemical analysis of freshwater. 2nd Ed. IBP Handbook no.8 Blackwell scientific publication.
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5. Hutchinson, G.E. (1976). A Treatise on limnology. Vol. I & II John Wiley & sons.
6. Jeffery S. Levinton (2000). Marine Ecology, Biodiversity and Function. Oxford, UK
7. Jhingaran, V.G. (1985). Fish and Fisheries of India. Hindustan publication Corp., New Delhi.
8. Lecren, E.D. and Lowe-Mac Connel, R.H. (1980). The functioning of freshwater ecosystem. Cambridge University Press, UK.
9. Nair, B. N. and Thampy D.M. (1980). A text Book of Marine Ecology, Macmillan Co. India Ltd., Delhi,
10. Nybakken, J.W. (2001). Marine Biology an Ecological Approach. 4th Edn, Addison Wesley Publishing, Boston.
11. Perkins, E.J. (1980). The Biology of Estuaries and coastal water. Academic Press, London.
12. Mishra, S R (2002). Management of Aquatic Habitats, Daya Publishing House, Delhi
13. Allan, J.D. and Castillo, M.M. 2009. Stream Ecology (Second Ed.). Springer, Netherlands.
14. Mackie, G. 2005. Applied Aquatic Ecosystem Concepts (2nd Ed.). Kendall/Hunt Publishing, Dubuque, Iowa
15. Wetzel, R.G. 2001. Limnology. Lake and Reservoir Ecosystems (3rd Ed.). Academic Press, San Diego

16. Chapman, V.J. and D.J. Chapman, 1980. Seaweed and Their Use. Chapman & Hall, London
17. Greene, Thomas F. 2004. Marine Science: Marine Biology and Oceanography, 2nd Edition. Amsco School Pub. Inc.
18. Kathiresan, K and S.Z. Qasim 2005. Biodiversity of Mangrove Ecosystems. Hindustan Lever Limited
19. Biswas, K.P. 1996. A Textbook of Fish, Fisheries and Technology. 2nd ed. Narendra Publishing House., India
20. Jayaram, K.C. 1999. The Freshwater Fishes of the Indian Region. Narendra Publishing Company., New Delhi
21. Khanna, S.S. & H.R. Singh 2006. A Textbook of Fish Biology and Fisheries. Narendra Publishing House., India
22. Meenakshi, J., N.K. Yadava & R.K. Gupta. 2010. Freshwater Ornamental Fishes. Mangalam Publications, Delhi

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Syllabus - Semester-I

AQB- 102: Aquatic Pollution and Toxicology

Total: 60 Hrs

Unit – I

General Introduction:

Water pollution: Introduction, Sources and Fate of Pollutants

Interaction of pollutants in Aquatic resources

Role of Central Pollution Control Board (CPCB) and Gujarat Pollution Control Board (GPCB) in the management of pollution.

Unit – II

Types of Pollution:

Sources, Fate, Biological Effects and Management of Thermal pollution, Oil pollution, Radioactive pollution, Detergent pollution and Acid rain

Unit – III

Effluents and their treatment:

Introduction and characteristics of domestic, industrial and agricultural discharges.

Biological concern: Eutrophication, Bioaccumulation and Biomagnification

Important methods for wastewater treatment.

Water quality standards and water quality indices.

Unit – IV

Toxicology:

Toxicology: Introduction, concepts, principles and factors affecting the toxicity

Classification of toxicants: metals, pesticides, teratogens, xenobiotics, toxins of animal and plant origin

Toxicity test procedures: Bioassay, Biostimulation and Bioinhibition

Biomarkers in Aquatic system

Reference:

1. Agarwal, S.K. (2008). Water pollution, ABH publishing corporation, New Delhi
2. Albert, A. (1951). Selective toxicity, John Wiley and Sons, Chichester
3. Cremllyn, R. (1978). Pesticides, John Wiley and Sons, Chichester

4. Ghosh, G.K. (2002). Water of India, A.P.H. publishing corporation, New Delhi
5. Goel, P.K. (2006). Water pollution, New age international publishers, New Delhi.
6. Kukal S.S. and Dhaliwal, G.S. (2005). Essential of environmental science, Kalyani Publishers, Ludhiana
7. Prabhakar, V.K. (2001). Marine ecology & pollution, Anmol publications New Delhi.
8. Rand, G.M. (1995). Fundamentals of Aquatic toxicology, Taylor and Francis, Washington, D.C.
9. Rao, M.K. (2007). Environnemental pollution & Toxicology, Manglam Publishers, Delhi.
10. Salpekar, A.C. (2008). Marine pollution, Jnanada Prackashan, New Delhi
11. Schmitz, R.J. (1995). Introduction to water pollution Biology, Gulf publishing company, Texas
12. Sinha, P.C. (1998). Marine pollution, Anmol Publications, New Delhi
13. Trivedi, R.K. and Goel, P.K. (1984). Chemical & Biological methods for water pollution studies, Environmental publications, Karad
14. Trivedi, R.K. (2001). Aquatic Pollution & Toxicology, ABD publishers, Jaipur.

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Syllabus - Semester-I

AQB- 103: Fish Physiology and Endocrinology

Total: 60 Hrs

Unit – I

Digestion: Digestive system of fish and associated digestive glands (liver, pancreas and gall bladder), Mechanism of digestion.

Respiration: Structure and function of gills, Mechanism of respiration, haemoglobin–oxygen uptake and dissociation, Accessory respiratory organs.

Unit - II

Circulation: Structure and function of heart, Composition of blood.

Excretion: Structure and function of the kidney, Nitrogenous end products and pattern of excretion.

Osmoregulation: Introduction, Osmoregulation in freshwater, brackish water and marine fish.

Unit - III

Reproduction and Development: Introduction of the reproductive system, types of reproduction, GSI, Structure, function and development of gonads.

Fecundity, Fertilization, Incubation, Hatching, Larvae and Metamorphosis, Parental care in fishes.

Unit - IV

Endocrinology: Hormonal control of pineal, thyroid, pituitary gland in fishes, pancreatic hormone in fishes, pheromones in fishes, ecdysis in crustacean.

Reference:

1. Evans, Devid H. (1998): Physiology of Fishes. R.R. Bowker Company, book trade association of Philadelphia.
2. Hoar, W. S. and Randal, D. J. (1993): Fish endocrinology Vol. I to VII. Academic press, INC (London) Ltd.
3. Hoar, W. S., Randal, D. J. and Farrell, A. P. (1992): Cardiovascular system, Vol. 12, Part 2 of Fish Physiology, Academic Press. INC London Ltd.

