CURRICULAR LAYOUT FOR THE DEGREE OF B.Sc. FISHERIES (Hons.)

Level-1

Semester-1	Credit hour	Semester- 2	Credit hour
Compulsory		Compulsory	
FBG 111 Fisheries Zoology	3	FBG 121 General Ichthyology	3
FBG 112 Fisheries Zoology	1.5	FBG 122 General Ichthyology	1.5
AQ 111 Introductory Aquaculture	3	FBG 123 Biodiversity and Fishery Systematics	3
FM 111 Aquatic Ecology	3	FBG 124 Biodiversity and Fishery Systematics	1.5
FM 112 Aquatic Ecology	1.5	AQ 121 Freshwater Aquaculture	3
FT 111 Fish Harvesting-I	3	AQ 122 Freshwater Aquaculture	1.5
BCHEM 115 Biochemistry-I	3	FT 121 Fish Harvesting-II	3
BCHEM 116 Biochemistry-I	1.5	FT 122 Fish Harvesting-II	1.5
Elective (Any One)		RS 121 Rural Sociology	3
AQ 113 Geographical Information System (GIS) in Fisheries	3	**Elective (Any One)**	
FM 113 Fisheries Resources	3	FM 121 Wetland Ecosystem	3
LAN 111 English Language	3	FT 123 Principles of Fish Handling and Preservation	3
Total Credit	**22.5**	CSM 127 Computer Science	2
		CSM 128 Computer Science	1
		Total Credit	**24**

Level- 2

Semester-1	Credit hour	Semester- 2	Credit hour
Compulsory		Compulsory	
FBG 211 Embryology	3	FBG 221 Fish Physiology	3
AQ 211 Coastal Aquaculture	3	FBG 222 Fish Physiology	1.5
AQ 212 Coastal Aquaculture	1.5	AQ 221 Fish Parasitology	3
FM 211 Physico-chemical Limnology	3	AQ 222 Fish Parasitology	1.5
FM 212 Physico-chemical Limnology	1.5	AQ 223 Live Food Culture	3
FT 211 Fisheries Microbiology-I	3	FM 221 Fish Population Dynamics	3
BCHEM 213 Biochemistry-II	2	FM 222 Fish Population Dynamics	1.5
Stat 211 Statistics	3	FT 221 Fisheries Microbiology-II	3
Stat 212 Statistics	1.5	**FT 222 Fisheries Microbiology-II**	1.5
Elective (Any One)		**Elective (Any One)**	
FBG 213 Biology of Farmed Fishes	3	FBG 223 Shellfish Biology	3
FT 213 Marine Food Chemistry	3	FM 223 Aquatic Environmental Science	3
Total Credit	**24.5**	**Total Credit**	**24**

Level- 3

Semester-1	Credit hour	Semester- 2	Credit hour
Compulsory		Compulsory	
FBG 311 Principles of Genetics	3	FBG 321 Reproductive Physiology of Fishes	3
FBG 312 Principles of Genetics	1.5	AQ 321 Fish Nutrition	3
AQ 311 Fish Pathology	3	AQ 322 Fish Nutrition	1.5
AQ 312 Fish Pathology	1.5	AQ 323 Fish Farm Design and Construction	3
FM 311 Biological Limnology	3	AQ 324 Fish Farm Design and Construction	1.5
FM 312 Biological Limnology	1.5	AQ 325 Shellfish Diseases	3
FM 313 Fish Stock Assessment	3	FM 321 Aquatic Soil Science	3
FT 311 Fish Processing	3	AE 327 Fishery Economics	3
FT 312 Fish Processing	1.5	**Elective (Any One)**	
Elective (Any One)		Genetics and Reproduction of Ornamental Fish	3
AQ 313 Environmental Management for Aquaculture	3	FT 321 Fishery Products and By-products	3
FT 313 Microbiology of Fishery Products	3	**Total Credit**	**24**
Total Credit	**24**		

Semester-1	Credit hour	Semester- 2	Credit hour
Compulsory FBG 411 Genetics and Fish Breeding	3	**Compulsory** FBG 421 Hatchery Management	3
FBG 412 Genetics and Fish Breeding	1.5	FBG 422 Hatchery Management	1.5
AQ 411 Prevention and Control of Fish Diseases	3	AQ 421 Fish Feed Technology	3
AQ 412 Prevention and Control of Fish Diseases	1.5	AQ 422 Fish Feed Technology	1.5
FM 411 Fisheries Management	3	AQ 423 Integrated Aquafarming	3
FM 412 Fisheries Management	1.5	FM 421 Oceanography and Marine Biology	3
FM 413 Fisheries Research Planning and Evaluation	3	FM 422 Oceanography and Marine Biology	1.5
FT 411 Quality Control of Fishery Products	3	AgExt 427 Agricultural Extension	3
FT 412 Quality Control of Fishery Products	1.5	AgExt 428 Agricultural Extension	1.5
Elective (Any One)		**Elective (Any One)**	
AQ 413 Ornamental Fish Culture	3	FBG 423 Principles of Molecular Biology and Biotechnology	3
FM 415 Aquatic Pollution and Toxicology	3	AQ 425 Fish Immunology	3
Total Credit	**24**	**Total Credit**	**24**

- **Odd** and **Even** numbers of the courses are **Theory and Practical**, respectively
- For Theory one credit = One contact hour

For Practical one credit = Two contact hours

SYLLABUS FOR B.Sc. Fisheries (Hons.)
Level - I, Semester - I
Department of Fisheries Biology and Genetics
Course No. FBG 111
Course Title: Fisheries Zoology
Credit: 3

1. Introduction: Course goals, objectives and outcomes
2. General survey and classification of animals up to sub-class level with special emphasis on groups having fisheries importance.
3. Adaptation of animals to aquatic life with special reference to temperature, salinity, current. depth, light etc.
4. Economic significance of the following groups of animals: Protozoans, Porifera, Coelenterates, Rotifers, Nematodes, Oligochaetes, Mollusks, Crustaceans, Aquatic insects, Echinoderms, Frogs, Aquatic reptiles, Fishing birds and Cetaceans.
5. Functional morphology and life history of the following aquatic animals: *Paramecium*, *Aurelia*, *Pila*, *Lamellidens*, *Loligo*, *Macrobrachium*, *Scylla*, *Rana*, *Chitra*, *Crocodilus*.

Course No. FBG 112
Course Title: Fisheries Zoology
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a Practical Note Book to be signed and checked by teacher(s) concerned.

Viva voce test will form an essential part of the Practical Examinations.

1. Collection and preservation of aquatic animals.
2. Characterization and identification of the collected specimens.
3. Study of external morphology of fresh and preserved specimens.
4. Study of anatomy of different organ systems of representative invertebrates and chordates.

Text books and references:

1. Barnes, R.D., 1978. Invertebrate Zoology. W.B. Saunders Co., Philadelphia. London.
2. Parker, T.J. and Haswell, W.A., 1960. A Text Book of Zoology (7th edition) Vol. I and II. Macmillan Co. Ltd. London.
3. Storer, T.I. and Usinger, R.L., 1965. General Zoology. McGraw Hill Book Co. New York.
4. Hyman, L.H., 1940. The Invertebrate, Vol. I-VI. McGraw Hill Publishing Co. New York.
5. Jordan, E.E. and Verma, P.S., 1985. Invertebrate Zoology. S.Chand and Company. Ramnagar, New Delhi.
6. Tonapi, G.T., 1980. Freshwater Animals of India. Oxford and IBH Publishing Co., New Delhi.
7. Walter, H.E. and Sayles, L.P., 1949. Biology of Vertebrates. The Macmillan Company, New York.
8. Young, J.S., 1962. The Life of Vertebrates (2nd edition) Oxford University Press.
9. Weinchert, C.K. and Presch, W., 1975. Elements of Chordate Anatomy., McGraw Hill Book Company, New York.
10. Kurian, C.V. and Sebastin, V.O., 1976. Prawn and Prawn Fisheries of India. Hindustan Publ. Co. Delhi.
11. Cobb, J.S. and Bruce, F. (eds), 1980. The Biology and Management of Lobsters. Vol. I and II. Academic press, New York. London.

12. Cantley, P.T. and Hodgson, B.H., 1980. Reptiles and mammals of Indian subcontinent. Cosmo Publ. New Delhi.
13. Warner, G.F., 1972. The Biology of Crabs. Van Nostrand Reinhold, New York.
14. Spence, A., 1989. Crab and Lobster Fishing. Farnham Fishing News.
15. Bryden, M.M. (ed.), 1986. Research on Dolphins. Oxford University Press.

Department of Aquaculture
Course No. AQ 111
Course Title: Introductory Aquaculture
Credit: 3

1. Introduction: Definition and aim of aquaculture, history of aquaculture, present status and scope of aquaculture in Bangladesh. Problems and prospects of aquaculture.
2. Aquaculture resources: Inland, brackish and marine water bodies. Culturable indigenous and exotic fishes. Technology and human resources. Organizations of aquaculture.
3. Fish ponds: Site selection. Classification and characteristics of an ideal fishpond. Pond construction-area, shape, pond dike, bottom, contour etc.
4. Water quality in aquaculture: Physical and chemical properties of water, primary productivity, phytoplankton, zooplankton and benthos.
5. Selection of species for stocking: Biological characteristics of aquacultural species. Economic and market considerations.
6. Nutrition and feeding: Major nutrients in fish feed. Natural food and artificial feed. Supplemental and balanced diets. Feeding habits and food utilization. Energy metabolism. Different types of live foods used in aquaculture.
7. Sources of fish seed: Natural sources of fish seeds. Artificial reproduction by environmental manipulation. Induced reproduction.
8. Control of weeds, pests and predators: Different types of aquatic weed. Weed problem in aquaculture. Methods of controlling of weeds and pests in aquaculture.
9. Mortality in aquaculture: Sanitation, disease, predation and canibalism.

Text books and references:

1. Huet, M. (1979). Textbook of fish culture Fishing News Books Ltd. U.K.
2. Pillay, T. V. R. (1990). Aquaculture. Principles and practices. Fishing News. Books Ltd. U. K.
3. Stickney, R. R. (1994). Principles of Aquaculture. John Wiley & Sons, INC. New York.
4. Bardach, J. E., J. H. Ryther and W. O. McLarney. (1972). Aquaculture. Wiley-Interscience, New York..
5. Islam, M. A. (2001). Aquaculture. Bangla Academy. Dhaka.
6. Karim, M. A. 1975. An introduction to fish culture in Bangladesh. Ruby Press, Mymensingh, Bangladesh.
7. Landau, M. (1992). Introduction to aquaculture. John Wiley & Sons, New York.
8. Shang, Y. C. 1981. Aquaculture Economics: Basic Concepts and Methods Analysis. Westview Press, Croom Helmm, England.
9. Wheaton, F. W. (1977). Aquaculture engineering. Wiley- Interscience, New York.

Department of Fisheries Management
Course No. FM 111
Course Title: Aquatic Ecology
Credit: 3

1. Introduction: Definition of population, community and ecology, scope of ecology, subdivision of ecology.
2. Ecosystem: Concept of ecosystem, habitat, ecological niche, food chain, trophic structure and ecological pyramids, productivity of water, homeostasis and ecological balance.
3. Limiting factors: Liebig's law of minimum, Shelford's Law of tolerance, combined concept of limiting factors, ecological indicators.
4. Population ecology: Concepts of population, population group properties, population density, rates, natality, mortality, age distribution, biotic potential and environmental resistance, growth form and carrying capacity, population dispersal and structure.
5. Concepts pertaining to organization at the interspecies population level: Types of interaction between two species, competition, predation, parasitism, commensalism, protocooperation and mutualism.
6. Community ecology: Community concept, community classification, composition, structure, stratification and periodicity, ecological succession and concept of the climax, ecotone and edge effect.
7. Freshwater ecosystem: Types and limiting factors, ecological classification of freshwater organisms, lakes, pools and other water-bodies, general models of production, running water communities, sources of food and energy flow in streams, floodplains, floodplain fisheries, modification of floodplain ecosystems.
8. Estuarine ecosystem: Definitions and types of biota, productivity, food production potential.
9. Marine ecosystem: The marine environment, communities of marine environment, function of marine ecosystem.

Course No. FM 112
Course Title: Aquatic Ecology
Credit: 1.5

Students shall be required to show a good knowledge of the topics included in the theoretical portion of the paper. They shall maintain a record of everything done in practical classes/ field trips in a practical note book to be signed and checked by the teacher (s) concerned. Viva-voce test will form an essential part of the practical examination.

1. Acquaintance with the equipment used in field study.
2. Study of pond as a lentic ecosystem.
3. Collection of freshwater fishes and their ecological classification.

4. Study of food web in a lentic habitat.
5. Study of stream as a lotic ecosystem.
6. Study of food web in a lotic habitat.
7. Study of species diversity indices in freshwater habitat.
8. Identification of aquatic weeds and their types.
9. Field visit to coastal mangrove and marine ecosystem and their community composition.

Text books and references:

1. Andrewartha, G.H., 1981. An introduction to animal populations.
2. Barnes, R.S.K. and Hughes, R.N., 1999. An introduction to marine ecology. 3rd Ed. Blackwell Science, 286 pp.
3. Cairns, Jr. J., 1995. Rehabilitating damaged ecosystems. 2nd Ed. Lewis Publishers, 424 pp.
4. Dudley, W.D., 1992. Aquatic insects. Wallingford: CAB International, 335 pp.
5. Elton, C. G., 1962. Animal ecology. Sidgwick & Jackson, London.
6. Gupta, O.P. 1992. Aquatic weeds. Today and Tomorrow's Printers and Pub., New Delhi, 272 pp.
7. Hynes, H.B., 1972. Ecology of running waters. Liverpool University Press, Liverpool.
8. Lincoln, R., Boxshall G. and Clark, P., 1998. A dictionary of ecology, evolution and systematics. Cambridge University Press, 361 pp.
9. Macan, T.T., 1974. Ecology of coastal waters. Blackwells, Oxford.
10. Moss, B., 1988. Ecology of freshwaters. Blackwell Scientific Publications, Oxford.
11. Odum, E.P., 1971. Fundamentals of Ecology. W.B. Saunders Company, London, 574 pp.
12. Odum, E.P., 1993. Ecology and our endangered life-support systems. 2nd Ed. Sinauer Associates, Inc., Massachusetts, U.S.A., 301 pp.
13. Pitcher, T.J. and Hart, P., 1982. Fisheries Ecology. Croom Helm, London.
14. Rahman, A.K.A., 1989. Freshwater fishes of Bangladesh. Zoological Society of Bangladesh, 364pp.
15. Santhanam, Velayutham R. P. and Jagatheesan, G., 1989. A manual of freshwater ecology. Daya, New Delhi.
16. Seagrave, C., 1988. Aquatic weed control. Fishing News Books, 154 pp.

Department of Fisheries Technology
Course No. FT 111
Course Title: Fish Harvesting-I
Credit: 3.0

1. Introduction to the history of Fishing. Fishing principle. Relationship between fish harvesting and fisheries management.
2. An introduction to fishing gear. Classification of fishing gears. Traditional fishing gear. Restricted fishing gear. Fishing implements other than nets. Fishing gear accessories. Mesh size of the net.
3. Raw materials for netting. Types of fibers used for fish nets and ropes. Construction of twine and rope. Terminology, Numbering systems of fishing twines. Characteristics of fishing twines and testing of netting yarns. Properties of synthetic fibers. Factors responsible for efficiency of fishing nets.
4. Net preservation: Objectives, different methods of net preservation. Merits and demerits of net preservation.
5. Making and mending of nets. Characteristics of netting by knot type. Knotted net and knotless net. Depth and length of netting. Underwater weight of netting. Float and buoy: Properties, materials and shape. Resin made float and buoy. Buoyant force. Sinkers: Properties, materials and shape. Calculation of sinking force. Fabrication and designing of fishing net.
6. Fish harvesting in aquaculture system: Seine nets, traps, gill nets, hooks and lines, lift nets, cast nets, pond draining and others.
7. Fish aggregating devices (FAD). Electrofishing, chemical fishing and other methods of stupefying fish.
8. Fishing crafts: Introduction, classification, common and technical terms for various parts of fishing boat. Sail boat, mechanized boat. Fishing crafts in Bangladesh freshwater and artisanal fishery.
9. Post-fishing activities: Handling on shore, boat and deck. Quality of fish and preservation of fish.

Text books and references:

1. Kristjonsson, H. (Ed.) 1975. Modern fishing gears of the World. Fishing News (Books) Ltd. Surrey, England
2. Training Department, SEAFDEC (Ed.) 1988. Fishing Technology outline. TD/TRB/45, October 1988. Text Reference book. Southeast Asian Fisheries Development Center, Phroprudoeng, Samutpraken, Thailand.
3. Nomura, M. 1978. Outline of fishing gear and method. Kanagawa International Fisheries Training Center. Nagai, Yokoshika-shi, Kanagawa-ken, Japan
4. Garner J. 1982. How to make and set nets or the Technology of netting. Fishing News (Books) Ltd. Surrey. England.
5. Gerhard, K. 1973. Netting materials for fishing gear. FAO Fishing Manuals. Fishing News (Books) Ltd. Surrey, England.
6. Perry Mrin, W. H. (Captain) (Ed.). 1982. Fishermen's handbook. Fishing News (Books) Ltd. Surrey, England.
7. Rabindran, K., Nair, N.U., Perigreen, P.A., Madhavan, P., Pillai, A.G.G., Panicker, A. and M. Thomas (Eds.) 1985. Harvest and post-harvest technology of fish. Society of Fisheries Technologies, Cochin, India.
8. Fyson, J. (Ed.). 1985. Design of small fishing vessels. FAO Publication. Fishing News (Books) Ltd. Surrey, England.

Department of Biochemistry
Course No. BCHEM 115
Course Title: Biochemistry-I
Credit: 3

Scope and importance of Biochemistry. Water and life. Solutions and methods of expressing concentration. pH and Buffers. Electrophoresis. Spectrophotometry. Chromatography.

Carbohydrates: Classification, biological function and structural features. Cell wall polysaccharides.

Proteins: Classification, Amino acids and their classification. Reactions in protein chemistry. Organisation levels. Denaturation.

Lipids: Classification and biological functions. Fatty acids, their classification and distribution. Importance of polyunsaturated fatty acids. Characterization and preservation of fish oils. Rancidity. Role of free radicals in lipid oxidation. Lipoproteins.

Nucleic acids: Composition, structural features and physicochemical functions.

Text books and references:

1. Conn, E.C. and Stump, P.K. 1987. Out lines of Biochemistry. 5th ed. J. Wiley and Sons, New York.
2. Elliot, W.H. and Elliot, D.C. 1997. Biochemistry and Molecular Biology.
3. Lehninger, A.I. 1976. Text Book of Biochemistry. 2nd ed. Worth Publishers, New York.
4. Lehninger, A.I. 1980. Principles of Biochemistry. Worth Publishers, New York.
5. Martin, D.W., Mayes, P.A. and Rodwell, V.W. 1981. Harper's Review of Biochemistry 18th ed. Lange Medical Pub. California.
6. Stryer, L. 1986. Biochemistry, S.K. Jain Publishers, Delhi, India.
7. Watson, D. 1987. Molecular Biology of Gene. Bengamin, Inc.

Course No. BCHEM 116
Course Title: Biochemistry-I
Credit: 1.5

Preparation of buffer solution and determination of pH.
Colour tests of carbohydrates and proteins. Separation of sugars and amino acids by TLC.
Isolectric pH determination of proteins.
Extraction of starch and glycogen.
Estimation of fish protein by Kjeldahl method.
Estimation of casein by Biuret method.
Estimation of reducing sugars.
Determination of saponification value, acid value and peroxide value of fish oils.
Estimation of alpha-amylase.
Protein fractionation by electrophoresis.

Text books and references:

1. David Glick, 1995. Methods of Biochemical Analysis. Interscience Publishers, Inc. N.Y.
2. Litwack, G. 1960. Experimental Biochemistry. John Wiley and Sons. Inc. N. York.
3. Malhotra, V.K. 1968. Practical Biochemistry for students. Lypee brothers, N.Y.
4. Plummer, D.T. 1995. An Introduction to Practical Biochemistry. Tata McGraw-Hill. Delhi.
5. Segel, I.H. 1968. Biochemical Calculations, John Wiley and Sons. New York.

Department of Aquaculture
Course No. AQ 113
Course Title: Geographical Information Systems (GIS) in Fisheries
Credit: 3

1. Introduction: Definition, history and components of GIS.
2. Spatial data: Mapping concepts, features and properties, maps and their influence on the character of spatial data. Data types: point, line and polygon. Vector and raster data, advantages and disadvantages. Other sources of spatial data. Census and survey data, aerial photographs, satellite images. Field data sources. Surveying and GPS.
3. Data input, verification, storage, and output: Methods of data input, editing, presentation, updating and storage.
4. Data analysis: Measurement in GIS. Lengths, perimeters and areas. Reclassification, buffering and distance. Vector to raster and raster to vector transformation. Integrating data into GIS – map overlay, spatial interpolation and their use in fisheries.
5. Multi criteria evaluation (MCE): Fish habitat suitability modelling (FHSM) for different fish species, mapping fish species and plankton distributions in lake, estuaries and sea using available information and satellite images. Detection of existing fish farming locations using satellite images.
6. Use of GIS for aquaculture planning and development.
7. Case Study: Fish habitat suitability modelling in different environmental conditions.

Text books and references:

1. Star, J. and Estes J. (1990). Geographical Information Systems: An Introduction. Prentice Hall, Englewood Cliffs.
2. Mathews Hugh and Foster Ian (1995). Geographical Data, sources, presentation and analysis. Oxford University Press.
3. Heywood, I, Cornelius S. and Carver S. (1998). An introduction to Geographical Information Systems. Longman, London.
4. Aguilar, M.J. and Nath, S.S. (1998). A strategic reassessment of fish farming potential in Africa. Food and Agriculture Organisation, Rome, Italy.
5. Antenucci, J. C. et al. (1991). Geographic Systems. A guide to the Technology. Van Nostrand Reinhold, New York.
6. EGIS (1997). Floodplain fish habitat study, Water resources planning organisation (WARPO), Ministry of water resources, Government of Bangladesh, Dhaka, Bangladesh.

7. Hugh Mathews and Ian Foster (1995). Geographical Data, sources, presentation and analysis. Oxford Universityu Press.
8. Ian Masser and Michael Blakemore (1991). *Handling Geographic Information*: Methodology and Potential Application. Longman Scientific and Technical, John Willy and Sons, Inc. New York.
9. Kapetsky, J.M. (1994). A strategic assessment of warm-water fish farming potential in Africa: CIFA TECHNICAL PAPER 27, Food and Agriculture Organisation, Rome, Italy.
10. Manfred M. Fischer and Peter Nijkamp (1993). Geographic Information Systems, Spatial Modelling and Policy Evaluation. Springer-Verlag, Berlin Heidelberg, New York, London, Paris, Tokyo, Hong Kong, Barcelona and Budapest.
11. Nancy J. Obermeyer and Jeffrey Pinto (1995). Managing Geographic Information Systems. The Guiford Press. New York, London.
12. William, J. Douglas (1995). Environmental GIS Application to industrial facilities. Lewis Publishers, Boca Raton, Ann Arbor, London, Tokyo.
13. GIS Journals:
14. International Journal of GIS.
15. Photogrametric Engineering and Remote Sensing.

Department of Fisheries Management

Course No. FM 113
Course Title: Fisheries Resources
Credit: 3

1. Physical resources of Bangladesh: (a) Waterbodies: Ponds and lakes, river, canals floodplain, beels, haors, baors, paddy fields, borrow pits and Bay of Bengal, their origin and morphology. (b) Institutional resources: Gos and NGOs, educational, research, training and extension. (c) Financial institutions: Banks, cooperatives, NGOs and other agencies.
2. Biological resources: Indigenous and exotic fish and non- piscine fisheries organisms, other aquatic living resources of commercial and economic importance.
3. Present status of water bodies, nature and extent of utilization, potentials for future management for sustainable development, sectoral policies and programmes for water-bodies belonging to different ministries and departments, current five-year development activities of the Ministry of Fisheries and Livestock.
4. Present status of seed production of fin fish, shell fish and non-conventional aquatic fauna from natural and artificial sources.
5. Impact of monsoon and flood, and flood control structures on inland capture fisheries resources.
6. Fisheries resource survey system of Bangladesh: Present status of fishery statistics, Methods used in FRSS: weakness, scope for further development.

Text books and references:

1. Ameen, M., 1987. Fisheries Resources and Opportunities in Freshwater Fish Culture in Bangladesh. PAT. NRD-11/DANIDA, Noakhali, Bangladesh. 244 pp.
2. Bazigos, G.P., 1974. The design of fisheries statistical survey- inland waters. FAO Fish. Paper No. 133, 122 pp.
3. Brockman, C.F., 1959. Recreational use of wild land. McGraw-Hill Co., Inc. New York.
4. Fernando, C.H. and Furtado. J.I., 1975. Reservoir fishery resources of South East Asia. Bull. Fish. Res. Sta. Sri Lanka, 26: 83-95.
5. FRI, 1994. Sustainable Development of Marine Fisheries Resources in Bangladesh. Proceeding of workshop held in Cox's Bazar, Bangladesh, 29 August 1994. 96 pp.
6. Hussain, M., 1979. Marine and Estuarine Fishes of the Northeast Bay of Bengal. BFDC, Chittagong.
7. Khan, M.A.R., 1993. A brief report on faunal survey of Northeast Region of Bangladesh. NERP/NACOM. 12 pp.
8. Khan, M.S., Haq, E., Haq, S., Rahman, A.A., Rashid S.M.A. and Ahmed. H., 1994. Wetlands of Bangladesh. Bangladesh Centre for Advanced Studies & Nature Conservation Movement. 91pp.
9. Lagler, K.F., 1966. Freshwater Fishery Biology. Willium C. Brown Co. Dubaque, Iowa, USA.
10. Lowe-Mc Connell, R.H., 1975. Fish Communities in Tropical Freshwater. Longman Ltd., London. 337 pp.
11. Naqui, S.A., Ali, M.Y., Sadeque S.Z. and Khan, T.A., 1994. Final report: Study on increased intervention by NGOs in the Third Fisheries Project on Floodplains. BCAS and Third fisheries Project, DOF. 119 pp.
12. Rahman, A.K.A., 1989. Freshwater Fishes of Bangladesh, Zoological Society of Bangladesh, Dhaka. 364 pp.
13. Rainboth, W., 1990. The Fish Communities and Fisheries of the Sundarbans: Development assistance and the dilemmas of the aquatic communities. Agriculture and Human Values, 7 (2): 61-72.
14. Statistical Pocket Book of Bangladesh, 1991. Bangladesh Bureau of Statistics. Statistical Division, Ministry of Planning, Bangladesh.
15. Tsai, C. and Ali. M.Y., 1997. Open water Fisheries of Bangladesh. Bangladesh Centre for Advanced studies. The University Press Limited, Dhaka. 212 pp.
16. World Bank, 1990. Bangladesh fisheries Sector Review. 195 pp.

Department of Languages

Course No. LAN 111
Course Title: English Language
Credit: 3

1. Textual study and comprehension of a few selective BBC talks.
2. Socio-linguistic rules to perform language function in English.
3. Basic grammatical structures:

i) Types and constructional forms of sentences; Sequence of tense; Voice; Verbs; verb patterns and verb modifiers; Syntax including transformation and combination of sentence and framing of WH-questions.
ii) Nouns, determiners and adjectives; Adverbials; Prepositional phrases; Headword, Infinitive phrases; Participle phrases; Apositives.
iii) Mechanics – Punctuation, Quotation marks, Capitalization, Numbers, Abbreviation Italics, Spelling (including most common mistakes).

4. Principles and methods of composition:
   i) Precis
   ii) Abstract or Summary
   iii) Paragraphs
   iv) Letters
   v) Short Essays
   vi) Reports

Text books and references:
Text books:

1. Close, R.A. 1988. The English We Use (24th Indian Edition). Longman, Calcutta.
2. Leech, G. and Svartvik, J. 1996. A communicative grammar in English (2nd Edition). Longman, London and New York.
3. Hornby, A.S. 1998. Guide to Patterns and Usage in English (2nd Edition). Oxford University Press, Delhi.

References:

1. Pyle, K.A. and Munoz, M.A. 1992. Chiffs TOFEL Preparation Guide (62 Revised Edition) BPB Publications, New Delhi.
2. Chowdhury, M.Y.A. and Hossain, M.M. 2002. Advanced Learner's Degree General English. Advanced Publications, Banglabazar, Dhaka.
3. Hornby, A.S. 1996. Oxford Advanced Learner's Dictionary of Current English (Ed. J. Crowler, 5th Edition) Oxford University Press, London.
4. Begum, J. 1988. A Text Book of Modern Functional English. Globe Library (Pvt.) Ltd. Dhaka.
5. Berkoff, N.A. 1975. Agriculture (English Studies Series: 10). Oxford University Press, London.

Level - I, Semester - II

Department of Fisheries Biology and Genetics

Course No. FBG 121
Title: General Ichthyology
Credit: 3

1. Introduction: Course goals, objectives and outcomes. History of Ichthyology
2. Definition of fish. Important facts and figures about fishes. Classification of major groups of freshwater and marine fishes
3. External morphology:
   Body forms, shapes and sizes. Body coverings. Appendages and openings.
   Skin, scales, skeleton, and fins. Derivatives of skin. Coloration in fishes and its significance
4. Muscles and locomotion:
   Types, and their roles in locomotion and movements of different body parts
5. Anatomy of different internal organs:
   Respiratory system: Structure of gills, accessory air-breathing organs.
   Digestive system: Food, feeding habits and feeding adaptations; comparative study of the alimentary canal in different groups of fishes.
   Circulatory system: Components of circulatory systems.
   Excretory system: Excretory organs, types of kidneys.
   Reproductive system: Types of reproduction, primary and secondary sexual characters.
6. Swim bladder: Origin and role in buoyancy
7. Integration systems in fishes:
   Nervous systems- brain and cranial nerves; spinal cord and nerves
   Receptors- types and functions
   Endocrine system- types of endocrine glands, their location and function.
8. Adaptive radiation in fish.

Course No. FBG 122
Course Title: General Ichthyology
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a Practical Note Book to be signed and checked by teacher(s) concerned.

Viva voce test will form an essential part of the Practical Examinations.

1. Identification of important marine and freshwater fishes.
2. Study of different types of scales.
3. Study of external morphology and internal anatomy of fishes.
4. Comparative study of digestive systems of fishes with different food and feeding habits.

5. Major circulatory blood vessels.
6. Identification of important bones and preparation of bone album.
7. Study of brain and pituitary gland.

Text books and references:

1. Lagler, K. F., Bardach, J. E., Miller, R. R.. and Passino D. R. M., 1977. Ichthyology. John Wiley & Sons, Inc., New York.
2. Love, M. S. and Cailliet. G. M. (eds.), 1979. Readings in Ichthyology, Prentice-Hall of India Ltd. New Delhi.
3. Bond, C. F., 1979. Biology of Fishes. Sunders College Publishing, Philadelphia.
4. Aleev, Y. G. (ed.). 1969. Function and Gross Morphology of Fish. Keter Press, Jerusalem.
5. Brown, M. E. (Ed.) 1957. The Physiology of Fishes. Vols. I and II. Academic Press, New York and London.
6. Day, F., 1971. The Fishes of India, Today and Tomorrows Book Agency, New Delhi. Goodrich, E. S., 1958. Studies on the Structures and Development of Vertebrates (Reprint edition) Vols. I an II. Dover Publications. New York.
7. Gunther, A. C. L. G., 1963. An Introduction to the Studies of Fishes (Reprint edition). Today and Tomorrows Book Agency. New Delhi.
8. Hyman, L. H., 1961. Comparative Vertebrate Anatomy. (2^{nd} edition, 18^{th} impression). The University of Chicago Press. U.S. A.
9. Jhingran, V. G. 1988. Fish and Fisheries of India, Hindustan Publishing Corporation(India), Delhi.
10. Lagler, K. F., 1950. Studies in Freshwater Fishery Biology. (3^{rd} rev. ed.), Michigan, USA.
11. Lagler, K. F., 1952. Freshwater Fishery Biology IOWA Press Inc. U.S.A.
12. Marshall, N.B., 1965. The Life of Fishes. Weidenfeld and Nicolson. London.
13. Rahman, A. K. A., 1989. Freshwater Fishes of Bangladesh., The Zoological Society of Bangladesh, Dhaka 1000.
14. Romer, A. S.,1949. The vertebrate body. W. B. Saunders Company. Philadelphia.
15. Schultz, L. P., and Stern, E. M., 1949. The Ways of Fishes. Van Nostrand Reinhold Company Inc.,New York .
16. Shafi, M. and Kuddus, M. M. A., 1982: Bangladesher Matsya Sammpad (Bangla). Bangla Academy, Dhaka.
17. Stockard, A. H. 1949: A Laboratory Manual of Comparative Anatomy of the Chordates. Edward Brothers, Michigan.

Department of Fisheries Biology and Genetics

Course No. FBG 123
Course Title: Biodiversity and Fishery Systematics
Credit: 3

1. Introduction: Course goals, objectives and outcomes.
2. Basic information on biodiversity : Definition of species. Ecosystem and genetic diversity. The nature and value of biodiversity- economic and ecological.
3. Aquatic biodiversity study: Species biodiversity
   Ecosystem diversity -
   Country level: Inland – ponds, swamps, lakes, canals and rivers and Marine – Bay of Bengal, coast, off-shore and estuaries
   Global level: Hydrosphere (7 oceans), Lithosphere (lands – 5 continents) and Atmosphere (Air), Rhythms: Scalar rhythm (24 h diurnal), Lunar rhythm (monthly) and solar rhythm (annual), wave and current
4. Loss of the biodiversity: Causes; natural variation in time and space; Present situation, endangered aquatic species of Bangladesh.
5. Systematics - an overview.
6. Taxonomic characters: Morphometric, meristic, physiological, ecological, and ethological.
   Criteria for taxonomic categorization.
7. Zoological nomenclature: The rules of Zoological nomenclature: International code, validity of names, homonymy, synonymy.
8. Mechanisms of speciation: Species concepts and speciation in fish.
9. Evolution and adaptive radiation in fish: Agnatha, chondrichthyes, primitive fishes, teleosts and acanthopterygii.
10. Recent developments in systematics.

Course No. FBG 124
Course Title: Biodiversity and Fishery Systematics
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a Practical Note Book to be signed and checked by teacher(s) concerned.

Viva voce test will form an essential part of the Practical Examinations.

1. Collection and preservation of aquatic animals.
2. Characterization and identification of collected specimens.
3. Study of morphometric and meristic characters of fishes.
4. Study of biodiversity of selected and protected areas.

Text books and references:

1. Mayr, E., 1969. Principles of Systematic Zoology. McGraw Hill Book Co. New York.
2. Helfman, G.S., Collette, B.B. and Facey, D.E., 1997. The Diversity of Fishes. Blackwell Science.
3. Gaston, K.J. and Spicer, J.I., 1998. Biodiversity - An Introduction. Blackwell Science.
4. Day, F., 1971. The Fishes of India. Today and Tomorrows Book Agency, New Delhi.
5. Mayr, E., 1963. Animal species and evolution. The Belknap Press, Harvard University Press, Cambridge.
6. Misra, K.S., 1962. An aid to the identification of the common commercial fishes of India and Pakistan. In. Rec. Indian Mus. Vol. 57.
7. Rahman, A.K.A., 1989. Freshwater Fishes of Bangladesh. The Zoological Society of Bangladesh. Dhaka 1000.
8. Shafi, M. and Kuddus, M.M.A., 1982. Bangladesher Matsya Sampad (Bangla) Bangla Academy, Dhaka.
9. Lagler, K.F. Bardach, J.E., Miller, R.R. and Passino, D.R.M., 1977. Icthyology. John Wiley and Sons, New York.
10. McNeely, J.A. and Somchevita, S. (eds.), 1996. Biodiversity in Asia: Challenges and Opportunity for Scientific Community. Proceedings of a Conference on Prospects of Cooperation on Biodiversity Activities. OEPP, MSTE, Bangkok, Thailand.
11. IUCN, 1996. The Multiple Dimension of Biodiversity. The World Conservation Union, Gland, Switzerland.
12. Brown, K., Pearce, D., Perrings, C. and Swanson, T., 1993. Economics and the Conservation of Global Biological Diversity. Working Paper No. 2. UNDP, UNEP & World Bank.
13. Castilleja, G., Poole, P.J. and Geisler, C.C., (Shelton, H.D. ed.), 1993. The Social Challenge of Biodiversity Conservation.. UNDP, UNEP & World Bank Working Paper No. 1.
14. Ponniah, A.G. and Sarker, U.K., 2001. Fish Biodiversity in North East India. National Bureau of Fish Genetic Resources, India.
15. Glowka, L., Pisupati, B., and de Silva, S., 2001. Access to Genetic Resources and Benefit Sharing. IUCN.

Department of Aquaculture

Course No. AQ 121
Course Title: Freshwater Aquaculture
Credit: 3

1. Aquaculture system: Management approach, extensive (traditional), improved traditional, semi-intensive and intensive culture. Monoculture, polyculture, composite fish culture and integrated aquaculture.
2. Pond aquaculture: Site selection, pond construction, drying, liming, fertilization, productivity, stocking and post stock management.
3. Nursery management: Pond preparation, fertilization, insect control, stocking and post stocking management.
4. Natural fish seed collection, seed production and transportation: Natural fish seed collection, bundh spawning, induced spawning, methods of packing and transport of fry and live fish, causes of mortality of fry and brood fish during transportation, use of anaesthetics, antiseptics and antibiotics in live fish transport.
5. Aquatic weeds: Common aquatic weeds and methods of their control. Preparation of compost with aquatic weeds, algal bloom and its control.
6. Culture of important freshwater species: Carp, prawn, catfish, tilapia, eel, snakes-heads and small indigenous species (SIS).
7. Cage and pen aquaculture: Site selection, design and construction of cages and pens, species selection, stocking, feeding and harvesting.
9. Impacts of aquaculture on environment.

Course No. AQ 122
Course Title: Freshwater Aquaculture
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a practical notebook to be signed and checked by teacher (s) concerned. Viva voce test will form an essential part of the practical examination.

1. Identification of common aquatic weeds and algae of aqauculture.
2. Identification of seeds of important aquacultural fish and shrimp species.
3. Preparation, fertilization and management of a nursery pond.
4. Preparation, liming, fertilization and management of a stocking pond.
5. Use of anaesthetics in handling of fish.
6. Transportation of fry, fingerlings and live fish.
7. Case study: Visit to hatchery and fish farms and preparation of cage study report.