4. Khanna S.S. (1989): An Introduction to Fishes. Central Book Depot, Allahabad.
5. Khanna S.S. and Singh, H.R. (2003): A text book of fish biology and fisheries. Narendra publishing house, New Delhi – 110 006.
6. Nikolsky, G.Y. (1989): The ecology of fishes. Academic Press, London.
7. Pandey A.K. and Sandhu G.S. (1992): Encyclopedia of fishes and fisheries of India Vol. I & IV, Amol publication, New Delhi.
8. Prosser, C. L. (1973): Comparative Animal Physiology, W. B Saunders Co., Philadelphia
9. Smith, L.S. (1982): Introduction of fish physiology. Narendra publishing house, New Delhi.
10. Yadav, B. N. (2006): Fish & Fisheries, Daya Publishing House, New Delhi.
11. Yadav, B.N. (1995): Fish endocrinology. Daya Publishing House, New Delhi.
12. Anderson, D.P. (2003): Text book of fish Immunology, Narendra publishing house, Delhi
13. Austin, B. (1999): Bacterial fish pathogen-Disease of farmed and wild fish, Paraxis publishing Ltd., U.K
14. Conroy, D.A. (1997): Textbook pf fish diseases, Narendra publishing house, Delhi
15. Cornell, J.J. (1995): Control of fish quality, Fishing new books
16. Duijn, C.V. (2000): Diseases of fishes, Narendra publishing house, Delhi
17. Inglis, V. (1993): Bacterial diseases of fish, Blackwell science Ltd., Oxford, U.K.
18. Roberts, R.J. (1982): Microbial diseases of fish, Society for general microbiology academic press, New York, USA
19. Roberts, R.J. (1978): Fish pathology, Baillere Tindall, Landon
20. Sharma, O.P. (2009): Handbook of fisheries and aquaculture, Agrotech publishing academy, Udaipur
21. Wedemeyer, G.K. (1999): Environmental stress and fish diseases, Narendra publishing house, Delhi
22. Woo, P.T.K. and Leathelard, F. (1998): Fish diseases and disorders, CABI publishers, Wallingford

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Syllabus - Semester-I

AQB- 104 (A): Instrumentation (Elective paper)

Total: 60 Hrs

Unit – I

Microscopy:

Microscopes: Introduction, principle and structural description

Types of microscopes: Simple microscope, compound microscope (Student's microscope, Stereoscopic microscope, Phase contrast microscope, fluorescence microscope and interference microscope) and Electron microscope

Unit – II

Photometry:

Introduction, principle and application of Colorimeter, Spectrophotometer, (Single beam & double beam), Infrared, NMR and Mass spectrometer

Unit – III

Separation method:

(A) Centrifuge and Centrifugation:

Centrifuge: Introduction, different parts and types of centrifuges

Centrifugation: Introduction, principle and types (Differential centrifugation and Density gradient centrifugation)

(B) Chromatography and Electrophoretic:

Chromatography: Introduction, Principle and types of chromatography

Electrophoresis: Introduction, Principle and types of electrophoresis

Blotting: Introduction, types and function

Unit – IV

Water quality analysers:

Introduction, structure, principle and operation of water quality analysers (Conductivity meter, pH meter, Salino meter, DO meter, turbidometer, COD reflaxor (close and open) and BOD analyser)

References :

1. Brown, S.B. (1980). An introduction to spectroscopy for Biochemists, Academic press, London, New York.
2. Robertis, E.D.P. and Robertis, E.M.F. (2001). Cell and Molecular Biology, Lippincott Williams & Wilkins, London
3. Hawcroft, D.M. (1996). Electrophoresis. The Basics IRL press, Oxford.
4. Jenning, W.G. (1993). Analytical Gas chromatography. Academic Press. New York.
5. Skoogs, H.P. and Nieman, M. (2006). Principle of Instrumental analysis. Thomson Inc. Ltd.

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AQB- 104 (B): Computer Application

Total: 60 Hrs

Unit – I

Computer and GUI Based Operating System

Introduction, History of Computers, Characteristics of Computer System, Computer and Latest IT gadgets and their applications

Components of Computer System: Hardware, Software

Introduction to GUI Based Operating System

The User Interface: Task Bar, Icons, Start Menu, Running an application, Simple Setting of Operating System

Unit – II

Processing of Word, Excel and PowerPoint

Basics: Title Bar, Menu Bar, Toolbars & Sidebar, creating a New Document, Opening and Closing Documents, Save and Save As Document, Page Setup, Print Preview, Printing of Documents and Saving a Document as PDF file, Word Document Creation, Formatting the Text, Table Manipulation, Mail Merge, Shortcut Keys

Excel Elements of Spread Sheet, Manipulation of Cells and Sheet, Formulas, Functions and Charts

PowerPoint Creation of Presentation, Manipulating Slides, Presentation of Slides, Providing Aesthetics to Slides & Printing

Unit-III

Internet and WWW

Introduction, Basic of Computer Networks: Local Area Network (LAN), Wide Area Network (WAN), Network Topology

Internet: Concept of Internet & WWW, Applications of Internet, Website Address and URL, Introduction to IP Address, ISP and Role of ISP, Internet Protocol, Modes of Connecting Internet (Hotspot, Wi- Fi, LAN Cable, Broadband, USB Tethering), Identifying and uses of IP/MAC/IMEI of various devices

Popular Web Browsers, Exploring the Internet: Surfing the web, Popular Search Engines, Searching on Internet, Downloading Web Pages, Printing Web Pages

Unit-IV

E-mail, Social Networking and e- Governance Services

Introduction and Structure of E-mail Using E-mails

Social Networking for researcher, Introduction to Blogs, Basics of E-commerce, Netiquettes, Academic Research Databases

Overview of e-Governance Services in education and fisheries sector

Accessing e-Governance Services on Mobile Using “UMANG APP”

Digital Locker, Application of computer, computerized information and data analysis in fisheries

Introduction to various statistical packages and development of programmes and their use in biological data analysis

Reference:

1. V.Rajaraman, 2002, Fundamentals of Computers, 3rd Edition, Prentice Hall of India.
2. Marilyn W. Meyer and Roberta L. Baber, Computers in your future, 2nd Edition Prentice Hall of India.
3. Chris Ewin (Author), Carrie Ewin (Author), Cheryl Ewin (Author),2017, Computers for Seniors: Email, Internet, Photos, and More in 14 Easy Lessons 1st Edition, No Starch Press
4. Computer Fundamentals: Concepts, Systems & Applications- 8th Edition Priti Sinha, Pradeep K, Sinha
5. Michael Miller, 2007, Absolute Beginner's guide to computer Basics, Fourth Edition, Pearson Education
6. Deborah Morley, Charles S. Parker,2007, Understanding computers today and tomorrow, 11th edition, Thomson

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AQB- 105 : Water & Sediment analysis and Fish physiology

Total: 180 Hrs

Unit I

Physical properties of water

Gravimetric method to estimate the Total solids, Total suspended solids and Total dissolved solids

Photometric/Colorimetric method to estimate the Turbidity and Transparency

Electrometric method to estimate the Conductivity and Salinity

Unit II

Chemical properties of water

Titrimetric method to estimate the Dissolved oxygen, Carbon dioxide, Alkalinity (PA and TA), Hardness (Total, Ca and Mg), Chloride, BOD and COD

Colorimetric/Photometric method to estimate the Nitrate, Nitrite, Inorganic Phosphate, Silicate, Ammonia and Sulphate

Electrometric method to estimate the pH

Unit III

Physical properties of sediment: Organic matter, Moisture, Water holding capacity, Bulk density, Particle density, Porosity and Texture

Unit IV

Chemical properties of sediment: Nitrate, Nitrite, Inorganic Phosphate, Silicate and Ammonia

Unit V

Haematological parameters: Preparations and observations of micronuclei in fish blood, Structure of blood cells, Counting of RBC and WBC, Haemoglobin content and Haematocrit value

Unit VI

Biological parameters of fish: Gut content analysis and Gastroscopic Index (GaSI)

Study of buccal cavity and associated structures (Gill rakers, Bucco pharynx)
Measurement of fecundity, Egg diameter and Gonadosomatic Index (GSI)

Reference:

1. APHA (2005). Standard method for the examination of water and wastewater, American Public Health Association, E.G. Arnold, S.C. Lenore, A.E. Eaton (Eds.), Washington.
2. Trivedy, R.K. and Goel, P.K (1986). Chemical and biological methods for water pollution studies, Environmental publication, Karad.
3. Skoogs, H, P.and Nieman, M (2006). Principle of Instrumental analysis. Thomson Inc Ltd.
4. Brown, S.B (1980). An introduction to spectroscopy for Biochemists, Academic press, London, New York

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Syllabus - Semester-I

AQB- 106 Aquarium Management for Employer

Total: 30 Hrs

UNIT-I

Introduction, history and present scenario of aquaculture. World trading of ornamental fish and export potential. Ornamental fisheries new dimensions in aquaculture entrepreneurship.

Introduction to aquarium and aquarium accessories. Profile and information of ornamental fishes and selected aquarium plants in the world and India.

UNIT- II

Design, settings up and maintenance of fresh water and marine aquaria. Introduction and construction of ornamental fish breeding unit and Ornamental fish farm.

Ornamental fish diseases management, feeding management and maintenance of aquarium.

Aquascaping: Introduction, types, setup and management

Reference:

1. Hawlins, A.D. (1981). Aquarium Systems. Academic Press.
2. Hunnam, P. Ward Lock, Living Aquarium.
3. Ratjak, K. and Zukal, R. (1971). Aquarium Fishes and Plants. Spring Books, London.
4. Spotte, S. (1979). Seawater Aquariums. John Wiley and Sons, New York.
5. Straughan, R. P. L. (1970). Salt water Aquarium in the Home. (2nd Ed.), A.S. Barnes & Co., NY.
6. Mills, D. (1987). Illustrated Guide to Aquarium Fishes. Galley and Price, an imprint of W.H. Smith and Sons Limited, England.
7. Spotte, S. (1993). Marine Aquarium Keeping. (2nd Ed.), A Wiley-Interscience Publication.
8. Mills, D., Vevers, G., Campbell and Douglas G. (1982). The Practical Encyclopaedia of Tropical Aquarium Fishes. Salamander Books Limited, London.

9. Carcasson, R.H. (1977). A Field Guide to the Coral Reef Fishes of the Indian and West Pacific Oceans. Collins, London.
10. Hargreaves, V.B. (1978). The Tropical Marine Aquarium. McGraw-Hill Book Company. New York.
11. Smith, G. N. (1979). Profitable Fish Keeping. Saiga Publishing Company, Limited.
12. Melzak, M. (1984). Marine Aquarium Manual. Acro pub.
13. Tekrival, K. L. and Rao, A. A. (1999). Ornamental Aquarium Fishes of India. Kingdom Books, Havant.
14. Cato, J. C. and Brown, C. L. (2008). Marine Ornamental species (collection, culture and conservation). (1st Ed.) Wiley -Blackwell.

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AQB- 201: Fisheries Technology

Total: 60 Hrs

Unit – I

Hatcheries: Types of Traditional, Circular, Vertical hatcheries, Shrimp/Prawn hatcheries and hatchery Management (Japanese, Galveston, Indian).

Induced breeding: Selection of brooders, extraction of pituitary gland, preparation of dosage and injection, spawning and fertilization, stripping method, use of inducing agents in induced breeding, Eyestalk ablation technique in shrimp.

Unit – II

Transportation: Causes of mortality during transportation, methods for transportation (traditional and modern) of fish seeds, fingerlings, brooders and trout eggs, use of chemicals in live fish transportation.

Age and growth of fishes: Utility and methods for determining age and growth, study of maturity, mortality and yield, factors affecting the age and growth.

Unit – III

Techniques for Fishing:

Introduction of fishing crafts, types of fishing crafts (mechanized and non-mechanized)

Introduction of fishing gears, types of fishing gears (Traditional, conventional, non-conventional and Active, Passive), Maintenance and preservation of fishing gears.

Remote sensing: Mechanism, satellites and cameras, Importance and Application of remote sensing in Aquatic biology.

Unit – IV

Post-harvest technology: Principles and techniques of processing and preservation, chilling, freezing, drying, salting, smoking, canning, pickling, pasting, preservation with chemicals, preservation by exposure of gamma rays, modern techniques of preservation, packaging of fish and fish products, Effect of

processing and preservation on nutritive aspects of fish, fishery products and by-products.