Text books and references:

1. Huet, M. 1979. Textbook of Fish Culture: Breeding and Cultivation of Fish. Fishing News Books Ltd. Farnham, Surrey, England.
2. Islam, M. A. 2001. Aquaculture. Bangla Academy, Dhaka. 352 pp.
3. Pillay, T. V. R. 1993. Aquaculture: Principles and practices, Fishing News Books Black well Scientific Publications Ltd. Osney Weed Oxford OX2 OEL, U.K. 592 pp.
4. Anonymous, 1997. Training on Integrated Fish Farming to the Thana Fisheries Officer, Fisheries Research Institute, Mymensingh.
5. Axelord, H. R. 1980. Schultz, L. P. 1983. Hand book of Tropical Aquarium Fishes, Neptune, New Jersey, T. F. H. Publications Inc. Ltd. 718 p 3rd rev. ed.
6. Chondar, S. L. 1980. Hypophysation of Indian Major Carps. Shatish Book Enterprise Motikatra, Agra-3, India, 146pp.
7. Edwards, P., D. C. Little and H. Demaine (eds.). 2002. Rural Aquaculture, CABI Publishing, CAB international, Wallingford, Oxon OX10 8DE, U. K.358 pp.
8. FAO (Food and Agricultural Organization) 1990. Farming Systems. Developments, Guidelines for the conduct of training course in farming systems development. FAO- United Nations.
9. Jhingran, V. G. 1977. Fish and Fisheries in India. Hindustan Publishing Delhi.
10. Jhingran, V. G. and R. S. V. Pullin 1985. A Hatchery Manual for Common, Chinese and Indian Major carps. Asian Development Bank, ICLARM, Manila, Philippines.
11. Karim, M. A. 1975. An Introduction of Fish Culture in Bangladesh, Ruby Press, Mymensingh, Bangladesh.
12. Kurian, C. V. and Sebastian, V. O. 1982. Prawns and Prawn Fisheries of India. Delhi, Hindustan Publishing Corporation (India) 186p. 2nd rev. ed.
13. Muir, J. F. and Roberts, R. J. (Eds.) , Recent Advances in Aquaculture, Vol. I, II, III and IV, Croom Helm, London.
14. Pillay, T. V. R. 1994. Aquaculture Development: Progress and Prospect. Fishing News Books Black well Scientific Publications Ltd. Oxford.
15. Pullin, R. S. V. and Lowe-McConnel, R. H. 1982. The Biology and Culture of Tilapias, ICLARM Conference Proceedings 7. 432 p. International Center for Living Aquatic Resource Management, Manila, Philippines.
16. Islam, M. A. 1985. Macher Chash Babosthapana. Bangla Academy, Dhaka. 277 pp.
17. Islam, M. A. 1989. Macher Chash Babosthapana. Bangla Academy, Dhaka. 174 pp.
18. Islam, M. A. 1992. Macher Pukurer Pani. Academy, Dhaka. 229 pp.

Department of Fisheries Technology

Course No. FT 121
Course Title: Fish Harvesting-II
Credit: 3.0

1. Modern trends in fishing. Fishing regulation. Fish harvesting and fisheries management for open waters.
2. Different types of fishing: Fishing machinery, industrial fishing, successful fishing and unsuccessful fishing, responsible fishing, sports fishing and ice fishing. Modern fishing gears and fishing crafts. Sinkers, floats, buoys in marine fishing. Fish responses to fishing gears.
3. Choice of netting material for bottom trawl, gill net and trammel net at sea.
4. Navigation in fishing. Location of fishing grounds in sea. Factors in locating fishing grounds – environmental conditions. Electronic equipment for fish finding techniques – radio direction finder (RDF), RADAR, LORAN (Long range navigation), Decca, Satellite. Fish detection. Acoustic equipment – echo sounder, echo-ranger, SONAR (sound navigation and ranging), net monitoring system. Mid water fish and bottom fish detection by SONAR.
5. Fishing grounds. Fish migration and fishing. Pattern of a typical fishing ground. Selection of fishing grounds. Fishing activities in fishing grounds. Fish detection and luring methods. Exploitation of fishing grounds and their maintenance. Fishing grounds in the Bay of. Attraction of fish. Fish response to different stimuli.
6. Commercial fishing gears and methods: Purse seining, trawl net. gill net, trammel net; lift net; estuarine set bag net; long line: types and operation. Trolling line and trolling jigs. Traps – characteristics of trap fishing. Others fishing implements– spatula, spears, tongs, seaweed twisters, rakes, scoop net and harpoon gun. Methods of harvesting pelagic, demersal and shell fish in the Bay of Bengal and coastal areas of Bangladesh.
7. Mechanized fishing vessel: Classification and characteristics. Marine diesel engine for fishing boat. Major equipment on a fishing trawler.

Course No. FT 122
Course Title: Fish Harvesting-II
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a Practical Note Book to be signed and checked by teacher (s) concerned.

1. Acquaintance with different types of fishing gears: Wounding gears, traps and nets. Identification, description, operation and significance.
2. Acquaintance with different types of fishing crafts used in Bangladesh: Identification, carrying capacities and significance.
3. Examination of different net materials: Yarn, strand, twine, cord and its direction. Study of count system of fishing twines.
4. Identification of different types of natural and synthetic fibers used in fishing.
5. Practice on net making and mending.
6. Exercise on different techniques of net preservation.
7. Field visit to a fish landing center.

8. Field visit to the river Brahmaputra to see different fishing operation.
9. Exercise on fish harvesting using seine net and caste net in a University fish pond.

Text books and references:

1. Kristjonsson, H. (Ed.) 1975. Modern fishing gears of the World. Fishing News (Books) Ltd. Surrey, England
2. Brandt, A. V. 1984. Fish catching methods of the world (Third Edition). Fishing News (Books) Ltd. Surrey, England
3. Nomura, M. 1978. Outline of fishing gear and method. Kanagawa International Fisheries Training Center. Nagai, Yokoshika-shi, Kanagawa-ken, Japan.
4. Garner, J. 1982. How to make and set nets or the Technology of netting. Fishing News (Books) Ltd. Surrey. England.
5. Different published manuals, papers, reports etc. on related topics in fish harvesting.
6. Training Department, SEAFDEC (Ed.) 1988. Fishing Technology outline. TD/TRB/45, October 1988. Text Reference book. Southeast Asian Fisheries Development Center, Phroprudoeng, Samutpraken, Thailand.
7. Sainsbury, J. C. 1975. Commercial fishing methods: an introduction to vessels and gears. Fishing News (Books) Ltd. Surrey. England.
8. Chokesanguan, B. (Ed.) 1985. Basic knowledge of trawl and trawling. Training Department. Td/LN/58, September 1985. Southeast Asian Fisheries Development Center. Samutpraken, Thailand.
9. Thomson, D. 1978. Pair trawling and pair seining. The technology of two-boat fishing. Fishing News (Books) Ltd. Surrey. England.
10. Thomson, D. 1981. Seine fishing. Bottom fishing with rope warps and wing trawls incorporating the *Seine Net – its origin, evolution and use.* Fishing News (Books) Ltd. Surrey. England.
11. Nomura, M. 1978. Outline of fishing gear and method. Kanagawa International Fisheries Training Center. Nagai, Yokoshika-shi, Kanagawa-ken, Japan
12. Garner, J. 1982. How to make and set nets or the Technology of netting. Fishing News (Books) Ltd. Surrey. England.
13. Perry Mrin, W. H. (Captain) (Ed.). 1982. Fishermen's handbook. Fishing News (Books) Ltd. Surrey, England.
14. Rabindran, K., Nair, N.U., Perigreen, P.A., Madhavan, P., Pillai, A.G.G., Panicker, A. and M. Thomas (Eds.) 1985. Harvest and post-harvest technology of fish. Society of Fisheries Technologies, Cochin, India.
15. Fyson, J. (Ed.). 1985. Design of small fishing vessels. FAO Publication. Fishing News (Books) Ltd. Surrey, England.

Department of Rural Sociology
Course No. RS 121
Course Title: Rural Sociology
Credit: 3

1. **Introduction**: Definition of Sociology and Rural Sociology, Origin and Development of Rural Sociology; Scope of Rural Sociology, Importance of Rural Sociology, Role of the Rural Sociologists in Agricultural Development.
2. **Methods and Techniques of Social Research:** Scientific research methods, importance, value judgement and ethical issues, types, research process, sampling, mode of data collection and analysis of social data.
3. **Culture:** Meaning, importance and function, elements, cultural universals and variability, ethnocentrism and relativism.
4. **Social Differentiation, Stratification and Rural Power Structure:** Nature and sources of social differentiation, importance and consequences, form of Stratification, class and caste, class system of rural Bangladesh, Nature of Rural Power Structure, kinship and rural elites, power structure and development activities.
5. **Society, Technology and Rural Social Change:** Technology and change in human society, Changes in traditional technologies, Green revolution, industrialization, urbanization, modernization, unemployment.
6. **Rural Livelihood and Sustainability:** Definition of Livelihood and Changing Socio-Economic activities, Institutional Arrangement, Intergraded Framing System: Agriculture, Rice-Fish Culture, Poultry and Livestock.
7. **Rural Poverty, Rural Development and GO and NGO Activities**: Meaning and nature of rural poverty, rural development models, GO and NGO activities.
8. **Fisheries and Environmental Quality:** History of environmental movement, impact of fish culture on environment, consequences for human communities, social impack assessment.
9. **Rural women and gender issues:** Women and development, gender discrimination, aspects of gender inequality, important issues and techniques of development of women in Bangladesh.
10. **Rural social policy and planning:** Meaning and contribution of rural sociology in social policy, objectives of rural social planning, pre-requisite, limitations and obstacles of effective social planning, application of social planning.

Text books and references:
Text books:

1. Browne, Ken. 1998. An Introduction to Sociology. Polity Press, London.
2. Rogers, E.M. *et al.* 1998. Social Change in Rural Societies: An Introduction to Rural Sociology, Prentice-Hall, London.
3. Giddens, Anthony. 1998. Sociology, 3rd edition, Polity Press, London.
4. Devi, Laxmi. 1998. Rural Sociology. Anmol, India.
5. Chitambar, J.B. 1993. Introductory Rural Sociology. Wily Eastern Ltd, India.

References:

1. Jansen, Erick G. Rural Bangladesh: Competition for Scarce Resources (2nd Impression). UPL, Dhaka.
2. Sufian, A.J.M. 1998. Methods and Techniques of Social Research, UPL, Dhaka.
3. Rahman, H.Z. 1995. Rethinking Rural Poverty: Bangladesh as a Case Study. UPL, Dhaka.
4. Rahman, Atiq, A. *et al.* (eds.). 1994. Environment and Development in Bangladesh, UPL, Dhaka.
5. Etienne, G. 1998. Rural Change in South Asia-India, Pakistan, Bangladesh. UPL, Dhaka.
6. Ellis, F. 2000. Rural Livelihood and Diversity in Developing Countries. Oxford University Press Oxford.

7. Hamid, Shamim. 1997. Why Women Count: Essays in Development on Bangladesh. UPL, Dhaka.

Department of Fisheries Management

Course No. FM 121
Course Title: Wetland Ecosystem
Credit: 3

1. Introduction: Definition, history and heritage of wetlands, hydrological context, importance of wetland for Bangladesh.
2. Kinds of wetlands: Saltwater, freshwater, riverine, lacustrine and palustrain wetlands, man made wetlands.
3. Ecology of wetlands: Geomorphological characteristics and forest status; habitat for migratory birds; fisheries organisms (freshwater and marine).
4. Socio-economic aspects of wetlands: Human settlements, role in bio-diversity conservation, wetland crops, navigation and communication media, source of food and medicinal plants, biomass production and role in cottage industries, coral reef formation, eco-tourism and flood control.
5. Developmental activities and threats: Impact of development activities, disappearing and pollution of wetlands, land use conflicts and reclamation, role in endangering bio-diversity.
6. Wetlands legislation: Proposed legislative framework, sectional laws, historical aspect and abolition of Jamidari; institutional and policy conflicts.
7. Future strategies for resource management, sustainable development and public awareness, and international collaboration.
8. Wetland management: Restoration, rehabilitation and management of wetlands.
9. Role of organizations in the conservation of wetlands: National management policy, role of the Ministry of Environment and Forest, Ministry of Livestock and Fisheries, Department of Fisheries (DoF), Bangladesh Fisheries Research Institute (BFRI), Bangladesh Fisheries Development Corporation (BFDC), Bangladesh Water Development Board (BWDB), Space Research and Remote Sensing Organization (SPARRSO); Non-government Organizations (national and international).

Text books and references:

1. Ahmed, A.T.A. 1994. Paper presented at the training programme on fisheries and environment under FAO/UNDP Project of the Fisheries Research Institute, Mymensingh.
2. Barber, C.V. 1995. The convention of biological diversity: why it matters to Asian Fisheries. Paper presented at Symposium on Biological Diversity, Asian Fisheries Forum, Beijing, China, October 16-20, 1995.
3. Finlason, M. 1992. Integrated management and conservation of wetlands in agricultural forested wetlands. International Waterfowl and Wetlands Research Bureau (IWWRB), Special Publication No. 22.
4. Khan, M.S., E. Haque, A.A. Rahman, S.M.A. Rashid and H. Ahmed. 1994. Wetlands of Bangladesh. Bangladesh Centre for Advanced Studies (BCAS), 91 p.
5. Norse, E.A. 1993. Global marine biological diversity. Island Press, Washington D.C., 383 p.
6. Philipp, D.P., J.M. Epifanio, J.E. Marsedn, J.E. Claussen and R.J.Wolotira. 1995. Protection of aquatic biodiversity. Oxford and IBH publishing Co. Pvt. Ltd., Calcutta, 282 p.
7. Sasckumar, A., N. Marshall and D.J. Macintosh. 1994. Ecology and conservation of Southeast Asian marine and freshwater environments including wetlands. Kluwer academic Publishers Group, London, 336 p.
8. Tsai, C. and M.V. Ali.1997. Openwater fisheries of Bangladesh. The University Press Limited, Dhaka, 204 p.
9. Vymazal, J. 1995. Algal and element cycling in wetlands. CRC Press, Inc., Florida, 689 p.

Department of Fisheries Technology

Course No. FT 123
Course Title: Principles of Fish Handling and Preservation
Credit: 3.0

1. Introduction: Physical structure of fish, general principles and methods of food preservation with special emphasis on finfish and shellfishes.
1. Fish as food: Major component of fish flesh, nutritive value and chemical composition of fish. Post-mortem changes in fish and nature of spoilage:
2. Commercial handling of fish and shellfish: Good practices of handling of raw material, handling of fish on board fishing vessel and shore plant, temporary and bulk preservation and transportation
3. Chilling of fish: Principles of chilling, chilling of fish with ice and other methods, types of ice and icemakers, storage of ice, chilling of fish at sea, distribution and retailing of chilled fish
4. Freezing: Principles of fish freezing, freezing methods and equipment, glazing and stowage.
5. Fish working premises: Layout and design, equipment, staff hygiene, sanitation and cleaning
6. Packaging of fresh fish: Modern packaging materials, wholesale packaging, traditional packaging, retail packaging and airfreight packaging

Text books and references:

1. Clucas, I, J. and Ward, A. R. 1996. Post-harvest Fisheries Development: A guide to handling, preservation, processing and quality. Natural Resource Institute, Central Avenue, Chatham Maritime, Kent ME44TB, UK.
2. Bogstrom, G. (Editor) 1965. Fish as Food. Vol. I-IV, Academic press, London
3. Stansby, M. E. 1963. Industrial Fishery Technology. Reinhold Publishing Corporation. Chapman and Hall, Ltd., London.
4. FAO Fisheries Reports 1975. Ice in Fisheries. Food and Agriculture Organization of the United Nations, No. 59
5. G.M. Hall, 1997. Fish processing technology. Blakie Academic & Professional, London, Weinheim, New York, Melbourne, Madras
6. Govindan, T.K. 1985. Fish Processing Technology, Oxford & IBH publishing Co., New Delhi

7. Madakia, H. 1985. Fish handling, ASEAN-CIDA-SEAFDEC Regional Training Course in Fish Handling and Processing, Samutprakarn: 6-30 March 1985
8. Donald (Editor) 1968: The Freezing Preservation of Foods. The Avi Publishing Company, INC.
9. Zaitsev, V.P. 1962. Preservation of fish products by refrigeration. U.S. Department of Commerce.
10. Wiryanti, J. and Madakia, H. (ed). 1997. Improved Quality Control for the Handling and Processing of Fresh and Frozen Tuna at sea and on shore. ASEAN-CANADA Fisheries Post-harvest Technology Project-Phase II.

Department of Computer Science & Mathematics

Course No. CSM 127
Course Title: Computer Science
Credit: 2

Computer basics: history and development, computer types on size and use, impact of computer on society and technology; computer systems, hardware and software, computer peripherals, i/o devices and storage media; systems software, language software, and applications software; program and algorithm; information coding, number systems and their internal representation; simple application and applet development using Java; introduction to HTML and java script in applet development; familiarity with word processing, database, spread sheet, and statistical packages; development of presentation materials using Microsoft Power Print.

Course No. CSM 128
Course Title: Computer Science
Credit: 1

Computer operations on DOS and windows environment; simple application and applet development; creation of document with figure, picture, column and table; financial book keeping and analysis using spread sheet; data storage and retrieval using Microsoft Access; simple statistical analysis using SPSS; preparation of presentation materials using Microsoft Power Point; file management.

Text books and references:

1. Office XP reference manual.
2. Frence, S. Computer science, 5th edition.
3. Warford. Computer science.

Level - II, Semester - I

Department of Fisheries Biology and Genetics

Course No. FBG 211
Course Title: Embryology
Credit: 3

1. Introduction: Course goals, objectives and outcomes.
2. Phylogenetic and ontogenetic development.
3. The origin and structure of gametes.
4. Fertilization: Types, mechanism of sperm-egg interaction, fusion of gametes, prevention of polyspermy.
5. Parthenogenesis: Natural and artificial parthenogenesis and their impact; gynogenesis, androgenesis.
6. Cleavage: Pattern of cleavage, cleavage in different animals; blastulation.
7. Gastrulation: Fate of cells; gastrulation in different animals and formation of organ rudiments.
8. Organization of early embryo, epigenesis, nucleic acid and protein synthesis.
9. Organogenesis: Formation of general body form.
10. Differentiation and growth mechanism of cell reproduction.

Text books and references:

1. Balinsky, B.J., 1975. Introduction to Embryology (4th edition). W.B. Saunders Co.
2. Gilbert, S.F., 1991. Developmental Biology (3rd edition) Sinauer Associates, Inc., Sunderland, Massachutates.
3. Wolpert, L., 1998. Principles of Development. Oxford University Press.
4. Nelson, O.E., 1953. Comparative Embryology of Vertebrates. McGraw Hill Book Company.
5. Hopper, A.F. and Nathan, H.H., 1980. Foundations of Animal Development. Oxford University Press.
6. Verma, P.S. and Agarwal, V.K., 1981. Cytology. S.Chand and Company, Ltd., Ramnagar, India.
7. Belon, E.K. (ed.), 1985. Early Life History of Fishes. Dr. W. Junk Publisher.
8. Davidson, E.H., 1968. Gene activity in early development. Academic Press.
9. International Review of Cytology. Volumes 121 and 136.
10. Nuccotilli, R., 1991. Current Topics in Developmental Biology Vol. 15, Academic Press.

Department of Aquaculture

Course No. AQ 211
Course Title: Coastal Aquaculture
Credit: 3

1. Introduction: History of coastal aquaculture, global, regional and national importance of coastal aquaculture.
2. Site selection: General consideration: physico-chemical properties of soil and water.
3. Farming techniques: Shallow water (finfish and shrimp), intertidal zone (oyster), deep water (rafts and cages).
4. Larval rearing of marine finfishes, shrimp and prawn and other marine organisms.
5. Culture of finfishes: Seabass (*Lates calcarifer*), milkfish, mullets, yellowtail, grouper and salmon.
6. Culture of crustaceans: Crabs, shrimp and prawn and lobsters.
7. Culture of marine mollusks and seaweeds: Mussels; clams; oysters (including pearl oyster); abalone; scallops; seaweeds.
8. Culture of marine algae, rotifers, cladocera, brine shrimp (*Artemia*) and other food organisms.
9. Mangrove forest and aquaculture: Mangrove ecosystem, energy flow in mangrove swamps, impact of deforestation and management of mangroves for sustainable aquaculture and fisheries.

Course No. AQ 212
Course Title: Coastal Aquaculture
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a practical note book to be signed and checked by teacher (s) concerned. Viva voce test will form an essential part of the practical examination.

1. Designing of a coastal shrimp and fish farm.
2. Transportation of larvae and PL of shrimp.
3. Nursing of brackish water fish and shrimp fry.
4. Demonstration of culture techniques for oysters, mussels and clams.
5. Decapsulation and hatching of *Artemia* in laboratory condition.
6. Culture of algae, rotifer and cladocera in laboratory condition.
7. Case study: Visit to a shrimp hatchery and a coastal aquaculture farm and report writing.