Reference:

1. Agrawal, S. C. (1994). A Hand Book of Fish Farming. Narendra Publishing House, Delhi.
2. Balachandran, K. K. (1998). Advances and Priorities in Fisheries Technology. Cochin.
3. Biswas, S. P. (2002). Fundamentals of Ichthyology. Narendra Publishing House, Delhi.
4. Deekshatulu, B. L. and Rajan, Y. S. (1984). Remote Sensing. Indian Academy of Sciences, Bangalore.
5. Felix, S. (2007). Aquaculture Management Techniques. Narendra Publishing House, New Delhi.
6. Gupta, S. K. and Gupta, P. C. (2002). General and Applied Ichthyology (Fish and Fisheries). S. Chand and Company, New Delhi.
7. Harrison, P.J. and Parsons, T.R. (2000). Fisheries Oceanography. Blackwell Science.
8. Jhingran, V. G. (2007). Fish and Fisheries of India (3rd Ed.). Hindustan Publishing Corporation. New Delhi.
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10. Khanna, S. S. and Singh, H. R. (2003). A Text Book of Fish Biology and Fisheries. Narendra Publishing House, Delhi.
11. Krjstjonsson, H. (1959). Modern Fishing Gear of the World. Vol. I to III, Fishing news (books) Ltd., England.
12. Meenakumari, B. (2009). Handbook of Fishing Technology. Central Institute of Fisheries Technology, Cochin.
13. Moyle, P.B. (2002). Fishes-An Introduction to Ichthyology. Prentice Hall Inc. NJ 07458.
14. Nikolsky, G.V. (1999). Ecology of Fishes, Allied Scientific Publishers.
15. Rao, D.P. (1995). Remote Sensing for Earth Resources. Association of Exploration Geophysicists, Hyderabad.
16. Regenstein, J.M. and Regenstein, C.E. (1997). Introduction to Fish Technology. CBS Publishers and Distributors, New Delhi.
17. Sabins, F.F. (1997). Remote Sensing, Principles and Interpretation. W.H. Freeman & Co., New Delhi.
18. Sharma, O.P. (2009). Handbook of Fisheries and Aquaculture. Agrotech Publishing Academy, Udaipur.

- 19.Sreekrishna, Y. and Shenoy, L. (2001). Fishing Gear and Craft Technology. Indian Council of Agricultural Research, New Delhi.
- 20.Welcomme, R.L. (2007). Inland Fisheries. Discovery Publishing House, New Delhi.
- 21.Yadav, B.N. (1997). Fish and Fisheries. Daya Publishing House, Delhi.
- 22.Yadav, N.K. (2009). Management Practices in Fish Farming. Manglam Publications, Delhi.
- 23.Ayappan, S (2011). Handbook of Fisheries and Aquaculture. ICAR, New Delhi.

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Syllabus - Semester-II

AQB- 202: Fish Nutrition and Feed Technology

Total: 60 Hrs

Unit – I

Fish nutrition: Introduction and Principles of nutrition. Nutritional requirements of fin fish and shellfish, Factors affecting nutritional requirements

Feeding evaluation: Feed dispensing devices, ration size/feeding rate, feeding frequency, check trays, restricted feeding, mixed feeding.

Unit - II

Biochemistry: Introduction, classification and function of nutritional compounds (Protein, Lipid, Carbohydrates, Vitamins and Minerals)

Nutritive value of live food: Algae, Artemia, Cladocerans, Ostracods, Rotifers and Copepods as fish food

Proximate composition of fish and feed

Unit – III

Biological evaluation:

Growth evaluation: Feed Conversion Ratio (FCR), Food Conversion Efficiency (FCE), absolute growth, relative growth. Specific Growth Rate (SGR), weight gain (%), Digestible growth coefficient (DGC), Gastro-somatic Index (GaSI)

Protein evaluation: Protein Efficiency Ratio (PER), Productive Protein Value (PPV), Net Protein Utilization (NPU).

Unit - IV

Feed Technology: Feed ingredients: Introduction, sources and anti-nutritional factors, Feed formulation, feed formulation methods (traditional and advances) Feed attractants, binders, growth promoters (antibiotics, probiotics), colouring and flavouring agents,

Types of feed: pellets, flakes, powdered, micro-encapsulated, micro-bound and micro-coated diets, Compact pellet feed, floating and sinking pellet feeds

Feed processing: Machineries, Effects of processing on the nutritional value of feeds, Feed Packing and storage.

Reference:

1. ADCP (Aquaculture Development and Co-ordination Programme) (1980). Fish Feed Technology, ADCP/REP/80/11.FAO, Rome.
2. D' Abramo, LR., Conklin, D.E and Aklyama. D.M, (1977). Crustacean Nutrition: Advances in Aquaculture Vol. 6. World Aquaculture Society, Baton Rouge, L.A.
3. Evans, D.H. and Claiborne, J.B. (2006). The Physiology of fishes. CRC press.
4. Guillame, J., Kaushik, S., Berqot P., and Metallier, R., (2001). Nutrition and feeding of fish and crustaceans, Springer Praxis Publishing, Chichester, UK.
5. Halver J.E. (1989). Fish Nutrition, Academic Press, San Diego, CA.
6. Halver, J and Hardy, R.W. (2002). Fish nutrition. Academic press, London.
7. Halver, J.E, and Tlews, K.T. (1979). Finfish nutrition and fish feed technology Vol. I and II Heenemann, Berlin.
8. Hepper, B. (1988). Nutrition of pond fishes. Cambridge Univ. Press, Cambridge, UK.
9. Houlihan, D., Boujard, T and Jobling, M. (2001). Food intake in fish. Blackwell science, Ltd, London.
10. Joachim W. Hertrampf and Felicitas Piedad-Pascual. (2000). Handbook on ingredients for aquaculture feeds. Kluwer Academic Publishers, London
11. Jobling, M. (1994). Fish Bioenergetics. Chapman & Hall. London
12. Keith Wilson and John Walker. (1995). Principles and Techniques of Practical Biochemistry. Cambridge University Press.
13. Lovell, R.T. (1998). Nutrition and Feeding of Fishes, Chapman & Hall, New York.
14. New, M.B. (1987). Feed and feeding of fish and shrimp. A manual on the preparation and preservation of compound feeds for shrimp and fish in aquaculture. F.A.O. Rome –
15. Rechcigl, M. (1977). CRC Handbook series in nutrition and food. CRC press.
16. Rechcigl, M. (1981). Handbook of nutritional supplements in a functional context. CRC press.
17. Sena S. De Silva, Trevor A. Anderson. (1995). Fish Nutrition in Aquaculture, Chapman & Hall Aquaculture Series, London
18. Guillame, J., Kaushik, S., Berqot, P. and Metallier, R. 2001. Nutrition and Feeding of Fish and Crustaceans. Springer Praxis Publishing, Chichester, U. K.

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Syllabus - Semester-II

AQB- 203: Fish Genetics and Biotechnology

Total: 60 Hrs

Unit - I

Fundamentals of Molecular Biology

DNA as a genetic material, DNA replication and Mutations, Structure and Types of RNA, Transcription, Protein synthesis.

Recombinant DNA technology, DNA barcoding.

Unit - II

Principle of Fish Genetics

Chromosome study: Fish chromosome preparation method, Banding techniques, Fish as a cytogenetic model.

Genetic manipulation: Sex-reversion and sex control, Chromosomal manipulation.

Transgenic fish

Unit - III

Fish Biotechnology: Scope and application.

PCR technique, Cryopreservation, Vaccination, Hybridization.