Text books and references:

1. Bardach, J. E. J. H. Ryther, and Mclarney, W. O. 1972. Aquaculture. John willey & Sone. Inc. New York.
2. Imai, T. 1977. Aquaculture in shallow seas: Progress in shallow sea culture. Oxford. IBH Publishing Co. New Delhi, Bombay, Calcutta. 615 pp.
3. Iverson. E. S. 1968. Farming at the Edge of the Sea, Fishing News Books) Ltd. London. 301 pp.
4. Anonymous. 1985. Shrimp culture in the semisaline zone of the Delta. Final Report, Technical Report No. 13, Vol. 1. Aruhem. The Hague 60 pp.
5. Islam, A. 1988. Samudra Upakula Matsya Chash. Bangla Academy, Dhaka. 115 pp.
6. Kurian C. V. and V. O. Sehastian 1978. Prawn and Prawn Fisheries of India, Hindustan Publishing Corporation, Delhi.
7. Lee, D. O.C. and J. F. Wichins, 1991. Crustacean Farming. Oxford, Fishing News Books/Blackwell Scient. Publ. Ltd.
8. Mcvey, J. and J. Moore, 1983. CRC Hand book of Mariculture. Vol. I: Crustacean Aquaculture.
9. Mcvey, J. 1991. CRC Hand book of Mariculture. Vol. II. Finfish Aquaculture.
10. Mohan, M.J. (edited). 1980. Aquaculture in Asian Fisheries Society, Indian Branch Mangalore.
11. Muir, J.F. and R.J. Roberts (edited). 1982. Recent Advances in Aquaculture. Vol. 1. Croom Helm, London. 453 pp.
12. Muri, J.F. and R. J. Roberts, 1985. Resent Advances in Aquaculture. Vol. 2. Beckenham, U. K., Croom Helm, 282 pp.
13. Muir, J. F. and R. J. Roberts, 1988. Resent Advances in Aquaculture, Vol. 3. Beckenham, U. K., Croom Helm, 420 pp.
14. New, M. V. and S. Singholka. 1982. Freshwater Prawn Farming. A. manual for the culture of FAO Fish. Tech. Paper. (225): 116 pp.
15. Pillay, T. V. R. 1973. Coastal Aquaculture in the Indo-pacific region Fishing News (Books) Ltd. London. 497 pp.
16. Shigeno, K. 1978. Problems in prawn culture Amerind Publishing Co. PVJ. Ltd. New Delhi.

Department of Fisheries Management

Course No. FM 211
Course Title: Physico-chemical Limnology
Credit: 3

1. Definition of limnology. Scope of limnology. Introduction to the study of inland waters. Historical development in Limnology. Origin and morphology of ponds, lakes, and reservoirs. Lakes of the world and Bangladesh.
2. Rivers: Definition, types, origin, sources of water, rivers of Bangladesh, and rivers of the world.
3. The nature of water. The water molecule, physical and chemical characteristics of pure water.
4. The physical characteristics of inland water environments: Light, colour, turbidity, heat and temperature, thermal classification of lakes. Heat budget and lake stability. Holomixis and meromixis.
5. Chemical characteristics of inland waters: Dissolved gases (oxygen, carbondioxide and other gases). Dissolved solids (nitrogenous compounds, phosphorus, calcium and magnesium, sodium and potassium, iron, silicon, trace elements). Role of nutrients in primary production.
6. pH: definition, description, and effects on fishes and aquatic environment.
7. Biogeochemical cycles: definitions, biogeochemical cycles of nitrogen, phosphorus, calcium, carbon, silicon, sulfur, iron etc.
7. Estuaries: definition, types and description. Estuaries of Bangladesh.

Course No. FM 212
Course Title : Physico-chemical Limnology
Credit : 1.5

Students shall be required to show a good knowledge of the topics included in the theoretical portion of the paper. They shall maintain a record of everything done in practical classes/ field trips in a practical note book to be signed and checked by the teacher (s) concerned. Viva-voce test will form an essential part of the practical examination.

1. Studies of water-body morphometry. Shoreline surveys of ponds and lakes. Water level recording procedures. Method for determining area and volume of ponds, lakes and reservoirs.
2. Recording of temperature, turbidity, colour, light penetration and water flow of water-bodies.
3. Chemical analysis of water: Water sampling methods. Determination of dissolved oxygen, free carbondioxide, pH, total alkalinity, total hardness, phosphate, nitrate, nitrite, ammonia, calcium, iron, silicon and salinity.
4. Procedures of removing turbidity by different methods.
5. Lime application: Determination of dose and application procedures.
6. Field visit to study water quality parameters of fish farm.

Text books and references:

1. American Pablic Health Association, 1987. Standard Methods for the Examination of Water and Wastewater. 11th Edition. American Public Health Association. New York.
2. Boyd, C.E. 1979. Water Quality in Warmwater Fish Ponds Aubum Univeristy, Alabama.
3. Goldman, C.R. & A.J. Horne. 1983. Limnology. McGraw-Hill Book Company, New York.
4. Golterman, H.L. 1969. Methods for chemical Analysis of Fresh Waters. ISH 8. Blackwell Scientific Publications. Oxford.
5. Jorgensen, S.E. 1980. Lake Management. Pergamon Press Ltd. Oxford.
6. Lecren, E.D. & R.H. Low-McConnell. 1980. The Functioning of Freshwater Ecosystems. IBP 22. Cambridge University Press. Cambridge, London.
7. Lind. O.T. 1985. Handbook of common methods in Limnology. Kendall/Hunt, Iowa.
8. Rahman, M.S. 1992: Water quality management in aquaculture. BRAC Prokashana, Dhaka-1212.
9. Reid G.K. & R.B. Wood. 1976: Ecology of Inland waters and Estuaries, Reinhold Publishing Co., New York.
10. Schwoerbel, J. 1987. Handbook of Limnology. Ellis Horwood Limited, New York.
11. Serruya, C. & U. Pollinger. 1983. Lakes of Warm Belt. Cambridge University Press, Cambridge, London.
12. Stirling, H.P. 1985. Chemical and Biological Methods of Water Analysis for Aquaculturists. Institute of Aquaculture, Stirling.
13. Welch, P.S. 1952: Limnology. McGraw-Hill Book Co. New York.
14. Wetzel, R.G. 1983. Limnology, CBS College Publishing, The Dryden Press.
15. Wetzel, R.G. & G.E. Likens. 1991. Limnological Analysis. Springer – Verlag, New York, London, Tokyo, Baracelona.

Department of Fisheries Technology

Course No. FT 211
Course Title: Fisheries Microbiology-I
Credit: 3.0

1. Introduction: Scope, historical development, ecology and geographical distribution.
2. Taxonomic classification of microorganisms: Mold, yeast, bacteria, mycoplasma, chlamydia, virus and rickettsia. General characteristics of prokaryotes and eukaryotes.
3. Molds and yeasts: General morphology, structural and reproductive characteristics, cultural characteristics, physiological characterises, distinguishing characterises of important genera and industrial importance.
4. Bacteria: Morphology and structure (cell wall, cell membrane, capsule, pilli, flagella, spores, cytoplasm, and nuclear material). Cultural and physiological characteristics. Description of important genera.
5. Viruses: General characteristics, classification, morphology and structure, viral reproduction.
6. Microbial growth and nutrition: Microbial growth curve, factors affecting microbial growth (water activity a_w , pH, temperature, redox-potential E_h, nutrient, microbial interactions, antimicrobial agents)
7. Immunity: Antigen, antibody, antigen-antibody reactions (agglutination, precipitation, complement fixation and cytolysis, phagocytosis, hypersensitivity),Immunological methods (FAT, ELISA).
8. Antibiotic, antiseptics and disinfectants: Definition, types, characteristics, mode of action and economic importance.

Text books and references:

1. Alcamo, I. Edward, 1984. Fundamentals of Microbiology. Addison-Wesley Publishing company.
2. Burrows, W. 1985. Textbook of Microbiology. 22nd Ed. W. B. Saunders Co., Philadelphia and London.
3. Franklin, T. J. and Snow, G. A. 1971. Biochemistry of Antimicribial Action. Chaoman and Hall, London.
4. Frazier, W. C. and Westhoff, D. C. 1990 Food Microbiology. 3rd edition. McGrow Hill Book Co., New York, London.

Department of Biochemistry

Course No. BCHEM 213
Course Title: Biochemistry-II
Credit: 2

Concept of free energy, entropy and enthalpy. Exergonic and endergonic reactions. ADP-ATP cycle. Bioluminescence.

Enzymes: Class. elements of kinetics. Mode of action and inhibition. Coenzyme and prosthetic groups. Allosteric enzyme. Lysozymes. An overview of metabolism.

Carbohydrate Metabolism. Glycolysis. TCA Cycle. Gluconeogenesis. Anaplerotic pathway. Hexose monophosphate slunt. Cori cycle. Regulation of TCA cycle and glycolysis. Electron transport chain and oxidative phosphorylation.

Protein Metabolism: Food protein quality evaluation. Basic processes of amino acid catabolism. Nitrogen excretory products in aquatic animals. Fixation of nitrogen by aquatic plants.

Lipid Metabolism: Fatty acid oxidation. Biosynthesis of fatty acids and cholesterol. Interrelationship of fat, protein and carbohydrate metabolism.

Nucleic acids: Replication, transcription and translations- Biological functions of restriction enzymes. Concept of recombinant DNA and cloning.

Hormones: Characteristics and classification. Mode of action and biological functions of pituitary, hypthalamus, adrenal cortex and sex hormones.

Text books and references:

1. Conn, E.C. and Stump, P.K. 1987. Outlines of Biochemistry. 5th ed. J. Wiley and Sons, New York.
1. Elliot, W.H. and Elliot, D.C. 1997. Biochemistry and Molecular Biology.
3. Lehninger, A.I. 1976. Text Book of Biochemistry. 2nd ed. Worth Publishers, New York.
4. Lehninger, A.I. 1980. Principles of Biochemistry. Worth Publishers, New York.
5. Martin, D.W., Mayes, P.A. and Rodwell, V.W. 1981. Harper's Review of Biochemistry 18th ed. Lange Medical Pub. California.
6. Stryer, L. 1986. Biochemistry, S.K. Jain Publishers, Delhi, India.
7. Watson, D. 1987. Molecular Biology of Gene. Bengamin, Inc.

Department of Agricultural Statistics

Course No. Stat 211
Course Title: Statistics
Credit: 3

Definition and scope of statistics. Variables. Construction of frequency distribution and graphical representation of data. Measures of central tendency, dispersion, moments, skewness and kurtosis. Elementary theory of probability, laws of probability. Probability distribution: Binomial, Poisson and Normal distribution. Fitting Binomial and Poisson distribution to observed data. Population and sample. Preliminary idea on sampling distribution. Simple correlation and regression. Fitting simple linear regression to observed data.

Hypotheses, test of hypothesis, type 1 and type II errors and level of significance. Preliminary idea on t-test, F-test, chi-square test and their application. Testing hypothesis regarding population mean, equality of two means, population variance equality of two population variances, goodness of fit and independence of two attributes in contingency table and test of significance of correlation coefficient and regression coefficients(s).

Principles of experimental design. Field layout and analysis of variance in completely randomized design, randomized block design and Latin square design. Analysis of covariance in a completely randomized design and randomized block design.

Course No. Stat 212
Course Title: Statistics
Credit: 1.5

Frequency table construction and graphical representation of data. Calculation of various measures of central tendency, Quantiles, various measures of dispersion. Fitting Binomial and Poisson distribution to observed data. Calculation of correlation coefficient and fitting simple linear regression to observed data.

Testing hypothesis regarding population mean, testing significance of simple correlation coefficient and regression coefficient(s). Use of Chi-square for testing goodness of fit and test of independence of attributes in a contingency table.

Field layout, analysis of variance and interpretation of data collected in completely randomized design, randomized block design and Latin square design. Examples of covariance analysis in a completely randomized design and randomized block design.

Text books and references:

1. Meed, R. and Curnow, R.N. (1983). Statistical Methods in Agriculture and Experimental Biology. Chapman and Hall, London.
2. Gupta, S.C. & V.K. Kapoor (1983). Fundamentals of Mathematical Statistics, S. Chand and Company Ltd., New Delhi.
3. Shil, R.N. and S.C. Debnath (1992). An Introduction to the Theory of Statistics, Minati Shil and Amita Debnath, Mymensingh.
4. Steel, R.G.D. and J.H. Torrie (1960). Principles and procedures of Statistics, McGraw-Hill Book Co. Inc. New York.
5. Yule, G.U. and M.g. Kendall (1965). An Introduction to the Theory of Statistics, Charles Griffin, London.
6. Avn‡g`, Avãyi iwk`, Avjx AvRMi f‚Bqv I RyjwdKvi. cwimsL¨vbt ZË¡ I cÖ‡qvM, kvgmyb bvnvi Avn‡g` Ms, DËi †mIZv, gvwbKMÄ
7. Lvb †gvt Rqbvj Av‡e`xb I myfvl P›`ª †`ebv_ (1987). cÖv_wgK cwimsL¨vb, Rvnvbviv Lvb I AwgZ †`ebv_, gqgbwmsn|

Department of Fisheries Biology and Genetics

Course No. FBG 213
Course Title: Biology of Farmed Fishes
Credit: 3

Introduction: Course goals, objectives and outcomes
Present status of farmed fishes: an overview

Life history of important group of farmed fishes with references to food and feeding habit, digestion, growth and reproduction:
Freshwater fishes-
Cyprinids, Cichlids, Catfishes, Snakeheads, Perches, Exotic fishes, and Trout Marine fishes
Sea bass, Sea bream, Eel, Flounder, Yellow tail, Mullet, Milkfish, and Salmon

Early life history stages of farmed fishes: Gonadal embryonic and larval development.
Environmental effects: Temperature, salinity, light, current and metabolic effects on feeding.

Behavior manipulation in farmed fishes:
Environmental control through Pond/Cage/Tank/Pen design, Water quality and feeding patterns. Dominance regulation and suppression of aggressive behavior.
Domestication and environmental manipulation.

5. Recent developments in the field of biology of farmed fishes

Text books and references:

1. Black, K.D. and Pickering, A.D. (eds.), 1998. Biology of Farmed Fishes. Sheffield Academic Press, England
2. Chakrabarty, N.M., 1998. Biology, Culture and Production of Indian Major Carps – A Review. Narendra Publishing House, Delhi, India
3. Nash, C.E. and Novotny, A.J. (eds.). 1995. Production of Aquatic Animals. Fishes. Elsevier, Amsterdam, The Netherlands
4. Beveridge M.C.M. and McAndrew, B.J. (eds.), 1998. Tilapias: their Biology and Exploitation. Chapman and Hall, London
5. Pillay, T.V.R., 1990. Aquaculture: Principle and Practice. Fishing News Books, Oxford, England.
6. Billard, R., 1999. Carp: Biology and Culture. Springer (in association with Praxix Publishing, (UK).
7. Billard, R. and Gall, G.A.E. 1995. The Carp. *Aquaculture*, Vol. 129. Elsevier.
8. Winfield, I.J. and Nelson, J.S. (eds), 1991. Cyprinid Fishes: Systematics, Biology and Exploitation. Chapman and Hall.

Department of Fisheries Technology

Course No. FT 213
Course Title: Marine Food Chemistry
Credit: 3.0

1. Main groups of marine organisms used as food:
   Marine plants, mollusks, crustaceans and fish.
2. Nutritive values of proteins of major groups of marine food organisms:
   Protein content, protein groups, stability of muscle proteins under various conditions
3. Flavour compounds of sea-foods: Nitrogenous and volatile compounds.
4. Nutritive value of marine fish and shellfish lipids: Lipid types and their variations, polyunsaturated fatty acids, essential fatty acids. Convenience food and modern diet.
5. Vitamins in marine fish and shellfish: Fat and water-soluble vitamins. Vitamin content in farmed and wild fish. Effect of processing on vitamin composition.
6. Micro and trace elements in fish and shellfish: Inorganic matter in fish and shellfish. Effect of processing on mineral composition of fish.
7. Marine bio-toxins: Toxin in marine vertebrates, invertebrates, seaweed and plankton.

Text books and references:

1. Ruiter, A. 1995. Fish and Fishery Products: composition, nutritive properties and stability, Cab International
2. Noguchi, T. and Hashimoto, K. 1997. A Pictorial Handbook of the Toxic Fishes Related to Food Hygiene.
3. Huss, H.H. Jakobsen, M and Liston, J. 1992. Quality assurance in fish industry. In Development in Food Science, Elsevier, Amsterdam, London, New York, Tokyo.
4. G.M. Hall, 1997. Fish processing technology. Blakie Academic & Professional, London, Weinheim, New York, Melbourne, Madras.

Level - II, Semester - II

Department of Fisheries Biology and Genetics

Course No. FBG 221
Course Title: Fish Physiology
Credit: 3

1. Introduction: Course goals, objectives and outcomes. Overview of physiological processes in fish.
2. Temperature regulation: Classification of fish based on thermal regulation; low and high thermal effect, temperature regulation in homeotherms. Fish as poikilotherms. Endothermic fishes.
3. Physiology of digestion: Digestion mechanism of different classes of food: role of HCl, bile, enzymes and hormones; gastric evacuation; parameters to study efficiency of digestion; absorption of digested food
4. Metabolism: Metabolism and its phases. Classification of metabolic rate based on activity level. Factors controlling metabolism of fish.
5. Physiology of blood circulation**:** Importance of blood circulation. Components of circulatory system. Cardiovascular parameters and controlling factors.
6. Physiology of respiration: External and internal respiration. Mechanism of gas transport and exchange; factors affecting O_2 and hemoglobin affinity. Respiratory volume.
7. Physiology of excretion: Excretory products in different groups of fishes. Mechanism of excretion.
8. Osmoregulation: Definition of relevant terminology; osmoregulatory approaches in hagfish, lamprey, elasmobranches, marine and freshwater teleosts and euryhaline fishes.
9. Reproductive physiology: Reproductive cycle. Oogenesis and spermatogenesis. Hormones controlling gonad maturation and reproduction. Environmental and hormonal interplay in controlling reproduction in fishes.
10. Physiological integration by endocrine system: Hormones and their roles in the life processes of fish. Mechanism of hormonal action at cellular level. Hormonal hierarchy. Feedback control of hormones.
11. Special organs: light and electric organs
    Types of bioluminescence: Structure of light organs. Mechanism of light production. Anatomy of electric organ in fishes. Physiology of electricity production; electro sensation.

Course No. FBG 222
Course Title: Fish Physiology
Credit: 1.5

1. Test of pepsin enzyme in stomach.
2. Study of oxygen consumption rate under different metabolic levels.
3. Preparation of blood smear and study on different types of blood cells.
4. Counting of RBC and WBC by haemacytometer.
5. Histological study of fish gill.
6. Histological study of fish kidney.
7. Studies on ammonia excretion in fishes.
8. Study of the effects of salinity changes on different species of fish.

9. Studies on developmental stages of fish gonad.

Text books and references:

1. Evans, D.H. (ed.), 1998. The Physiology of Fishes. Second edition. CRC Press
2. Jobling, M., 1995. Environmental Biology of Fishes. Chapman and Hall, London Fish and Fisheries Series 16.
3. Moyle, P.B. and Cech, J.J., 1988. Fishes: An Introduction to Ichthyology. Second edition. New Jersey: Prentice-Hall Inc., Eaglewood Cliffs.
4. Bond, C.E., 1979. Biology of Fishes. Saunders College Publishing
5. Hepher, B., 1988. Nutrition of Pond Fishes. Cambridge Univ. Press.
6. Hoar, W.S., 1983. General and Comparative Physiology. Third Edition. New Jersey. Prentice-Hall Inc., Eaglewood Cliffs.
7. Hoar, W.S. and Randall, D.J (eds.), 1969--. Fish Physiology. Academic Press Inc.
8. Hopson, J.L. and Wessells, N.K., 1990. Essentials of Biology. McGraw-Hill Publishing Company.
9. Iwama, G. and Nakanishi, T. (eds.), 1996. The Fish Immune System. Academic Press.
10. Steffens, W., 1989. Principles of Fish Nutrition. Ellis Howard Ltd.
11. Turner, C.D. and Bagnara J.T. 1976. General Endocrinology. Sixth edition. W. B. Saunders Co.