Unit - IV

Bioinformatics: Use of computers in Bioinformatics, Search engines and databases, Application of Bioinformatics in Aquatic Biology.

Nanotechnology: Introduction, History, Applications in Aquatic Biology.

Reference:

1. Lesk, A. M. (2003). Introduction to Bioinformatics Oxford Uni. Press.
2. Falcon, D. S. (2000). An Introduction to Quantitative Genetics. ELBS Publisher, England.
3. Lakra, W. S. (2000). Fish Genetics and Biotechnology. CIFE, Mumbai.
4. Benjamin, L. (2008). GENES- IX London, Jones & Bartler Publ.

5. Claverie, M. and Notredame, C. (2003). *Bioinformatics A Beginners Guide*. Wiley India Private Limited.
6. Claverie, J. M. and Notredame, C. (2003). *Bioinformatics for Dummies*. Wiley India Private Limited.
7. Murthy, C.V.S. (2004). *Bioinformatics*. Himalaya Publishing House.
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9. Sinit, E. W., Dunn, L. C. and Dobzhansky, T. (1998). *Principle of Genetics*. Macgrodo Hill Publishing Company Ltd.
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26. Kirpichnikov, V. S. (1981). *Genetic Basis of Fish Selection*. Springer-Verlag.

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28. Zipursky, L. and Darnell, J. (2004). Molecular Cell Biology (5th Ed.). W.H. Freeman.

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AQB- 204 (A) : Fisheries Legislation

Total: 60 Hrs

Unit – I

Fisheries legislation:

Introduction, History and Importance in aquatic resources management.

Unit – II

Inland Fisheries Regulation and Development:

Inland Fisheries Act, Leasing policies for water bodies. Issues of property rights in Inland water bodies.

Unit – III

Marine fisheries legislations in India and Gujarat:

Coastal Aquaculture legislations (Environmental Protection Act, Biodiversity Act and Aquaculture Authority Act).

Maritimes Zones of India Act 1981, Coastal Regulation Zone (CRZ) and Integrated Coastal Zone Management.

Unit – IV

International Law of the Sea:

Historical perspectives. Exclusive Economic Zone, Regulatory and developmental issues concerning deep sea fishing – Guidelines for operation Indian deep sea fishing vessels in Indian EEZ.

Reference:

1. Branson, E.J. (2008). Fish welfare. Pub. Blackwell Publication, Oxford.
2. Malhotra, S.P. and Sinha, V.R.P. (2007). Indian Fisheries and Aquaculture in a Globalizing Economy, 2 Vols. Narendra publishing house New Delhi.
3. Coupes, A., and Edgar, H. (1987). The marine environment and sustainable development; law, policy and science law of the sea institute, Honolulu.

4. G.W. (2009). Towards Sustainable Fisheries Law: A Comparative Analysis. IUCN Environmental Policy and Law Paper No. 74. IUCN publication Service, Switzerland
5. Neler, A.P., Rangnar Ameson and Nina Mollett. (1997). Right Based Fishing. Klupner Academic Publisher.
6. O'Connell, D.P. (1982). The international law of the sea. Clarendon press.
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Syllabus - Semester-II

AQB- 204 (B) : Biostatistical analysis

Total: 60 Hrs

UNIT – I

Fundamental of Biostatistics:

Introduction and Scope of biostatistics, Concepts of population and sample, Sampling and its types, Primary and Secondary data, Classification and tabulation of data, Frequency distribution, Graphic representation of data- bar diagram, histograms, pie diagram, frequency polygon and Ogive. Measures of central tendency: mean, median, mode. Measures of Dispersion: variance, standard deviation, coefficient of variation, Skewness, kurtosis and moments

Methods of Data Collection – Quantitative and qualitative

Quantitative Methods: Questionnaire (mail method, interviews through telephone, internet and computers), interview schedule

Questionnaire/interview schedule design and construction: Principles of constructing a questionnaire/interview schedule, Types of questions, framing of questions, sequencing of sections and questions and Interview techniques

Qualitative Method: Walk through and observation (participatory and non-participatory), Social mapping, key informant interview, In-depth interviews, Focus group discussion, content analysis, free listing, pile sorting, mechanical devices (camera, tape recorder)

Applications of statistics in fisheries

UNIT – II

Probability and hypothesis:

Probability and probability distributions-definition of probability - binomial, Poisson and normal distributions

Hypothesis testing and its applications in biological data-Null and Alternate Hypotheses, Errors in Hypothesis Testing-Critical Region and error probabilities Level of Significance-One Tailed and Two Tailed tests

Unit - III

Statistical test:

Bivariate Data: Scatter diagram. Correlation coefficient and its properties, Correlation ratio. Rank– Spearman's and Kendall's measures of correlation. Principle of least squares, linear regression, fitting of curves reducible to polynomials by transformation. Multiple regression, Multiple and partial correlation coefficients.

Tests of significance: Z test, t test, F test, Chi-square test, ANOVA (one way and two way)

Non parametric test: Wilcoxon test, Mann-Whitney U-test, Kruskal and Wallis test and Friedman's test

Unit - IV

Use of computer software for data analysis:

Computer applications: Analyses of data using Microsoft Excel and SPSS

Reference :

- 1.Chakravorti S.R.and Giri N.(1997): Basis Statistics South Asian Publishers New Delhi.
2. Clarke G.M. and Cooke D. (1994): A Basic Course in Statistics Arnold London.
3. Goon A.M. Gupta M.K. and Dasgupta B. (1985): Fundamental of Statistics Vol. I. The World Press Private Ltd. Calcutta.
4. Gupta S.C. and Kapoor V.K. (1986): Fundamental of Mathematical Statistics Sultan Chand and Sons Publishers
5. Whitlock, C. & Schluter, D. (2014). The analysis of biological data, 2nd Edition. Roberts and Company Publishers. ISBN 978-1936221486.
6. Dutta, N. K. (2004). Fundamentals of Biostatistics, Kanishka Publishers.
- 7.Gurumani N. (2005). An Introduction to Biostatistics, MJP Publishers.
- 8.Daniel, W. W. (2007). Biostatistics- A Foundation for Analysis in the Health Sciences, Wiley
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AQB- 205 : Fisheries Technology and Biostatistics

Total: 60 Hrs

Unit I

Determination of Age and Growth of fin fishes (by hard parts)
Biometric study of fish

Unit II

Identification and demonstration of different gears (Bag net, Trawls Otter trawl, Beam trawl Cast net, Drage net Drag net without pocket, drag net with pockets, Gill net) and crafts (Dugout canoes, Plank built canoes, Outrigger canoes, Rampani, Raft, Raft catamaran, Masula boats, Non-rigid Masula) by models and images

Unit III

Description of Remote sensing techniques (by images)
Identification and description of fish products and by-products (by specimens and images)

Unit IV

Preparation of reagents, standard graph and biochemical estimation of Protein, Lipid, Reducing Sugar and carbohydrate in fish and fish feed

Unit V

Estimation of Ash and Moisture content in fish and fish feed
Feed formulation by Pearson square method

Unit VI

Preparation of Schiff's reagent, Toludene blue and Pyronin-Y
DNA staining (by Schiff's reagent) and RNA staining (by Toludene blue and Pyronin-Y) in aquatic plants
Study of banding techniques (by images)
Isolation of DNA from aquatic organism (demonstration)

Reference:

1. Ravindranath, M. H. (1981). Manual of Research Methods for Crustacean Biochemistry and Physiology. CMFRI, Cochin-682018.
2. Nielsen, S. S. (2017). Food Analysis. Purdue University, Springer International Publishing.
3. Bioseparation Technology Laboratory. Department of Biotechnology, SRM University.
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5. Cummings, S. A. and Thorgaard, G. H. (1994). Extraction of DNA from fish blood and sperm. Biotechniques, 17(3): 426-430.
6. Sumner, A. T. (1990). Chromosome Banding. Unwin Hyman, London; Boston.
7. Sharma, L. L., Sharma, S. K., Saini, V. P. and Sharma B. K. (2008). Management of Freshwater Ecosystems. Agrotech Publishing Academy, Udaipur, India.
8. Sreekrishna, Y. and Shenoy, L. (2001). Fishing Gear and Craft Technology, Indian Council of Agricultural Research, New Delhi.
9. Gupta, S.K. and Gupta, P.C. (2002): General and Applied Ichthyology (Fish and Fisheries). S. Chand and Company, New Delhi.
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12. Balachandran, K. K. (2016). Post-Harvest Technology of Fish and Fish Products. Daya Publishing House.
13. Raghavarao, D. (1983): Statistical Techniques in Agricultural and Biological Research. Oxford and IBH Publishing Co., Mumbai.

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AQB- 206 : Fish Products and By-products technology

Total: 60 Hrs

UNIT - I

Introduction and principle of fish preservation and processing. Principles, quality dimensions, methods of preparation, packaging and storage of various fish products - Fish and prawn pickles, fish sauce and fish paste, fish sausage, fish ham, surimi, fish cake, kamaboko battered and braided products fish finger, fish cutlet, fish wafer, fish soup powder etc.

UNIT - II

Principles, quality dimensions, methods of preparation, packaging and storage of various fish byproducts - Fish oil, chitosan, fish protein concentrate, fish hydrolysate, fish silage, fish maws, shark leather, fish glue, fish gelatin, isinglass, pearl essence, shark fin rays, beach-de-mer etc.

Application of HACCP concept in surveillance and quality assurance program for packaged and freeze-dried products.

Reference:

1. Gupta, S.K. and Gupta, P.C. (2002): General and Applied Ichthyology (Fish and Fisheries). S. Chand and Company, New Delhi.
2. Joseph, J. (2009): Post Harvest Technology of Freshwater Fish. Central Institute of Fisheries Technology, Cochin.
3. Ninawe, A. and Rathnakumar, K. (2008). Fish Processing Technology and Product Development. Narendra Publishing House.
4. Sachindra, N. M. and Mahendrakar, N. S. (2014). Fish Processing Byproducts: Quality Assessment and Application. Studium Press, LLC, US.
5. Balachandran, K. K. (2016). Post-Harvest Technology of Fish and Fish Products. Daya Publishing House.
6. Martin, R. E., Carter, E. P., Flick, G. J. and Davis, L. M. (2000). Marine and Freshwater Products Handbook, CRC Press.

7. Balasundari, S., Raghu, G. and Felix, S. (2020). Fish Products and Value Addition. Daya Publishing House.

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AQB- 301: Aquatic Microbiology and Disease Management

Unit – I

Total: 60 Hrs

Microorganisms associated with Aquatic Ecosystem: General structure and characteristics of microbes (bacteria, fungi, algae and virus).
General classification of microbes (conventional and modern methods) in Aquatic environment.

Biogeochemical Cycles: Carbon, Nitrogen, Phosphorus and Sulphur cycles and their significance.

Unit - II

Methods of Studying Microorganisms

Quantitative estimation of microorganisms in aquatic ecosystems.

Collection, isolation, cultivation and characterization of microorganisms.

Introduction and significance of Biofilm.

Nutrition, growth and preservation of aquatic microorganisms.

Quality Control of Fish

Post mortem changes (Hyperemia, Riger mortis, Autolysis, Microbial Pultrification, Auto oxidation) in fishes, Prevention and control of fish pathogens, Microbial quality control of processed fish products, HACCP.

Unit - III

Fish Diseases and Health Management

Non-pathogenic diseases: symptoms and control - Environmental, Nutritional and Hereditary diseases.

Pathogenic diseases: symptoms and control - Bacterial, Fungal, Viral and Algal diseases in fin fishes and shell fishes.

Parasitic diseases: symptoms and control - Protozoan, Crustacean, and Worm diseases in fin fishes and shell fishes.

Unit - IV

Etiology

Physical, chemical and physiological defence mechanisms in fishes, Methods of pathological examination of fish, Disease diagnosis: Histopathological and Biotechnological (PCR and ELISA) methods.

References:

1. Frazier, W. C and Westnoff, D. C. (2008). Food Microbiology. Tata McGraw Hill Publishing Company, New Delhi.
2. Modi, H. A. (1995). Elementary Microbiology. Ekta Prakashan, Nadiyad.
3. Mukundan, M. K. and Balasubramaniam, S. (2007). Seafood Quality Assurance. Central Institute of Fisheries Technology, Cochin.
4. Rheinheimer, G. C. (1974). Aquatic Microbiology. John Wiley and sons, England.
5. Sigeo, D. C. (2005). Freshwater Microbiology. John Wiley and Sons, England.
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7. Whitman, K. A. (2004). Finfish and Shellfish Bacteriology. CBS Publishers, New Delhi.
8. Mitra, A. and Banerjee, K. (2004). Marine Microbiology. Narendra Publishing House, Delhi.
9. Pelezar, M. J., Cahn, E. C. S. and Krieg, H. R. (1981). Elements of Microbiology. McGraw Hill Book Co., NY.
10. Tortora, G. J., Funke, B. R. and Case, C. L. (2007). Microbiology. Dorling Kindersley (India) Pvt. Ltd., New Delhi, India.
11. Willey, J., Sherwood, L. and Woolverton, J. (2017). Prescott, Harley and Klein's Microbiology. McGraw Hill Education.