Department of Aquaculture

Course No. AQ 221
Course Title: Fish Parasitology
Credit: 3

1. Introduction to parasitology: Definition. Symbiosis and its types, infestation and infection.
2. Parasitic fauna of freshwater and marine fishes: Classification of protozoan, helminth, copepod and annelid parasites of fishes; their characteristics and examples.
3. Ecology of parasites: Host-parasite-environment relationship, types of parasitism.
4. Life cycles of representative protozoan and metazoan fish parasites: key to their control.
5. Common protozoan parasitic diseases of fishes: causative agents, clinical and pathological signs, prevention and control measures.
6. Common metazoan parasitic diseases of fishes: causative agents, signs, pathology, prevention and control measures.
7. Hosts reaction to parasites: cell and tissue reactions. Immunity in fishes against parasitic infestation and infection. Principles of immunization against protozoan and metazoan parasitic diseases in fishes.
8. Physiological factors of parasitic diseases: stress and susceptibility of fish to parasitic diseases. Infestation to infection and diseases.
9. Fish consumption and public health: Fish as carrier of human diseases - zoonotic diseases. Prevention and control of zoonotic diseases.

Course No. AQ 222
Course Title: Fish Parasitology
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a practical note book to be signed and checked by teacher (s) concerned. Viva voce test will form an essential part of the practical examination.

1. Calibration of the microscope for measurements
2. Study of museum specimens of fish parasites.
3. Plan data accessation for examination of vertebrate host
4. Technique of investigation of fish host for parasitological study
5. Collection, fixation, and preservation of parasites.
6. Permanent preservation of parasites--staining, dehydration, clearing and mounting
7. Key out, identification and description of collected parasites
8. Field trip: to a fish farm and preparation of report on parasitological investigation.

Text books and references:

1. Cheng. T. C. 1982. General Parasitology Academic Press, Inc.
2. Dogiel, V.A. 1962. General Parasitology. Oliver and Boyd, Edinburgh, U. K.
3. Kabata, Z. 1985. Parasites and diseases of fish cultured in the tropics. Taylor and francis, London.
4. Woo, P.T.K. (Ed.) 1995. Fish diseases and disorders. Vol. I. Protozoan and metazoan infections. CAB, international.
5. Esch, G.W., Bush, A. O. and Aho J. M. 1990. Parasite communities : Patterns and Processes. Chapman and Hall, London.
6. Kennedy C.R.1975. Ecological Animal Parasitology. Blackwell Scientific Publications, Oxford.
7. Williams, H.H. and Jones, A. 1994. Parasitic Worm of fish. Tayler and Francis, Basingstocke.
8. Kennedy, C.R. 1976. Ecological Aspects of Parasitology. North Holland, Amsterdam.
9. Roberts R. J. 1989. Fish Pathology (2nded.) Baillere Tindal, London, UK.
10. Chandratchakool, P., Tuabull, J. F. and Limsuwan, C. 1994. Health Management of Shrimp Ponds .Aquatic Anima lHealth Reseaech Institute Bangkok, Thailand.
11. Lom, J. and I. Dykova. 1992. protozoan parasites of fishes. Development in aquaculture and Fisheries Science, 26. Elsevier, Amsterdam.
12. Hoffman, G.L. 1967. Parasites of North Americal Freshwater Fishes.University of California Press, Burkeley.
13. Cable. R.M. 1963. An illustrated Manual of Parasitology. Allied Pacific Private Limited, India.
14. Tonguthai,K., Chinabut, S., Somsiri, T., Chanratchakool, P. and Kanchanakhan, S. Diasnostic Procedures for Finfish Diseases. AAHRI, Department of Fisheries, Kasetsart Univ. Campus, Bangkok, Thailand.

15. Yamaguti, S. (1958, 1959, 1961, 1962, 1963) . Systema Helminthum . Vol. I – V. Interscience Publishers Inc.

Department of Aquaculture

Course No. AQ 223
Course Title: Live Food Culture
Credit: 3

1. Introduction: Importance, present status, and prospect of live food in aquaculture.
2. Types of live food organisms: Phytoplankton, zooplankton, microcrustaceans and other food organisms; their nutritive values.
3. Culture of algae: Freshwater and sea water media. Physico chemical factors, isolation, sterilization and maintenance of culture. Culture technique - batch culture, and continuous culture. Harvesting and preservation.
4. Culture of zooplankton: Techniques with particular emphasis on freshwater and marine rotifers.
5. Culture of micro-crustaceans: Daphnia, Moina, Copepod and Cyclops.
6. Culture of brine shrimp (*Artemia*): Decapsulation, hatching and culture techniques for *Artemia* in Lab condition and in salt ponds.
7. Culture of other food organisms: Oligochaete worms (*Tubifex*), nematodes (Trochophora larvae), earthworms and frog tadpoles.
8. Culture of microorganisms: Preparation of media, isolation and culture techniques for fish food microorganisms (Yeast and bacteria).
9. Preservation and storage of fish food organisms. Economics of live food culture.

Text books and references:

1. Fulks, W and Main, K. L. (eds) (1992). Rotifer and microalgae culture systems. Argent Laboratory Press. 364 pp.
2. Lavens and Sorgeloos (eds). 1996. Manual on the production and use of live food for Aquaculture. 295 pp.
3. Stottrup (2002) Live feed for fish. (in press) 336 pp.
4. Barnalee, G. (1980). Rotifers; biology and rearing technology. In: Barnabe, G. (ed). Aquaculture Vol. 1. ELLIS. Harwood Publications, London, England.
5. Bhat, B. V. (1995). *Artemia* In: Live feed Hand book on Aquaculture. The Marine Products Export Development Authority (Ministry of Commerce, Government of India) Kochi, India.
6. Dhert, P; Sorgeloos, P. (1995). Live feeds in aquaculture. Info fish International, (2): 31-39.
7. Fogg, G. E. (1996) Algal culture and phytoplankton ecology. University of Wiscon press.
8. Omori, M. and T. Ikeda (1984). Methods in Marine Zooplankton Ecology, John Willy & Sons. 332 pp.
9. Simpson, K. L. Klein-mcPhee, G. & Beck. A. D. (1982). Zooplankton as food source. Proc. 2nd conf. on Aquaculture Nutrition. Biochem. and Physiol. Approches tio shellfish Nutrition. Rohoboth Beach, Delaware/USA; October, 180-201.
10. Stanley, J. G. and Jons, J. B. (1976). Feeding alage to fish. Aquaculture, 7: 219-223.
11. Verreth, J. (1999). Fish Larval Nutrition. Chapman & Hall. 256 pp.

Department of Fisheries Management

Course No. FM 221
Course Title: Fish Population Dynamics
Credit: 3

1. Introduction: Importance and definition of different terminologies, salient features of population ecology.
2. Factors limiting abundance: Physical , chemical and biological factors.
3. Fecundity of fish: Methods of preservation of eggs, methods of estimation,. Numerical, volumetric and gravimetric method.
4. Marking and tagging: Objectives, group and individual marking methods (Tagging): types of tag - external and internal , tagging materials and choice of marking methods. Description of commonly used tags for marking fish.
5. Fish population estimation: Direct and indirect methods. Factors affecting the estimation of population.
6. Migration: Definition, types , migration of hilsa and eel in Bangladesh and Indian waters.
7. Mortality: Definition, causes of mortality, estimation of total mortality and factors affecting the estimation of total mortality. Estimation of fishing mortality by tagging experiment.
8. Effects of exploitation: Effects of exploitation on size, age, species composition, catch per unit of effort (CPUE), economic level of abundance, area of eggs and young distribution, recruitment, equilibrium yield and shifting of fishing grounds.
9. Balanced and unbalanced population: Criteria of a balanced population, causes for unbalanced condition, F-class and C-class fishes. F/C ratio, Y/C ratio, A_T value and their uses.

Course No. FM 222
Course Title: Fish Population Dynamics
Credit: 1.5

Students shall be required to show a good knowledge of the topics included in the theoretical portion of the paper. They shall maintain a record of everything done in practical classes/ field trips in a practical note book to be signed and checked by the teacher (s) concerned. Viva-voce test will form an essential part of the practical examination.

1. Estimation of catch per unit of effort and species composition and gear selectivity.
2. Estimation of fecundity by different methods.
3. Estimation of fish population by mark and recapture method and Delury's Regression method.
4. Estimation of total mortality and fishing mortality rate by mark and recapture method.
5. Total length- standard length and total length-fork relationships of fish, length-weight relationship and condition factor of fish.
6. Determination of age and growth of fish by length-frequency method and scale method.

Text books and references:

1. Cushing, D.H. 1968. Fisheries Biology: A study in population dynamics. Univ. Wisconsin, Madison, USA. 200 pp.
2. Cushing, D.H., 1977. Science and the Fisheries. Edward Arnold Publishers Ltd. 25, Hill Street, London WIX 8 LL. 60 pp.
3. Dwiponggo, A., 1986. Growth, mortality and recruitment of commercially important fishes and penaeid shrimps in Indonesian waters. Filipiniana Specialist, Manila. 91 pp.FAO. 2001. Yearbook of fishery. Statistics of catches and landings.
4. Gulland, J.A. (ed.), 1983. Fish Stock Assessment: A Manual of Basic Methods. Chichester, U.K., Wiley Interscience, FAO/Wiley series on food and agriculture, Vol. 1. 223 pp.
5. Gulland, J.A. (ed.), 1988. Fish Population Dynamics. Second edition. John Wiley & Sons, Inc., New York.
6. King, M., 1995. Fisheries biology, assessment and management. Fishing News Books, 342 pp.
7. Lagler, K.F., 1956. Freshwater Biology, Second edition, William C. Brown Co. Dubuque, Iowa. 421 pp.
8. Nielsen, L.A., 1992. Method of Marking Fish and Shellfish. American Fish. Soc.,Special Publication 23, 208p.
9. Nikolskii, G.V., 1982. Theory of fish population dynamics. Bishen Singh, Mahendra Pal Singh and Otto Koeltz, Sci. Publishers. 323 pp.
10. Odum, E. P., 1971. Fundamentals of Ecology. W.B. Saunders Co., 574 pp.
11. Parker, N.C., Albert, E.G., Roy, C.H., Douglas, Jr.J.B., Eric, D.P. and Gary. A.W., 1990. Fish Marking Techniques. Amer. Fish. Soc. Symp.-7, 876 p.2.
12. Pauly, D., 1984. Fish population dynamics in tropical waters. A manual for use with programmable calculators. ICLARM, Manila, 325 p.
13. Ricker, W.E., 1958. Hand book of computations for biological statistics of fish populations. Bulletin No. 19. Fisheries Research Board of Canada. Ottawa. 300 p.
14. Ricker, W.E., 1968. Methods of assessment of fish production in freshwaters. Blackwell Scientific Publications, Oxford, 321 pp. Solomon, M.E. 1976. Population dynamics. Second edition, Arnold (Publishers) Ltd., 67 p.
15. Rounsefell, G.A. and Everhart, W. H., 1953. Fishery Science: Its methods and application. John Wiley & Sons, Inc., New York. 444 pp.
16. Swingle, H.S., 1950. Relationships and dynamics of balanced and unbalanced fish population. Alabama Agricultural Experiment Station. Auburn, Bulletin No. 274,74 p.

Department of Fisheries Technology

Course No. FT 221
Course Title: Fisheries Microbiology-II
Credit: 3.0

1. Aquatic microorganisms: Microorganisms of freshwater and marine environment. Factors effecting growth of aquatic microorganisms and their activities related to aquatic animals. Economic importance of aquatic microoganisms.
2. Contamination and spoilage of fresh fish: Microorganisms of cold, temperate and tropical regions. Sources of contamination, causes of spoilage, factors affecting kinds and rates of spoilage, evidence of spoilage, chemical changes caused by microorganisms in fish.
3. Spoilage of fishery products: Frozen fish, canned fish, cured fish, fermented fish and surimi based products.
4. Effect of processing on microorganisms: Effect of low and high temperature, curing and others processing methods.
5. Food borne illness Chemical and biological intoxication and bacterial food poisoning and infection (Botulism, Staphylococcal intoxication, Salmonellosis, Shigellosis, *Clostridium perfringens* infection etc.)
6. Food safety and quality control: Microbiological quality of fishery products. Quality control and quality assurance. Microbiological standard and sanitation in fish processing industry. Definition and principles of HACCP. Application of HACCP in fish processing industry.

Course No. FT 222
Course Title: Fisheries Microbiology-II
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a Practical Note Book to be signed and checked by teacher (s) concerned.

1. Important terminology and guideline for exercise in the practical classroom.
2. Study of different types of microscopes (principles and operation)
3. Study of different sterilization techniques: Moist heat sterilization, dry heat sterilization, tyndallization, gaseous sterilization and filtration by membrane filter.
4. Study of culture media: Ingredients, types, and preparation of culture media.
5. Culture of microoganisms: Broth culture, pour plate culture, spread plate culture, streak plate culture, stab culture and shake culture.
6. Microscopic observation of bacteria: Gram's stain, spore stain, flagella stain, Ziehl-Neelsen' s stain, Hiss's methods and Albert's staining.
7. Isolation and identification of bacteria**:** Morphological, biochemical and serological study.
8. Quantitative estimation of bacteria: Consecutive decimal dilution method and most probable number method.

9. Field visit for sample collection from selected fish landing centers, fish markets and processing plants and bacteriological analysis and preparation of report.

Text books and references:

1. Frazier, W. C. and Westhoff, D. C. 1990. Food Microbiology. 3rd edition. McGrow Hill Book Co., New York. London.
2. Nickerson, J. T. and Sinskey, A. J.. 1993. Microbiology of Food and food processing. Alsevier, New York, Oxford, Amsterdam
3. Ravindran, K. N., Nair, I. A., Perigreen, P. A. Paniker and Thomas, M.. 1985. Harvest and Post-harvest Technology of Fish. Society of Fisheries Technologists, India.
4. Reinheimer, G. 1985. Aquatic Microbiology. John Wiley & Sons. New York, Brisbane, Toronto.
5. Ward, D. R. and C. R. Hackney. 1991. Microbiology of Marine Food Products. A AVI Book, Van Nostrand Reinhold, New York.
6. Collins, C. H. and Lyne, P. M., 1976. Microbiological Methods (4th ed.) Butterworths & Co. Ltd., London
7. Barrow, G. L. and Feltham, R. K. A. (Ed.) 1993. Cown and Steel's Manual for the Identyification of Medical Bacteria, Cambridge University Press.
8. Miwa, K. and Low, Su Ji. 1992. Laboratory manual on analytical methods and procedures for fish and fish products (2nd ed.). Marine Fisheries Research Department, SEAFDEC, Singapore.
9. Marvin L. Speck (Ed.) 1984. Compendium of methods for the microbiological examination of foods. American Public Health Association. Washington, D. C

Department of Fisheries Biology and Genetics

Course No. FBG 223
Course Title: Shellfish Biology
Credit: 3

1. Introduction: Course goals, objectives and outcomes.
2. Shellfish resources and their role in the economy of Bangladesh
3. Factors affecting the life of shellfishes in aquatic environment..
4. Morphological features and biology with special reference to food and feeding habits, digestion, respiration, reproduction, embryonic and larval developments and shell formation of:

(a) Freshwater giant prawn; (b) Marine shrimp; (c) Mudcrab; (d) Octopus; (e) Lobster, and (f) Oyster.

5. Adaptation of shellfish in relation to food and feeding, respiration, reproduction osmoregulation and migration.

Text books and references:

1. Mantel, L.H., 1983. The Biology of Crustacea Vol. 5. Internal Anatomy and Physiological Regulation. Academic Press Inc. 111 Avenue New York.
2. Provenzano, A.J. (ed.), 1985. The Biology of Crustacea Vol. 10. Economic Aspects, Fisheries and Culture. Academic Press Inc. Sandiego, New York, Boston. London.Tokyo.Toronto.
3. Angell, C.L., 1986. The Biology and Culture of Tropical Oysters. ICLARM, Manila, Philippines.
4. Green. J., 1961. A Biology of Crustacea. Quadrangle Books Inc.
5. Vernberg F. J. and Vernberg, W. B., 1983) The Biology of Crustacea. Vol. 8. Environmental Adaptations. 111 Avenue, New York.
6. Jordan E. L. and Verma, P. S., 1985. Invertebrate Zoology. S. Chand & Company, Ramnagar, New Delhi.
7. Kotpal R. L., 1997. Phylum Arthopoda. Rastogi Publication, Shivaji. Rd. Meerut. India.
8. Kotpal R. L, 1997. Mollusca . Rastogi Publication, Shivaji. Rd. Meerut. India.

Department of Fisheries Management

Course No. FM 223
Course Title: Aquatic Environmental Science
Credit Hours: 3

1. Introduction on aquatic environment: Key concepts; Importance of aquatic environmental maintenance; Sensitivity of aquatic biota on environmental changes.
2. Environmental degradation and fisheries resources: River-bed siltation, loss of habitats, water development Projects (FCD and FCDI installations), impact of water abstraction and irrigation, barrages, roads, highways and embankments etc.
3. Agriculture and aquatic environment: Practices and inputs used, fertilizers (phosphatic and nitrogenous), pesticides and insecticides, impacts on aquatic flora and fauna.
4. Impact of aqua farming on aquatic environment: Nutrient accumulation and eutrophication, drainage effect due to excess feed, fertilizer and therapeutants. Loss of natural habitats- mangroves, agricultural lands, livestock pastures etc.
5. Industrial development and environment: Types of industries, location, raw materials used and byproducts, effects of tannery, pharmaceutical, dying, fertilizer industries on underground and riverine waters.
6. Coastal and marine environment: Causes of degradation of coastal and marine environment (shrimp farming, salinization, sewages, oil spillage, industrial wastes, ship breaking activities, municipal wastes, disposal of solid wastes), impact on coastal and marine fisheries.

Text books and references:

1. Alabaster, J.S. and Lloyd, R., 1982. Water Quality Criteria for Freshwater Fish. Second Edition. Butterfly Scientific Publisher, London.
2. Ali, M.Y., 1991. Towards sustainable development: Fisheries resources of Bangladesh. IUCN, NCS and BARC. 96 pp.
3. Baird, D.J., Beveridge, M.C.M., Kelly, L.A. and Muir, J.F. (eds.), 1994. Aquaculture and Water Resource Management. Fishing News Books, UK. 219 pp.
4. Boyd, C. E., 1988. Water Quality Management for Pond Fish Culture. elsevier Scientific Publisher B. V., Amsterdam. 318 pp.
5. Calow, P., 1993, 1995. A Handbook of Ecotoxicology. Vols. 1 & 2. Blackwell Scientific Publications, UK.
6. Flood Action Plan (FAP)-17, 1994. Fisheries Studies and Pilot Project, Final Report, GOB and ODA (UK).
7. Flood Action Plan (FAP)-6, 1994. Fisheries Specialist Study. Main Report. Vol. 1 GOB and CIDA (Canada). 301 pp.
8. Forbes, V.E. and Forbes, T.L., 1994. Ecotoxicology in Theory and Practice. Chapman and Hall Publishers, London, UK.
9. Haslam, S.M., 1991. River Pollution: An Ecological Perspective. CBS Publishers & Distributors (Pvt.) Ltd.
10. Islam, A., 1989. Prathamic Paribeshic Jibabijnan. Bangla Academy, Dhaka. 181 pp.
11. Lloyd, R., 1992. Pollution and Freshwater Fish. Fishing News Books, Oxford, UD. 176 pp.
12. Master Plan Organization, 1987. Fisheries and Flood Control, Drainage and Irrigation Development. Technical Report No. 17. Dhaka, Bangladesh.
13. Muller, R. and Lloyd, R., 1994. Sublethal and chronic effects of pollution on freshwater fish. Fishing News Books, UK. 288 pp.
14. Nishat, A., Hossain, Z., Roy, M.K. and Karim, A. (eds.), 1993. Freshwater wetlands in Bangladesh: Issues and Approaches for Management IUCN, Gland, Switzerland. 383 pp.
15. Penman, D., 1994. Coastal environmental Management for Sustainable Aquaculture Workshop Proceedings of AADCP Component I, held in Bali, Indonesia, 31 October, November, 1994. AADCP/PROC/7. 221 pp.
16. Pillay, T.V.R., 1992. Aquaculture and Environment. Fishing News Books, UD.

17. Pullin, R.S.V., Rosenthal, H. and Maclean, J.L., 1993. Environment and Aquaculture in Developing Countries. ICLARM Conference Proceedings 31. 359 pp.
18. Rahman, A.K.A., 1989. Freshwater Fishes of Bangladesh. Zoological Society of Bangladesh, Dhaka. 364 pp.
19. Rand, G.M. and Petrocelli, S.R. (eds.), 1985. Fundamentals of Aquatic Toxicology. Hemisphere, Washington, D.C.
20. Tsai, C. and Ali, M.Y., 1997. Openwater Fisheries of Bangladesh. Bangladesh Centre for Advanced Studies. The University Press Limited, Dhaka. 212 pp.

Level - III, Semester - I

Department of Fisheries Biology and Genetics

Course No. FBG 311
Course Title: Principles of Genetics
Credit: 3

1. Introduction: Course goals, objectives and outcomes; milestone of genetics; scope and significance of genetics
2. Physical bases of heredity: Introduction of animal and plant cells, prokaryotic and eukaryotic cell, constituents of eurokaryotic cells, their structure and function; structure of chromosome and its organization, variation in chromosome number, cell division; gametogenesis- spermatogenesis and oogenesis.
3. Mendelian genetics: Mendel and his work; Mendel's laws of inheritance- principles of segregation, principles of independent assortment; monohybrid and dihybrid cross; lethal genes, pleiotropy, peneterance and expressivity; linkage and linked genes, kinds of linkage, difference in linkage and independent assortment, arrangement of linked genes; crossing over and meiosis, genetic recombination.
4. Interaction of genes: Complete and incomplete dominant gene action, additive gene action; epistasis, epistatic and non-epistatic interaction, dominant and recessive epistasis; multiple allelism.
5. Sex determination and sex chromosome: Different sex determining systems; sex-linked traits, sex-influenced and sex-limited traits; sex manipulation techniques.
6. Chemistry of gene: Introduction of nucleic acid, nucleic acid structure and nomenclature; DNA and RNA structure; Chemistry of DNA synthesis; DNA repairing, packaging of DNA as nucleosome.
7. Phenotypic expression of gene: Protein synthesis, transcription and translation, regulation of protein synthesis; the genetic code and its properties.
8. Mutation: Definition, germinal and somatic mutation, spontaneous and induced mutation; types of mutation, mutagens; practical application of mutations.

Course No. FBG 312
Course Title: Principles of Genetics
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a Practical Note Book to be signed and checked by teacher(s) concerned.

Viva voce test will form an essential part of the Practical Examinations.
1. Introduction to practical session: Familiarization with the practical courses and facilities of the department for the practical classes.
2. Cell division and chromosome: Study of cell division; chromosome preparation from tissue or embryo.
3. Mendelian genetics: Excercise on inheritance of qualitative phenotypes; pedegree analysis and chi-square.
4. Sex ratio analysis: Sex ratio analysis from crosses of fish with pre-determined sex chromosome. Chi-square test will be used to determine any significant difference between the observed and expected sex ratio.
5. Genomic DNA isolation: Techniques of genomic DNA isolation from fish tissue or embryos.

Text books and references:

i) Douglas Tave. 1993. Genetics for Fish Hatchery Managers, Second Edition. Published by Van Nostrand Reinhold, New York.
ii) Verma, P.S. and Agarwal, V.K. 1989. Genetics. S. Chand and Company
iii) Garderner, E.J., Simmons, M.J. and Snustad, D.P. 1991. Principles of Genetics (8^{th} edition), John Willey and Sons, Inc.
iv) Watson, J.D., Gilman, M., Witkowski, J. and Zoller, M. 1992. Recombinant DNA (2th edition). Scientific American Books, distributed by W.H. Freeman and Company, New Work.
v) Lewis, B. 1997. Genes. Oxford University Press.
vi) Strickberger, M.W. 1990. Genetics (3^{rd} edition). Macmillan Publishing Company, New York.

Department of Aquaculture

Course No. AQ 311
Course Title: Fish Pathology
Credit: 3

1. Introduction: General significance of fish disease. Sources and degree of infection. Factors producing diseases in fish. General signs of diseased fish.
2. Pathological changes in diseased fish: Circulatory disturbances, cellular degeneration, necrosis, inflammation, disturbances of growth and development.

3. Systemic pathology of fish: Integument and musculoskeletal pathology, gill pathology, digestive and related system pathology, renal pathology, pathology of eye.
4. Viral diseases of fish: Fish pathogenic viruses. Characteristics of major viral fish pathogens. Epozootiology, distribution etiology, clinical signs, pathology, and diagnosis.
5. Bacterial diseases of fish: Epizootiology, distribution, etiology, clinical signs, pathology and diagnosis. Major typing of bacterial diseases based on pathological signs.
6. Fungal diseases of fish: Characteristics and life cycle of major fungal fish pathogens. Epizootiology, distribution, etiology, clinical signs, pathology and diagnosis.
7. Stress and infectious disease: Environmental stress and their effects on fish.
8. Nutritional Pathology of fish: Pathological syndrome associated with dietary imbalance.
9. Hereditary fish diseases: Tumors and growth abnormalities.

Course No. AQ 312
Course Title: Fish Pathology
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a practical note book to be signed and checked by teacher (s) concerned. Viva voce test will form an essential part of the practical examination.

1. Diagnostic procedure for fish diseases: (a) conventional laboratory techniques for viral, bactrial and fugal identification (b) case study.
2. Study on clinical and pathological signs of diseased fish under laboratory and field condition.
3. Study on histopathological techniques: Sampling, tissue processing, microtomy, staining, mounting and microscopic observation
4. Observation of histopathological changes of different tissues and organs of diseased fish.
5. Case study for investigation of clinical and pathological signs of fish.

Text booksand references:

1. Inglis, V., R.J. Roberts and N.R. Bromage. 1993. Bacterial Diseases of Fish. Blackwell Science.
2. Roberts, R. J. (Editor). 1989. Fish Pathology. 2nd ed. Bailliers and Tindall, London.
3. Plumb, J.A.1999. Health Maintenance of Cultured Fishes: Principal Microbial Diseases. Iowas State University Press.
4. Bonded-Reantaso, M.G., McGladdery, S.E., East, I., and Subsinghe, R.E. (eds) (2001). Asia Diagnostic Guide to Aquatic Animal Diseases. FAO Fisheries Technical Paper No 402, Supplement 2. Rome, FAO, 240 pp.
5. Frerichs, N.G and Millar, S.D. 1993. Manual for the Isolation and Identification of Fish Bacterial Pathogens, Pisces Press, Stirling.
6. Post, G. 1987. Textbook of Fish Health. T.F.H. Publications, Inc. USA.
7. Austin, B and D. A. Austin. 1999. Bacterial Fish Pathogens: Disease of Farmed and Wild Fish, Ellis Horwood, England.
8. Bullock, G.L. 1980. Identification of Fish Pathogenic Bacterial TFH Publication.
9. Chainabut, S and R.J. Roberts. 1999. Pathology and Histopathology of Epizootic Ulcerative Syndrome (EUS), AAHRI, Department of Fisheries, Bangkok, Thailand.
10. Chanratchakool, P, J. F Turnbull, S, Funge-Smith, I. H MacRae and C. Limsuwan. 1998. Health Management in Shrimp Ponds (3rd Ed.), AAHRI, Bangkok, Thailand.
11. Brown, L.1994. Aquaculture for Veterinarians: Fish Husbandry and Medicine, Pergmon Press, Oxford.
12. Noga, E.J. 2000. Fish Disease: Diagnosis and Treatment. Iowa State University Press.
13. Cross, J.H (Editor). 1983. Bacterial and viral diseases of fish. Washington Sea Grant Publication.
14. Egusa, S. 1992. Infectious Diseases of Fish. Oxonian Press Ltd. New Delhi.
15. Ferguson, H.W. Systemic Pathology of Fish. 1989. Iowa State University Press.
16. McMillan, T. 2000. Fish Histology, Chapman & Hall.
17. Roberts. R. J. (Editor). 1982. Microbial Diseases of Fish. Academic Press.
18. Sarig, S. 1981. Diseases of Fishes. (edited by S.F. Snieszko and H.R. Axelrod). Book 3. The Prevention and Treatment of Diseases of Warm water Fishes under Subtropical Conditions, With Special Emphasis on intensive Fish Farming. TFH. Publication.
19. Sindermann, J. 1990. Principal Diseases of Marine fish and shell fish Vol. 1 & 2 second ed. Academic press inc.
20. Sindermann. A.J. and O.V. Lighter. 1988. Diseases Diagnosis and Control North Americal Marine Aquaculture. Elsevier.
21. Sineszko, S.F. and H.R. Axelrod, (Editor). 1976. Diseases of Fishes. V. Environmental Stress and Fish Diseases. TFH. Publication.
22. Trever-Brown, K.M. 2000. Applied Fish Pharmacology (Aquaculture, Vol. 3). Kluwer Academic Publications.
23. Austin, B and D. A. Austin (eds). 1989. Methods for the Microbiological examination of Fish and shellfish.Ellis Horwood, England.
24. Tonguthai, K., Chainabut, S., Somsiri, T., Chanratchkakool and Kanchanakhan, S. 1999. Diagnostic procedure for finfish diseases. Aquatic animal Health Research Institute, Department of Fisheries, Bangkok, Thailand.
25. Chainabut, S and R.J. Roberts 1999. Pathology and Histopathology of Epizootic Ulcerative Syndrome (EUS), AAHRI, Department of Fisheries, Bangkok, Thailand.
26. McMillan, T. 2000. Fish Histology, Chapman & Hall.

Department of Fisheries Management

Course No. FM 311
Course Title: Biological Limnology
Credit: 3

1. Introduction: Biological relations in inland waters; influence of physical and chemical factors on aquatic biota; classification of freshwater aquatic organisms of both lotic and lentic habitats.
2. Phytoplankton: Characteristics of major groups; morphology, life history, flotation; cosmopolitanism of freshwater plankton, distribution; seasonal succession; eutrophication and phytoplankton bloom- factors influencing phytoplankton bloom, biological effects of phytoplankton bloom, dinoflagellates and red tides, interactions with other organisms. Control of phytoplankton bloom. Relations between producers and consumers. Culture of phytoplankton.
3. Aquatic primary production: Factors affecting primary production; estimation of primary production, variations in primary productions in different habitats.
4. Zooplankton: Characteristics of major groups, seasonal variations in abundance. Food and feeding habits, reproduction biology, diurnal vertical migrations, cosmopolitanism, cyclomorphosis, relations with other organisms, phytoplankton-zooplankton relations. Culture of zooplankton.
5. Benthos: Significance, benthic regions, qualitative and quantitative distribution, factors affecting distribution. Life cycle of some common benthic fauna.

6. Periphyton (aufwuchs): Characteristics of major groups, substrates, seasonal variations in abundance and distribution in lentic and lotic habitats. Importance in the ecosystems and relations with other organisms.
7. Secondary production: Factors affecting secondary production; estimation of secondary production (zooplankton, benthos), relations with water depth and water areas; variation in lentic and lotic habitats
8. Bacteria and their role in bio-geochemical cycles: Bacteria, phytoplankton, zooplankton and benthos relations; feeding relations, detritus and filter feeders, bottom deposits and detritivores.
9. Aquatic vascular plants: Major groups available in closed and open freshwater systems; role in the floodplain and oxbow lake systems; influence on biological production; economic and aesthetic importance.

Course No. FM 312
Course Title: Biological Limnology
Credit: 1.5

Students shall be required to show a good knowledge of the topics included in the theoretical portion of the paper. They shall maintain a record of everything done in practical classes/ field trips in a practical note book to be signed and checked by the teacher (s) concerned. Viva-voce test will form an essential part of the practical examination.

1. Collection, preservation, identification, enumeration and estimation of phytoplankton, zooplankton, macrophytes and benthos from different freshwater habitats.
2. Quantitative study of phytoplankton, zooplankton, periphyton and benthos.
3. Estimation of primary productivity using light and dark bottle method.
4. Phytoplankton pigments analysis. Estimation of plankton standing crop through determination of Chlorophyll-*a*.
5. Demonstration of plankton culture techniques: Isolation of plankton, culture media preparation, inoculation, incubation; maintenance of stock.

Text books and references:

1. A.P.H.A., 1976. Standard methods for the examination of water and wastewater including bottom sediments and sludge. 14th Ed. APH, New York.
2. Barber, H.G. and Haworth E.Y., 1981. A Guide to the Morphology of the Diatom Frustule. Freshwater Biological Association; Publication No. 4. Scientific Publication. Wilson & Son Ltd., Britain.112 pp.
3. Bellinger, E.G., 1992. A Key to Common Algae. The Institute of Water and Environmental Management. John Street, London. 138 pp.
4. Boney, A.D., 1975. Phytoplankton, Institute of Biology Study. 52, Crane, Russak Co, New York. 116 pp.
5. Boyd, C. E., 1979. Water quality in Warmwater Fish Ponds. Auburn University Agricultural Experiment Station, Auburn, Alabama, 359 pp.
6. Downing J.A. and Rigler, F.H., 1984. A Manual of Methods for the assessment of secondary productivity in freshwater. IBP Publication no. 17. Blackwell Scientific Publications.
7. Goldman G.R and Horne, A.J., 1983. Limnology. McGraw-Hill Book Co.
8. Hutchinson G. E., 1967. A Treatise on Limnology Vol. 2. Introduction to lake Biology and Limno plankton. John Willey & Sons., Inc., New York.
9. Jeffrey, S.W., Mantoura R.F.C. and Wright S.W., 1997. Phytoplankton Pigments in Oceanography: guidelines to modern methods. Sponsored by SCOR and UNESCO, pp. 19-445.
10. LeCren, E.D., Lowe-MxConnel, R.H., 1980. The Function of freshwater ecosystems. IBP publication No. 22. Cambridge University Press.
11. Moss B., 1988. Ecology of freshwater: Man and Medium. 2nd Ed. Blackwell Scientific Publications.
12. Needham, J.G. and Lloyd, J.T. The life of Inland waters.
13. Pennak. R.W., 1978. Freshwater Invertebrates of the United States. 2nd Ed. Wiley, New York.
14. Pinder, L.C.V., 1978. A Key to Adult Males of British Chironomidae. Freshwater Biological Association; Publication No. 37. Scientific Publication. Wilson & Son Ltd., Britain.
15. Pontin, R.M., 1978. A Key to British Freshwater Planktonic Rotifera. Publication No. 38. Scientific Publication. Wilson & Son Ltd., Britain. 178 pp.
16. Prescott G.W., 1962, Algae of the Western Great Lakes Area. 2nd Ed., William C. Brown Co., Dubuque, Lowa.
17. Rahman M. S., 1992. Water Quality Management in Aquaculture. BRAC prokashana, Dhaka –1212
18. Raymont, J.E.G., Plankton & Productivity in the Oceans
19. Serruya, G and Pollingher, U., 1983. Lakes of Warm Belt. Cambridge University Press.
20. Welch, P.S., 1952. Limnology. 2nd Ed. McGraw-Hill Book Co., New York.
21. Wetzel E.G., 1983. Limnology. 2nd Ed. Saunders College Publishing.

Department of Fisheries Management

Course No. FM 313
Course Title: Fish Stock Assessment
Credit: 3

1. Introduction: Concept of stock, objective of stock assessment, types of assessments, information collection techniques.
2. Criteria for separation of stock: Importance, characteristics of unit stock and Criteria of separation - study of racial characters, genetic characters, age composition, growth rate, vital parameters, bio-chemical study and tagging method.
3. Collection and handling of stock assessment data: Sample and sampling, general sampling, truisms of sampling, basic tenets of sampling, sources of assessment data, types of measurements, data from commercial fisheries, catch effort data, commercial catch-at-length data.
4. Overview of stock assessment models: Analytical models, holistic models and surplus production models.

5. Cohort, VPA and gear selectivity: Concept of cohort and dynamics of a cohort. Concept of Virtual population analysis (VPA) and analysis of VPA. Concept of gear selectivity and estimation of trawl net, seine net and gill net selectivity.
6. Age and growth of fish: Methods of Age and growth determination, length-weight relationship, condition factor and estimation of growth parameters.
7. Recruitment: Factors affecting recruitment- environmental factors, success of spawning, food, predation, density dependent effect, indiscriminate fishing.
8. Yield models: ELEFAN-I and II, FiSAT and surplus yield models-Schaefer models and Fox models, yield per recruit models, length based models and stock assessment from egg survey.
9. Maximum sustainable yield (MSY): Concept and usefulness

Text books and references:

1. Cushing, D.H., 1968. Fisheries Biology: A study in population dynamics. Univ. Wisconsin, Madison, USA. 200 pp.
2. Gayanilo, Jr. F.C. and Pauly, D. (eds.), 1997. FAO-ICLARM Stock Assessment Tools: Reference manual. FAO, Rome, 262 pp.
3. Gulland, J.A. (ed.), 1983. Fish Stock Assessment: A Manual of Basic Methods. Chichester, U.K., Wiley Interscience, FAO/Wiley series on food and agriculture, Vol. 1. 223 pp.
4. Gulland, J.A. (ed.), 1988. Fish Population Dynamics. Second edition. John Wiley & Sons, Inc., New York.
5. Gulland, J.A., 1991. Fish population dynamics. 2nd ed. John Wiley and Sons Ltd., 422 pp.
6. King, M., 1995. Fisheries biology, assessment and management. Fishing News Books, 342 pp.
7. Lagler, K.F., 1956. Freshwater Biology, Second edition, William C. Brown Co. Dubuque, Iowa. 421 pp.
8. Morales-Nin, B., 1992. Determination of Growth in Bony Fishes from Otolith Microstructure. FAO Fisheries Technical Paper-322, 51p.
9. Ricker, W.E., 1958. Hand book of computations for biological statistics of fish populations. Bulletin No. 19. Fisheries Research Board of Canada. Ottawa. 300 p.
10. Ricker, W.E., 1968. Methods of assessment of fish production in freshwaters. Blackwell Scientific Publications, Oxford, 321 pp. Solomon, M.E. 1976. Population dynamics. Second edition, Arnold (Publishers) Ltd., 67 p.
11. Rounsefell, G.A. and Everhart, W. H., 1953. Fishery Science: Its methods and application. John Wiley & Sons, Inc., New York. 444 pp.
12. Spare, P. and Venema, S. C., 1998. Introduction to tropical fish stock assessment, Part-1.Manal. FAO Fisheries Technical Paper No. 306.2, Rev.-2 Rome, FAO, 94p.
13. Spare, P. and Venema, S. C., 1998.Introduction to tropical fish stock assessment,Part-1.Manal. FAO Fisheries Technical Paper No. 306.1, Rev.-2 Rome, FAO, 407p.