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15. Schaperclaus, W. (2001). Fish Diseases. Vol I & Vol II, Oxonian Press Pvt. Ltd., New Delhi.
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17. Duijn, C. V. (2000). Diseases of Fishes. Narendra Publishing House, Delhi.
18. Wedemeyer, G. K. (1999). Environmental Stress and Fish Diseases. Narendra Publishing House, Delhi.
19. Woo, P. T. K. and Leatheland, F. (1998). Fish Diseases and Disorders. CABI Publishers, Wallingford.

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AQB- 302: Aquaculture practices

Total: 60 Hrs

UNIT I

Introduction, culture methods, harvesting and marketing of important major carps, catfishes and freshwater prawns
Fish culture practices with reference to Composite fish culture, integrated fish culture and Sewage fed fish culture

UNIT II

Introductions, types and advances in brackish water aquaculture
Introduction, culture methods, harvesting and marketing of important brackish water fin fishes and shell fishes (Mullet, Milk fish, Sea bass, peal spot and shrimp)

UNIT III

Introductions, types and advances in Marin water aquaculture.
Introduction, culture methods, harvesting and marketing of Edible oyster, Pearl oyster and techniques of pearl production, Lobster and Clam.

Unit-IV

Taxonomy of economically important seaweeds. Distribution, morphology, reproduction, life cycle, growth physiology and Culture techniques of sea weeds (*Gracilaria*, *Caulerpa*), Products from seaweeds, *Spirulina*, *Chlorella*

References:

1. Bardach, E.J. Rhyther, J.H. and W.O. McLarney (1972): Aquaculture. The Farming and Husbandry of freshwater and Marine Organisms. John Wiley and Sons. New York
2. Brown, E.E., Gratzek, J.B. (1980): Fish Farming Hand Book. AVI Publishing Company, West port USA

3. Fast, A.W. and Lester, L.J. (1992): Marine Shrimp culture – Principles and Practices. Elsevier Science Publishers, Amsterdams
4. James, P. McVey (1983): Handbook of Mariculture Vol. I. Crustacean Aquaculture. CRC Press. Inc. Florida; 442 pp.
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7. Mathew, L. (1992): Introduction to Aquaculture, John Wiley and sons, INC, New York
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9. Pillay, T.V.R. and Kutty, M.N. (2005): Aquaculture – Principles and Practices, Black Well Sciences, U.K.
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13. Dawson, R.Y (1966): Marine Botany. An Introduction Holt, Reinhart and Winston Inc., U.S.A.
14. Desikachary, T.V. (1975): Marine Plants. C.S.I.R., New Delhi.
15. Dring, M.J. (1982): The Biology of Marine Plants. Edward Arnold Publishers, London.
16. Kapraun, D.F. (1980): An illustrated guide to the benthic marine algae of coastal North Carolina- Rhodophyta. University North Carolina Press.
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AQB- 303: Planktonology

Total: 60 Hrs

Unit - I

Introduction of plankton:

Introduction and General classification of plankton, general account of instruments and nets employed for collection of plankton, Methods of fixation and preservation of plankton.

Unit - II

Productivity:

Method of estimation of Primary productivity, secondary and tertiary productivity, factors affecting productivity. Estimation of standing crop: wet and dry weight estimation, plankton volume settling and displacement method. Oxidation as carbon. (as organic matter)

Unit - III

Mechanisms in plankton:

Adaptation of plankton – structural (weight, increases of surface area, floatation) and physiological (specific gravity, water content, fat content, defensive vacuoles, gas, mono and divalent ions) mechanisms, Interrelation of phytoplankton and zooplankton, Harmful algal blooms - its causes and effects

Unit – IV

Ecological and Commercial Importance of Primary Producers:

Effects of plankton production in the aquatic environment. Microalgae as a source of protein. Periphyton - Importance of Periphyton in the aquatic environment, Biofuel and other commercial products from algae. Types of larvae and their

distribution, chemical communication and settlement of larvae of marine benthic organisms

References:

1. Edmondson, W.T. (1976). Freshwater Biology. 2nd Ed. John Wiley (Ed) and sons Inc.
2. Hutchinsn, G.E. (1976). A treatise on limnology. Vol. I & II John Wiley & Sons.
3. Jhingran, V.G. (1985). Fish and fisheries of India. Hindustan Publication Corp., New Delhi.
4. Nybakken, J.W. (2001). Marine Biology an Ecological Approach 4th edition. Addison Wesley Edu. Pub. Inc.
5. Peter McRoy, C. and G. Helferich (1977). Sea grass Ecosystems. A scientific perspective. Marcel Dekker Inc. New York
6. Sumich, J. I. (1999). Introduction to the biology of marine life 7th Edition. The McGraw hill Companies Inc.
 7. Welch. P.S. (1952). Limnology. 2nd Ed. McGraw Hill Book Co.

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AQB- 304 (A): Fisheries Extension Education

Total: 60 Hrs

UNIT I

Extension Education:

Definition, meaning, history, objectives, scope, concepts, philosophy and principles of fisheries extension education. Pioneering Extension efforts and their implications of Extension systems ICAR, SAU, State Departments and NGOs.

UNIT II

Communication process:

Concept, elements, functions and models of communication.

Teaching strategies and models: Meaning and various types of teaching strategies. Models of Teaching – Characteristics, Functions and elements.

UNIT III

Diffusion and innovation:

Concept and meaning, elements.

Adoption: adoption process, adopter categories and factors influencing adoption.

UNIT IV

Information communication technology:

Concept, role in fisheries development and types of ICTs (print and electronic media, video, teleconferencing, computer assisted instructions, touch screen and web technologies).

Cooperatives: Introduction, Concept of Co-operation, Objectives of Co-operative Movement, Models of Co-operatives and types of Co-operatives.