Department of Fisheries Technology

Course No. FT 311
Course Title: Fish Processing
Credit: 3

1. Introduction to fish processing: Production and marketing steps of fish and prawn in Bangladesh. Loss of food value due to improper handling and transportation. Bio-factor of fish and quantity of bio-factors in different groups of fish. Role of bio-factor on human health.
2. General principles of fin fish and shellfish preservation and storage. Structure of fish muscle, biochemical properties of white and dark muscle of fish.
3. Postmortem changes in fish: Rigor mortis. Biochemical changes in fish during rigor mortis. Rigor mortis and keeping quality of fish. Effects of rigor mortis on fish processing and control measures.
4. Fish processing at low temperature: Types and methods of freezing. Shrimp/fish freezing method in Bangladesh. Factor affecting the quality of fish and shrimp during freezing transportation and storage. Time-temperature relationship in freezing.
5. Fish curing (Drying and dehydration, salting, smoking): Basic principles and methods of fish curing. Details of each curing method. Variations in curing methods for different species of fish. Quality aspects and storage.
6. Fish canning: Principles, preparation of raw materials and steps of canning. Types of can materials. Examination of processed fish can.
7. Modern approaches to fish processing: Modified atmosphere packaging. *Saus vide* technology in fish processing. Vacuum packaging. Hurdle's approach in fish processing. Irradiation in fish processing.
8. Packaging: Functions of packaging. Appropriate package selection. Packaging materials. Packaging regulation.
9. Planning and design of cold storage and fish processing plant.

Course No. FT 312
Course Title: Fish Processing
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a Practical Note Book to be signed and checked by teacher (s) concerned.

1. Acquaintance with fish processing laboratory.
2. Study of proximate composition of fish- (Moisture, lipid, ash and crude protein)
3. Determination of non-protein nitrogen (NPN) of fish.
4. Determination of salt (NaCl) content in salted fish.
5. Freshness test of fish by subjective method.
6. Processing and preservation of fish by sun drying, salting and smoking method and observation on their physical and chemical changes.

Text books and references:

1. G.M. Hall, 1997. Fish processing technology. Blakie Academic & Professional, London, Weinheim, New York, Melbourne, Madras
2. Tanikawa, E. Motohiro, T, and Akiba, M. 1985. Marine products in Japan, Published by Koseisha Koseikaku Co., Ltd., Tokyo.
3. Govindan, T.K. 1985. Fish Processing Technology, Oxford & IBH publishing Co., New Delhi.
4. Motohiro, T.; Hashimoto, K.; Kadota, H. and Tokunaga, T. (1992). Science of Processing Marine products, Vol. I & II. Kanagawa International Fisheries Training Center. Japan International Cooperation Agency.
5. Stansby, M. E. (1963). Industrail Fishery Technology. Reinhold Publ Corp. New York.
6. Zaitsev, V. P. (1965). Preservation of Fish Products by Refrigeration. U.S. Department of Commerce.
7. Clucas, I, J. and Ward, A. R. 1996. Post-harvest Fisheries Development: A guide to handling, preservation, processing and quality. Natural Resource Institute, Central Avenue, Chatham Maritime, Kent ME44TB, UK.
8. A O A C. (1980). Official methods of analysis. Association of Official Analytical Chemists. Washington, D. C.
9. Howgate, P., A. Johnston and Whittle, K. L. (1992) Multilingual Guide to EC freshness grades for fishery products (Torry Research Station, Food Safety Directorate, Ministry of Agriculture, Fisheries and Food; Aberden. Scotland, UK.
10. Hasegawa, H. (1987). Laboratory Manual on Analytical Methods and procedures for Fish and Fishery Products. Marine Fisheries Research Department, Southeast Asean Fisheries Development Center, Singapore.

Department of Aquaculture

Course No. AQ 313
Course Title: Environmental Management for Aquaculture
Credits: 3

1. Environmental impact of aquaculture: Introduction, aquaculture wastes, environmental consequences of hypernutrfication and eutrophication. Conflict with other users.
2. Impact of aquaculture on environment: Chemicals used in aquaculture, administration, environmental concerns and their effects on microbial community and environment.
3. Waste production in aquaculture: Feed derived and metabolic waste products, wastes from food and foodstuffs, methods of measuring waste production and fertilizer-derived wastes.
4. Waste minimization: Waste minimization and aquaculture planning. Environmental impact assessment (EIA). Operational management for waste reduction.
5. Waste water treatment - physical methods: Solid removal, sedimentation, floatation, sludge denaturing and disposal. Interception of solids from floating net cage aquaculture. Pathogen elimination from waste water. Oxygenation.
6. Wastewater treatment-biological methods: Biofilters, implication of biofilter design and management and application of biofilters in aquaculture.
7. Socio- economic impacts: Impacts of aquaculture on socio-economic condition of the community.
8. Environmental management systems: Environmental policy, environmental management and pollution control. Environmental management system and organizational ethics.
9. Future developments in waste minimization: Integrated farming systems development. Systems optimization and chemical usage. A strategic frame work for environmental management in aquaculture.

Text books and references:

1. Milden, A. and T. A. Redding (2000). Environmental Management for Aquaculture. Kluwer Academic Publisters, London. 223 pp.
2. Pillay, T. V. R (1992). Aquaculture and Environment Fishing News Books Ltd., Onsey Mead, Oxford, England. 189 pp.
3. European Commission (1995) Aquaculture and the Environment in the European Community, office for official Publications of the European Communities, Brussels.
4. Goddard, S. (1996). Feed Management in Aquaculture. Chapman & Hall, New York, 194 pp.
5. Bergheim, A. and Asgard, T. (1996). Waste production from aquaculture, In: Aquaculture and Water Resource Management (eds. D. J. Baird, M. C. M. Beveridge and L. A. Kelly), Blackwell Science, Oxford.
6. Beveridge, M. C. M. (1987). Cage Aquaculture, Fishing News Books, Oxford, 351 pp.
7. EIFAC (1982). Report of the EIFAC Workshop on Fish- Farming Effluents, Silkeborg, Denmark, (ed. J. S. Alabaster), ELFAC Technical Paper 41, FAO, Rome, pp. 313-166
8. Gray, N. F. (1989). Biology of Waste water Treatment, Oxford University Press, Oxford.
9. Lawson, T. B (1995). Fundamentals of Aquaculture Engineering, Chaman & Hall, 351 pp

10. Kautsky, N. and Folke, C. (1991). Integrating open system aquaculture. Ecological Engineering for waste water Treatment, Proceeding of a conference at stensund Folk college, Sweden, Maroh 24-28, 1991. Bokskogen, Sweden (Pub).
11. Westerman, P. W. Losords, T. M. and Wildhaber, M. W. (1996). Evalution of various biofilters in an intensive recireulating fish production facility. Transactions of the American Society of Agricultural Engineers 39 (2) 723-727.
12. ESCAP (1985). Environmental impact assessment- Guidelines for planners and decision makers. ESCAP. Environment and Development Series. UN-ESCAP, Bangkok, 198 pp.

Department of Fisheries Technology

Course No. FT 313
Course Title: Microbiology of Fishery Products
Credit: 3

1. Microbiology of finfish and finfish processing: Harvesting and onboard handling, fishing vessel sanitation, processing and preservatives.
2. Microbiology of molluscan shellfish: Microflora of molluscan shellfish at harvest, during processing. Indicators of spoilage and public health concern.
3. Microbiology of crustacean processing (crabs, shrimps, prawns and crayfish): Naturally occurring microflora , microbiological changes through distribution system, microoganism associated with spoilage and public health concern. Effect of processing, handling and retail procedures.
4. Microbiology of cured and fermented fish: Dried fish, salted fish, marinades, smoked fish, fish sausages and fermented fish.
5. Microbiology of mince, surimi and value added products.
6. Indicator microoganisms and pathogens in fish and fishery products.

Text books and references:

1. Ward, D. R. and Hackney, C. R. 1991. Microbiology of Marine Food Products. An AVI Book, Van Nostrand Reinhold, New York.
2. Chichester, C. O. and Graham, H. D. 1973. Microbial safety of fishery products. Academic Press, New York and London.
3. Frazier, W. C. and Westhoff, D. C. 1990. Food Microbiology. 3rd edition. McGrow Hill Book Co., New York. London.
4. Nickerson, J. T. and Sinskey, A. J. 1993. Microbiology of Food and food processing. Alsevier, New York, Oxford, Amsterdam.

Level - III, Semester - II

Department of Fisheries Biology and Genetics

Course No. FBG 321
Course Title: Reproductive Physiology of Fishes
Credit: 3

1. Introduction: Course goals, objectives and outcomes.
2. Functional morphology of fish gonads: Primordial germ cells and sex differentiation. Morphology and composition of eggs. Egg membrane and micropyle. Morphology of sperm;. Gonadal development.
3. Gametogenesis: Oogenesis and folliculogenesis; primary oocyte growth; cortical granule formation; vitellogenesis; pigment formation. Spermatogenesis and biology of sperm: sperm production, biochemistry of sperm, sperm motility and metabolism, sperm survival and maturation. Endocrine control of gametogenesis: inducing hormones and maturation promoting factors.
4. Viviparity in fishes: Viviparity and gestation- evolutionary considerations, viviparity among the chondrichthyes, internal fertlization, ovoviviparity, viviparity among the teleosts and maternal-embryonic relationship.
5. Factors regulating reproductive activity: Environmental factors and social factors. Environmental influences- photoperiod, temperature and feeding on gonadal activity and timing of reproductive cycle. Endocrine control of fish reproduction: the brain and neurohormones in fish reproduction;, gonadotropin releasing hormones. Input of physiological factors: steroid feed back; regulation of onset of puberty; regulation of gonadal recrudescence and regulation of ovulation and spermiation.
6. Reproductive behavior: Pheromones, sex recognition and behavior; territory and space recognition; courtship, nest-building and parental cares.
7. Water pollution and fish reproduction: Action of pollutants on reproductive processes- hormonal control, egg production, oocyte and embryo energy metabolism. Changes in pollutant sensitivity and hatching time.

Text books and references:

1. Hoar, W.S. and Randall, D.J., 1984. Fish Physiology Vols. IXA and IXB. Academic Press.
2. Potts, G.W. and Wootton, R.J. (eds), 1984. Fish Reproduction: Strategies and Tactics. Academic Press, London.
3. Hoar, W.S., Randall, D.J., and Donaldson, E.M. (eds.), 1983. Fish Physiology Vol. IXA and IXB. Academic Press.
4. Hoar, W.S. and Randall, D.J., 1969. Fish Physiology Vol. III. Academic Press.
5. Heath, A.G., 1987. Water Pollution and Fish Physiology. CRC Press.
6. Muir, J.F. and Roberts, R.J., 1993. Recent Advances in Aquaculture IV. Blackwell Science Publication.
7. Hoar, W.S. and Randall, D.J., 1988. Fish Physiology Vol. XI (B).
8. Matty, A.J., 1985. Fish Endocrinology. Croom Helm, London, Sydney. TIMBER PRESS Portland, Oregon.
9. Zohar, Y. and Breton, B. (eds.), 1988. Reproduction in Fish: Basic and Applied Aspects in Endocrinology and Genetics. INRA Press, Paris.
10. Billard, R. and Gall, G.A.E., 1995. The Carp: Aquaculture Vol. 129. Elsevier.
11. Rankin, J.C., Pitcher, T.J., and Duggan, R. (eds.), 1983. Control and Processes in Fish Physiology. Croom Helm, London.

12. Billard, R. and Marcel, J. (eds.), 1986. Aquaculture of Cyprinids. INRA, Press, Paris.
13. Gaillard, P.J. and Boer, H.H. (eds.), 1978. Comparative Endocrinology. Elsevier/ North Holland Biomedical Press.
14. Thorpe, J.E.(ed), 1978. Rhythmic Activity of Fishes. Academic Press, New York.
15. Harvey, B.J. and Hoar, W.S., 1979. The Theory and Practice of Induced Breeding in Fish. International Development Research Center. IDRC-TS21e, Canada.
16. Shilo, R. and Sarig, S. (eds.), 1989. Fish Culture in Warm Water Systems: Problems and Trends. CRC Press.

Department of Aquaculture

Course No. AQ 321
Course Title: Fish Nutrition
Credit: 3

1. Introduction: Role of nutrition in aquaculture practices. Terminology used in fish nutrition.
2. Protein and amino acids: Classification and functions, quantitative dietary protein requirements for fish and crustaceans, protein as an energy source and amino acid requirement. Factors affecting protein and amino acid requirement. Amino acid availability, evaluation of protein quality.
3. Lipid and fatty acids: Dietary lipid requirement of fish and shellfish, lipid as energy and essential fatty acid source, essential fatty acid requirement of fish and shellfish and sources of fatty acids.
4. Carbohydrates: Carbohydrates as energy source. Utilization of dietary carbohydrates and fibre.
5. Minerals: Classification and general functions, macro and microelements, functions and sources, and mineral requirement for fish.
6. Vitamins: Water-soluble and fat-soluble vitamins, biological functions and dietary sources.
7. Energy metabolism in cultivated fish and crustaceans: Partitioning of biological energy, specific dynamic action, energy metabolism and energy requirement of fish and crustacean. Factors affecting energy requirements, Dietary energy sources. Nutrient budget in pond ecosystem.
8. Digestion and absorption of nutrients: Digestive fluids and enzymes, protein, fat, carbohydrate and microbial digestion. Rate of digestion, factors affecting rate of digestion, absorption and assimilation and excretion.
9. Digestibility and digestibility coefficients: Apparent and true digestibility, direct and indirect methods of digestibility determination - advantages and disadvantages. Factors affecting digestibility.
10. Nutritional disorders in fish due to nutrients.
11. Larval and broodstock nutrition: Energy partitioning for reproduction, effect of dietary quality on reproductive output, nutritional requirements of broodstock and larvae.

Course No. AQ 322
Course Title: Fish Nutrition
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a practical note book to be signed and checked by teacher (s) concerned. Viva voce test will form an essential part of the practical examination.

1. Introduction to laboratory equipment and safety procedures
2. Proximate composition analysis, feed ingredients, compounded feed and naturally produced food and carcass samples: a) moisture/ dry matter, b) protein, c) lipid, d) ash, and e) crude fibre.
3. Estimation of gross energy value by Bomb Calorimeter
4. Techniques for faecal collection.
5. Determination of chromic oxide content in feed and fecal sample.
6. Digestibility studies of dry matter, protein and lipid content in feed.
7. Analysis of growth responses, food conversion and protein utilization.
8. Aquarium setting for nutritional studies.
9. Study of growth performances under different feeding practices in field conditions.

Text books and references:

1. De Silva, S.S. and Anderson, T.A., 1995. Fish Nutrition in Aquaculture. Chapman & Hall, London, 319 pp.
2. Halver, J.E. 1988. Fish Nutrition. Academic Press, New York,798pp.
3. Hepher, B., 1990. Nutrition of Pond Fishes. Cambridge University Press, Cambridge, 388 pp.
4. AOAC, 1990. Official Methods of Analysis-15th Edition, Association of Official Analytical Chemists, Washington DC.
5. Goddard, S., 1996. Feed Management in Intensive Aquaculture, Chapman & Hall, Dept. BC, 115 Fifth Avenue, New York, NY 10003, 194 pp.
6. Guillaume, J., Kaushik, S., Bergot, P. and Metailler, R., 2001. Nutrition and Feeding of Fish and Crustaceans. Praxis Publishing, Chichester, UK, 408 pp.
7. Lovell, T., 1998. Nutrition and Feeding of Fish. Kluwer Academic Publishers, 3300 AH Dordrecht, The Nethelands, 267 pp.
8. New, M.B., 1987. Feed and Feeding of Fish and Shrimp. ADCP/REP/87/26, UNDP/FAO, Rome, 275 pp.
9. Steffens, W., 1989. Principles of Fish Nutrition. Ellis Horwood Ltd., West Sussex, 384 pp.
10. Tacon, A.G.J., 1990. Standard Methods for the Nutrition and Feeding of Farmed Fish and Shrimp. Argent Laboratories Press, Washington, 454 pp.
11. Tacon, A.G.J. and Basurco, B., 1997. Feeding Tomorrow's Fish. CIHEAM/FAO/IEO, Zaragoza (Espana), 307 pp.
12. Webster, C.D. and Lim, C.E., 2002. Nutrient Requirements and Feeding of Finfish for Aquaculture. CABI Publishing, CAB International, Wallingford, Oxon OX10 8DE, UK, 448 pp.

Department of Aquaculture

Course No. AQ 323
Course Title: Fish Farm Design and Construction
Credit: 3

1. Introduction: Importance and scope. Basic engineering principles for aquafarming; its present status and prospects.
2. Site selection: General considerations, soil and water quality. Survey techniques.
3. Aquaculture systems: Land based, water based and specialized systems.

4. Design process: Project planning; farm layout including hatcheries, nurseries and grow out units for carp, catfish and shellfish. Cages, raceways, tanks, recirculatory system, on-bottom and off-bottom culture systems.
5. Construction process: Contract, tender and bid; bill of quantity, project costing, project site management, project monitoring and project ancillaries.
6. Basic hydraulic systems: Basic relationships in hydraulic systems; pumps and its installation procedures. Water flow through channel, pipe, sluice gate, monk, tidal gate and pen stock gate.
7. Feeding system: Feed storage, different type of feeders and feed delivery systems.
8. Aeration systems: Oxygen budget; types of blowers, aerators, compressors and oxygenation systems.
9. Farm hygiene: Sterilization and disinfection of farm units by heat, clorination, oozonation, UV-irradiation and other methods.
10. Wastewater treatment and disposal: Types of wastes in aquafarms, waste management, wastewater treatment by physical, chemical and biological methods.

Course No. AQ 324
Course Title: Fish Farm Design and Construction
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a practical note book to be signed and checked by teacher (s) concerned. Viva voce test will form an essential part of the practical examination.

1. Acquaintance with laboratory equipment.
2. Determination of soil texture.
3. Plane table and contour survey.
4. Site selection for commercial farms by individual student in his/her respective locality.
5. Design and cost estimation of a pond construction.
6. Design and cost estimation for the construction of pond complex.
7. Design and cost estimation for the construction of cage, recirculatory system, raceway, finfish and shellfish farm.
8. Design and construction of inlet, outlet and overflow structures.
9. Case study: Field visit to different government and private fish farms to study their design and construction.

Text books and references:

1. Bose, A. N., S. N. Ghosh, C. T. Yang and A. Mitra. 1991. Coastal Aquaculture Engineering. Cambridge University Press, Cambridge, U. K. 365 pp.
2. Lawson, T. B. 1995. Fundamentals of Aquacultural Engineering. Chapman and Hall, New York. 355 pp.
3. Pilay, T. V. R. 1993. Aquaculture: Principles and Practices. Cambridge University Press, Cambridge, U. K. 575 pp.
4. Coche, A. G. and J. F. Muir. 1992. Training Series, Pond Construction. FAO, Rome, Italy.
5. Coche, A. G., J. F. Muir and T. Laughlin. 1995. Training Series. FAO, UNO, Rome, Italy.
6. Coche, A. G. and T. Laughiin. 1998. Training series, Topographic Tools. FAO, Rome, Italy.
7. Williuam Seamen, Jr. L. M. Sprague. 1991. Artificial Habitats for Marine and Freshwater Fisheries. Academic Press, Inc., U. K. London.
8. Gray, C. W. 1990. A guide to shrimp and prawn hatchery techniques in Bangladesh. BAFRU, IOA, University of Stirling, Scotland, U. K.
9. Huet, M. 1979. Textbook of Fish Culture: Breeding and Cultivation of Fish. Fishing News Books Ltd. U. K.
10. Islam, M. A. 2001. Aquaculture. Bangla Academy. Dhaka. 352 pp.
11. Islam, M. A. Carp Jatiyo Macher Hatchery Mannual, Roushon Ara Choudhury, Mymensingh. 56 pp.
12. Muir, J. F. and R. J. Robert. 1982. Recent Advances in Aquaculture, Vol.3, Croon Helm, London, U. K.
13. Nelson, K. D. 1985. Design and Construction of Earth Dams. Inkata Press, Melbourne, Australia.
14. Walker, M. 1988. Aquaculture Engineering: Technologies for the Future. Ichem Symposium Series No. 111. EFCE Publication Series No. 66. The University of Chemical Engineers, Rugby, U. K. 418 pp.
12. Woynarovitch, E. 1975. Fish Ponds and their Construction: Elementary Guide to Fish Culture in Nepal, FAO, Rome, Italy.