References:

1. Dahama, O.P. (1983): Extension and rural welfare. Ramprasad and Son's, Agra
2. Dhote, A.K. (1989): Fisheries Management and Extension: Inland fisheries, instructional cum practical manual (VI) NCERT, New Delhi

3. Lynton P.R. and Pareek, U. (1978): Training for development, Kumarian Press, 29 Bishop Road, West Hartford, Connecticut 06119
4. Ray, G.I. (1991): Extension communication and management, Naya Prakash, Kolkatta
5. Srivastva, U. K. and Vathsals, S. (1985): Strategy for development of Inland fishery resources in India: Key issues in production and marketing concept Pub. Co. New Delhi.
6. Supe, S.V. (1986): An introduction to extension education, Oxford and IBH Publishing Co., New Delhi.
7. Gupta CB. 2001. Management Theory and Practice. Sultan Chand & Sons. Indu Grover. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy
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9. Ganesan R, Iqbal IM & Anandaraja N. 2003. Reaching the Unreached: Basics of Extension Education. Associated Publishing Co.
10. Jalihal KA & Veerabhadraiah V. 2007. Fundamentals of Extension Education and Management in Extension. Concept Publ.
11. Khan PM. 2002. Textbook of Extension Education. Himalaya Publ. Ray GL. 2006. Extension Communication and Management. Kalyani Publ
12. Dahama OP & Bhatnagar OP. 2005. Education and Communication for Development. Oxford & IBH.
13. Grover I, Kaushik S, Yadav L & Varma SK. 2002. Communication and Instructional Technology. Agrotech Publ. Academy
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AQB- 304 (B): Research methodology and Writing skill

Total: 60 Hrs

Unit – I

Research: Meaning, definitions, objectives, characteristics of Research

Criteria of Good Research

Types of Research

Research Problem & Formulation

Selecting the Problem, Sources of the Problem, Defining a Problem, Statement of a Problem

Hypothesis: Qualities of a good Hypothesis –Types of Hypotheses, Hypothesis Testing and interpretation

Research Design: Features of a good research design, Concept, types and application of Exploratory Research Design, Descriptive Research Design and Experimental research Design

Unit – II

Data Collection and analysis: Methods of data collection, Sampling Methods, Sampling Errors

Data Processing and Analysis strategies: Data presentation, statistical analysis and interpretation of data, types of analysis, simple regression analysis, correlation, coefficient of determination, (r^2), z-test, t-test, ANOVA, Chi-square test, multi-variate analysis of data and multiple regression.

Unit - III

Report and thesis writing: Structure and components of scientific reports, types of report

Thesis writing - different steps and software tools (LaTeX.) in the design and preparation of thesis, layout, structure (chapter plan) and language of typical thesis, Illustrations and tables, bibliography, referencing and footnotes.

The Review of Literature: Meaning, need, objectives, sources and the functions of Review of Literature, pattern of writing review of Literature

Oral presentation - planning, software tools, creating and making effective presentation, use of visual aids

Unit - IV

Research Paper Writing: Layout of a Research Paper, Journal selection, Impact factor of Journals, Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

Use of Encyclopaedias, Research Guides, Handbook etc. for paper writing

Use of tools and techniques for Research: methods to search required information effectively, Reference Management Software like Zotero and Mendeley, paper formatting tools, Software for detection of Plagiarism.

References:

1. Bhattacharyya D. K (2006) Research Methodology, Excel Books.
2. Gurumani. N. (2006) Research Methodology for Biological Sciences, MJP Publishers, Chennai
3. Day Robert (.2002) How to write and publish a scientific paper, Cambridge University Press
4. Janice Matthews and Robert Matthwes (2008). Successful Scientific Writing, Cambridge University Press
5. Matt Young (2006). The Technical Writer's Handbook, Viva Books Private Limited, India
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AQB- 305 : Aquaculture management and Extension Education

Total Hrs. 180

Unit I

Preparation of media

Isolation methods for bacteria (streak plate, spread plate and pour plate method)

Cultivation of bacteria by broth culture technique

Identification of bacteria by Gram's staining technique

Assessment of microbiological quality of water bodies, fish and fish products using SPC technique

Assessment of microbiological quality of water bodies using MPN technique

Demonstration: Isolation and identification of pathogenic bacteria from fish

Study of diseased fish with the help of images

Unit II

Identification freshwater higher vascular plants

Identification of sea weeds

Identification of aquatic insects and prawn larvae

Identification of seed stages (eggs, spawns, fry and fingerlings)

Identification of cultivable fin fishes, shell fishes, predatory and weed fishes

Hatching and culturing of Artemia

Culture of Microalgae

Unit III

Collection, preservation and Identification of plankton (freshwater and marine water) Quantitative estimation of plankton (counting method) & chlorophyll estimation

Unit IV

Preparation of farm literature (Leaflet, Pamphlet and Folder)

Preparing of research paper

Visit of Induced breeding farms/ Krishi Vigyan Kendra/ ATIC

References:

19. Patel, R. J. (2000). Experimental Microbiology. Aditya, Ahmedabad, India, Vol. I & II.
20. Surendran, P. K., Thampuran, N., Nambiar, N. V. and Laliha, K. V. (2009). Microbiological Examination of Seafood. Central Institute of Fisheries Technology, Cochin.
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Syllabus - Semester-III

AQB- 306 : Entrepreneurship development in Fisheries

Total: 30 Hrs

Unit – I

Concept of entrepreneurship; entrepreneurial and managerial characteristics; motivation and entrepreneurship development; managing competition; entrepreneurship development programs; Entrepreneurship process.

Women entrepreneurship: concept, problems and development of women entrepreneurs

Unit -II

Government schemes and incentives for promotion of entrepreneurship, Government policy on Small and Medium Enterprises

Financial Management:

Financing procedure and financial incentives, Banking norms as in vogue.

Financial ratios & and their significance, Costing and Pricing.

Fund flow and Cash flow concept.

Preparation of enterprise budget for fish farming. Fiscal and monetary policies and their impact on entrepreneurship.

Unit – III

Infrastructural and other financial requirements for fishery entrepreneurship. Contract farming and joint ventures, public-private partnerships.

Overview of fisheries inputs industry. Characteristics of Indian fisheries processing and export industry.

Production Management: Elements of production process, Production Planning and Control, Product development, Testing facilities, Patents, Quality Assurance, Total Quality Management

Unit – IV

Supply chain management- meaning, advantages, stages, process, drivers and scope of aqua-supply chain management.

References:

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2. Gupta, C.B. (2001). Management, Theory and Practice. Sultan Chand and Sons, New. Delhi.
3. Indu G. (2008). Handbook on Empowerment and Entrepreneurship. Agrotech, Public Academy, Udaipur.
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Syllabus - Semester-IV

AQB 401: Dissertation

Research work along with dissertation writing will be carried out in the related field of Aquatic Biology. That would be carried out at the research laboratory of the department **OR** laboratory of other institutes and organizations. The research work must be presented in front of the examiners.

AQB 402: Seminar

Seminar would be prepared in the field of Aquatic Biology and presented in front of examiners.

AQB 403: Certificates and Licenses

The procedural report has to be prepared to receive either Certificates or Licenses for assigned aquacultural practice.

AQB 404: Educational excursion/project submission/ Fieldwork

Educational visits and tours have to be carried out in different institutes, organizations, laboratories, farms, industries, etc. at the local, state, and national levels. The detailed tour report submitted by the students will be used for the internal and external exam evaluation.

If such a tour or visit cannot be organized by the department or cannot be participated by any student (with valid reason) that condition student has to submit the project or perform field work in related subject.