Department of Aquaculture

Course No. AQ 325
Course Title: Shellfish Diseases
Credit: 3

1. Introduction: Importance of shellfish diseases with special reference to shrimp. Disease producing factors and general indications of shellfish health.
2. Viral diseases of shrimp and prawn: Etiology, epizootiology, clinical signs, pathology, diagnosis, distribution, prevention and control measures.
3. Bacterial diseases of shrimp and prawn: Etiology, epizootiology, clinical signs, pathology, diagnosis, distribution, prevention and control measures.
4. Fungal diseases of shrimps and prawns: Clinical signs, pathology, epizootiology, diagnosis, distribution, prevention, and control measures.
5. Common protozoan and metazoan parasitic diseases in shrimp and prawn: Causative agents, clinical signs, pathology and control measures.
6. Environmental diseases of shrimp and prawn and their management.
7. Dietary diseases of shrimp and prawn: Effects on shrimp and prawn health. Care and management.
8. Diagnostic procedures for shrimp diseases: Clinical and laboratory diagnoses.
9. Diseases of non-shrimp crustaceans: Diseases of lobsters, crabs and crayfishes - causative agents, clinical signs and control measures.
10. Diseases of molluscs: Causative agents, clinical signs and control measures for common diseases in oyster, clam and abalone.

Text books and references:

1. Sindermann, C. J. 1990. Principal Diseases of Marine Fish and Shellfish-Diseases of Marine Shellfish. Vol 2. (2^{nd} ed.) Academic Press Inc.
2. Manas, K. and R. K. Das. 1997. Fish and Prawn Diseases in India-Diagnosis and Control. Inland Fisheries Society of India.
3. Charnatchakool, P., J. F. Turnbull, S. J. Funge-smith, I. H. MacRae and C. Limsuwan. 1998. Health Management in Shrimp Ponds. 3^{rd} ed. AAHRI, Bangkok, Thailand.
4. Anthony, E. E. (editor). 1985. Fish and Shellfish Pathology. Academic Press, Inc.
5. Sindermann, C. J. and D. V. Lightner (Editor). 1988. Disease Diagnosis and Control in North American Marine Aquaculture. 2^{nd} ed. Elsevier Scientific Publishers.
6. Sindermann, C. J. 1990. Principal Diseases of Marine Fish and Shellfish. Vol 1. (2^{nd} ed.) Academic Press Inc.
7. McVey, J. 1991. CRC Handbook of Mariculture. Vol 1: (Crustacean Aquaculture). Fish Printing. CRC Press. Inc. Boca Raton Florida.
8. Lightnor, D. V. 1996. A Handbook of Shrimp Pathology and Diagnostic Procedures for Diseases of Cultured Penaeid Shrimp. World Aquaculture Society, Baton Rouge LA.
9. Diagnostic Manual for Aquatic Animal Diseases. 1997. Edited by the OIE Fish Diseases Commission.

Department of Fisheries Management

Course No. FM 321
Course Title: Aquatic Soil Science
Credit : 3

1. Definition, physical properties of soil- texture, colour, consistency and temperature. Suitability of soil for pond construction and fish culture.
2. Chemical properties: pH, cation-anion exchange and adsorption. Soil fertility and productivity.
3. Soil-water interactions and their effects on productivity of waterbodies.

4. Bioturbation: Benthic organisms responsible for bioturbation, effects of bioturbation on physico-chemical properties of overlying water.
5. Bottom-mud: Bottom-mud as a store-house of nutrients for aquatic productivity. Physico-chemical factors affecting release and retention of nutrients from/to mud. Management of bottom mud.
6. Saline soils and acid sulphate soils: Characteristics, reclamation and impacts in coastal aquaculture and mangrove fisheries.
7. Sandy soils: Problems of very sandy soils in pond construction and fish culture and their solutions.
8. Red soil: Characteristics, problems to fish culture and mitigation measures.
9. Soil microorganism: Role in nutrient cycling.

Text books and references:

1. Boyd, C.E., 1988: Water quality management for pond fish culture. Elsevier Science Publishers B.V., Amsterdam. 318pp.
2. Buckman, H.O. and Brady, N.C., 1988. The Nature and Properties of Soils. Ninth edition. S. Chand & Company (Pvt.) Ltd. co. Inc. 750pp.
3. Donahue, R.L., Miller, R.W. and Shickluna, F.C., 1990. Soils-an Introduction to Soils and Plants Growth. Fifth edition. Prentice-Hall of India private Ltd. New Delhi. 667pp.
4. Fitzpatrick, E.A., 1986. Soils-their formation, classification and distribution. English language Book Society. Longman, England. 353pp.
5. Golterman, H.L. (ed.), Interactions between sediments and freshwater: Proceedings of an international symposium held at Amsterdam. The Netherlands, September 6-10, 1976.
6. Tamhane, R.V., Motiramoni, D.P. and Bali, Y.P., 1970. Soils: Their Chemistry and Fertility in Tropical Asia. Third edition. Prentice-Hall Int. Inc. 475pp.
7. Thompson, L.M. and Troeh, F.R., 1978. Soils and soil fertility. Fourth edition. McGraw Hill Book Co., New York. 516 pp.

Department of Agricultural Economics

Course No. AE 327
Course Title: Fishery Economics
Credit: 3

Economic Concepts and Principles Applicable to Fishery Economics: Definition and basic concepts of economics, Consumer behaviour, Law of demand and supply, Factors of production, Production function, Law of returns, Costs and revenue, Market mechanism, Banking system and financing.

Economics of fish production: Fish Production and its economic importance, culture, capture and marine fisheries, Economic factors related to aquacultural production, Investment and economic returns, Fish population dynamics and sustainable yield. Present status and potentiality of inland and marine fish production. Problems and constraints related to fish production. Measures and steps for improvement of fishery sector.

Taxt books and references:

1. Shang, Y.C. 1981. *Aquaculture Economics*: *Basic Concepts and Methods of Analysis,* Westview Press, London.
2. Samuelson, P.A. and Nordhaus, W.D. 1989. *Economics,* 13th edn. McGraw Hill, New York.
3. Bell, F.W. 1978. *Food from the Sea: The Economics and Policies of Ocean Fisheries,* Westview Press, Boulder.
4. Hill, B. 1980. *An Introduction to Economics for Students of Agriculture,* Pergamon Press, London.
5. Lecomber, R. 1979. *The Economics of Natural Resources,* MacMillan, London.
6. Panayotou, T. 1987. *Small-Scale Fisheries in Asia: Socio-economic Analysis and Policy*, IDRC-229c, Canada.
7. Randal, A. 1987. *Resource Economics: An Economic Approach to Natural Resource and Environmental Policy*, Wiley, New York.
8. Dillon, J.L. and Hardaker, J.B. 1993. *Farm Management Research for Small Farmer Development*, 2nd end., Farm Systems Management Series, FAO, Rome.
9. Henderson, J.M. and Quandt, R.E. 1985. *Microeconomic Theory- A Mathematical Approach,* 3rd edn., McGraw Hill, London.
10. Gittinger, J.P. 1994. *Economic Analysis of Agricultural Projects*, 2nd edn., John Hopkins University Press, Baltimore.

Department of Fisheries Biology and Genetics

Course No. FBG 323
Course Title: Genetics and Reproduction of Ornamental Fish
Credit: 3

1. Introduction: Course goals, objectives and outcomes.
2. An overview of the ornamental fishes. Economic importance. Importance as model animals for basic, genetical and molecular biological research. Prospects of ornamental fish seed business in Bangladesh.
3. The genetics and pattern of inheritance of the special features of ornamental fish: Color pattern, fin structure, scale pattern, sexual dimorphism. Mendelian inheritance, simple gene effects, complex effect of alleles, interaction of genes. Sexual dimorphism and sex-linked phenotypes; mechanism of sex-determination. Selective breeding of ornamental fishes to produce desired phenotypic combinations. Genetic manipulation.
4. Modes of reproduction in representative aquarium and farmed ornamental fishes. Factors influencing reproduction of aquarium fishes.

5. The basic principles of setting up aquarium for fish keeping and breeding; Induced breeding technique of the ornamental fishes. Breeding by creating environment and hormonal induction. Breeding behavior of ornamental fishes in the aquarium.
6. Embryonic and larval development. Care for larvae and mass seed production techniques.

Text books and references:

1. Kirpichnikov, V.S., 1981. Genetic Bases of Fish selection. Springer-Verlag, Berlin, Heidelberg. New York.
2. Herbert, R., Axelrod, D., and Windelov, H., 1993. Complete Introduction to Breeding Aquarium Fishes. TFH Publisher.
3. Gratzek, J.B., 1992. Aquariology: Fish Breeding and Genetics. Tetra Press.
4. Herbert, R., Axelrod, D., and Sweeney, M.E., 1993. The Fascination of Breeding Aquarium Fishes.
5. Schroder, J.H., 1976. Genetics for Aquarists. TFH Publications Inc, Neptune
6. Andrews, C., 1986. A Fishkeeper's Guide to Fish Breeding. Tetra Press.
7. Jones, B., 1986. A Fishkeeper's Guide to Aquarium Plants. Tetra Press.
8. Leibel, W.S., 1993. A Fishkeeper's Guide to South American Cichlids. Tetra Press.
9. Loiselle, P.V., 1988. A Fishkeeper's Guide to African Cichlids. Tetra Press.
10. Schliewen, U., 1992. Aquarium Fish. Baron's Educational Series Inc.
11. Mills, D., 1993. You and Your Aquarium. Alfred A. Knopf, Inc., New York.
12. Hampton, C.H.and Hampton, C.D., 1979. Care and Maintenance: A Freshwater Aquarium. TFH Publications.
13. Petrovicky, I., 1989. Aquarium Fish of the World. Natural Sciences of the World Series.
14. Purdom, C.E., 1993. Genetics and Fish Breeding. Chapman and Hall.
15. Turner, B.J. (ed.), 1984. Evolutionary Genetics of Fishes. Plenum Press, New York.
16. Tamadachi, M., 1990. The Culture of the Koi. TFH Publications, New Jersey.
17. Yamamoto, T.O., 1975. Handbook of Genetics Vol. IV. Plenum Publ. Corp, New York.

Department of Fisheries Technology

Course No. FT 321
Course Title: Fishery Products and By-products
Credit: 3.0

1. Introduction to fishery products and by-products in Bangladesh**.** Scientific and technological development in fishery products.
2. Chilled and frozen products**:** Chilled and frozen fishery products, frozen storage, scientific and technological problems associated with chilled and frozen fishery products.
3. Dried and dehydrated fishery products**:** Types of various traditional sun dried and dehydrated products. Technological problems and quality control of dehydrated and dried products.
4. Salted products: Kinds of salted fish and fish roe. Technical problem in curing of fish and fish roe. Storage of salted products.
5. Smoked products: Categories of smoked fish and shellfish. Technical problems associated with smoked fish
6. Canned products: Kinds of canned products, shape and size of can, storage of canned fish, technical problem in canned fish.
7. Fermented fishery products: Types of fermented products and technical problems in fermented products.
8. Surimi and diversified value-added fishery products**:** Various minced and surimi based fish and shrimp products, fish ball, fish finger, kamaboko , chikwa, fish cakes, fish pickles, fish soup powder etc.
9. Fishery By-products: Fish meal, fish protein concentrate, fish oil and refining, shark fin rays, fish maws/Isinglass, pearl essence, fish glue, ambergris, fish marinades, fish silage, fish hydrolyzate etc.

Text books and references:

1. Tanikawa, E. Motohiro, T, and Akiba, M. 1985. Marine products in Japan, Published by Koseisha Koseikaku Co., Ltd., TokyoK. Gopakumar 1997. Tropical fishery products, Science Publishers, Inc
2. Windsor, M. and Barlow, S. 1981. Introduction to Fishery by-products. Fishing News Books Ltd.;
3. Hall, G.M. 1997. Fish processing technology. Blakie Academic & Professional, London, Weinheim, New York, Melbourne, Madras.
4. Govindan, T.K. 1985. Fish Processing Technology, Oxford & IBH publishing Co., New Delhi

Level - IV, Semester - I

Department of Fisheries Biology and Genetics

Course No. FBG 411
Course Title: Genetics and Fish Breeding
Credit: 3

1. Introduction: Course goals, objectives and outcomes.
2. Breeding, the applied aspects of genetics: Prospects of genetics and breeding in aquaculture and fisheries.
3. Genetics of populations: Genetic variability in a population, gene pool and gene frequency, Hardy-Weinberg equilibrium, factors influencing allele frequency. Heterozygosity and genetic distance.
4. Genetics of quantitative phenotypes: Quantitative phenotypic variation and its components. Characteristics of quantitative inheritance. Calculating the number of multiple alleles. Significance of quantitative genetics.
5. Selection as a breeding program: Heritability and selection response, different types of selection programs, individual selection, family selection and mass selection.
6. Hybridization: Dominant genetic variance and hybridization, uses of hybridization, heterosis and hybrid vigor, recurrent selection and impact of hybridization. Outbreeding depression.

7. Inbreeding: Genetic effects of inbreeding, practical applications of inbreeding, inbreeding coefficient, calculation of inbreeding coefficient, inbreeding depression, approaches for reducing inbreeding accumulation; assortative mating and inbreeding, genetic drift.
8. Gene-environment interaction variance: Environmental factors affecting productivity.
9. Genetics of brood stock management: Sources of brood fish. Genetic changes in hatchery populations. Unintentional selection and small population size.
10. Seed storage and genetic conservation: Cryopreservation of gametes, live and cryogenic gene banking.
11. Chromosome manipulation: polyploidy, gynogenesis, androgenesis, sex-reversal and production of monosex population.
12. Recent developments in genetics: Gene transfer: applications and biosafety of GMOs.

Course No. FBG 412
Course Title: Genetics and Fish Breeding
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a Practical Note Book to be signed and checked by teacher(s) concerned.

Viva voce test will form an essential part of the Practical Examinations.

1. Study of quantitative phenotypes: Collection of fish from a natural population; Measurement of their length and weight. Creating frequency distribution to study the normality of the distribution.
2. Comparison of difference in the distribution between a large and a small population. Calculation of heritability from a given data. Calculation of expected response from selection differential and heritability.
3. Population genetics: Familiarization with the techniques of starch gel electrophoresis. Calculation of gene and genotype frequencies from allozyme data/blood group data.
4. Study of sex-reversal and sex identification: Setting up experiment for hormonal sex-reversal using androgen and/or estrogen treated feed. Feeding the fry everyday and observation. Identifying the sexes of juvenile fish by acetocarmine squash method to evaluate the results of sex-reversal experiments.
5. Study of chromosome manipulation: Familiarization with the chromosome manipulation techniques to produce polyploid and gynogenetic fish.
6. Familiarization with cryobiology: Cryopreservation techiques.
7. Field visit: Visiting different government and privately-owned fish hatcheries to know the brood stock management practices by the hatchery operators and to learn the problems currently faced by the hatchery operators/fish farmers.

Text Books and references:

1. Tave, D., 1996. Genetics for Fish Hatchery Managers (3rd edition) Van Nostrand Reinhold, New York.
2. Ryman, N. and Utter, F. (eds.). 1987. Population Genetics and Fishery Management. University of Washington Press Seattle and London.
3. Falconer, D.S. 1996. Introduction to Quantitative Genetics (4th edition), Longman.
4. Tave, D., 1999. Inbreeding and Broodstock Management. FAO Technical Paper No. 392.
5. Reddy, P.V.G.K., 1999. Genetic Resources of the Indian Major Carps. FAO Fisheries Technical Paper No. 387.
6. Tave, D., 1995. Selective Breeding Programs for Medium-sized Fish Farms. FAO Fisheries Technical Paper No. 352.
7. Mostafa, S. (ed.). 1999. Genetics in Sustainable Fisheries Management. Fishing News Books.
8. Hillis, D.M., Moritz, C., and Mable, B.K., 1996. Molecular Sytematics. Sinauer Associates.
9. Kirpichnikov, V.S., 1981. Genetic Bases of Fish Selection. Springer-Verlag, Berlin, Heidelberg, New York.
10. Hussain, M.G. and Mazid, M.A., 2001. Genetic Improvement and Conservation of Carp Species in Bangladesh. Bangladesh Fisheries research Institute and International Centre for Living Aquatic Resources Management (World Fish Centre).
11. Purdom, C.E., 1992. Genetics and Fish Breeding. Chapman and Hall.

Department of Aquaculture

Course No. AQ 411
Course Title: Prevention and Control of Fish Diseases
Credit: 3

1. Introduction: Concept of fish disease and health. Causes of diseases outbreak in fish. General idea about prevention and control of diseases in fish.
2. Disease diagnosis: Clinical and laboratory diagnosis. Health management and its significance.
3. Mechanisms of disease protection: Responses of fish to pathogenic invasion. Pathogens' interactions on the host body and effect of pathogens on host.
4. Non-specific and specific responses: Organs involved in fish immune system and their role in the maintenance of non-specific and specific immunity.
5. Immunodiagnostic methods and vaccination
6. Therapy of fish diseases: Types of therapeutic measures. Principles of chemotherapy. Selection of drugs and their mode of actions. Methods of application of drugs. Use of common drugs in aquaculture.
7. Prevention and control of viral, bacterial and fungal diseases of fish.
8. Prevention and control of parasitic diseases.
9. Prevention and control of fish diseases caused by environmental, dietary and hereditary factors.

Course No. AQ 412
Course Title: Prevention and Control of Fish Diseases
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a practical notebook to be signed and checked by the relevant teacher (s). Viva-voce test is an essential part of the practical examination.

1. Study of prevention and control of diseases:
    a. Diagnosis of fish diseases,
    b. Chemotherapy in laboratory and farm condition, and
    c. Health management by husbandry method.
2. Study of imunodiagnostic techniques: ELAT, ELISA, IFAT, PCR, Western blot and immunohistochemistry
3. Immunization: Methods and vaccination trials
4. Pretreatment trial for reducing diseases in culture ponds
5. Case study for particular disease problem on any fish farm or culture facilities

Text books and references:

1. Woo, P.T.K. and D.W. Bruno, 1999. Fish Diseases and Disorders Vol. 3. CABI Publishing.
2. Treves-Brown, K. 1989. Applied Fish Pharmacology. Aquaculture Series. Chapman & Hall.
3. Brown, L. 1994. Aquaculture for Veterinarians: Fish Husbandry and Medicine Pergamon Press Oxford.
4. Tonguthai, K., Chainabut, S., Somsiri, T., Chanratchkakool and Kanchanakhan, S. 1999. Diagnostic Procedure for Finfish Diseases. Aquatic Animal Health Research Institute, Department of Fisheries, Bangkok, Thailand.
5. Stolen, J. S., Fletcher, T. C., Anderson, D. P., Robertson, B. S. and Uan Muiswinkel, W. B. (editors). 1993. Techniques in Fish Immunology, FITC-1
6. Frerichs, N.G and Millar, S.D. 1993. Manual for the Isolation and Identification of Fish Bacterial Pathogens, Pisces Press, Stirling.
7. Plumb. J. A. 1994. Health Maintenance of Cultured Fishes: Principal Microbial Diseases. Argent: B- HEAL-MCF.
8. Egusa, S. 1992. Infectious Diseases of fish. Oxonian Press Ltd. New Delhi, Argent: B- INFE- DF.
9. Thrusfield, M. 1995. Veterinary Epidemiology. 2nd ed. The University Press, Cambridge
10. Charnatchkool. P., J. F Turnbul and C. Limsuween 1996. Health Management in Shrimp Ponds AAHRI, Kasetsurt University Campus, Bangkok. 3rd ed.
11. Roberts, R. J. 1989. Fish Pathology. Baillere Tindall, London, 2nd ed.
12. Austin, B. and D. A. Austin. 1999. Bacterial Fish Pathogens: Diseases in Farmed and Wild Fish. 3rd ed. Ellis Horwood, England.
13. Gudding, R., A. Lillenaug, P. J. Midtlyng and F. Brown 1997. Fish Vaccinology. Development of Biological Standardization, Karger.
14. Thoesen. J. C (Editor). 1994. Bluebook: Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens, AFS, Fish Health Section. 4th ed. Argent. B- BLUE-SPD.
15. Bonded-Reantaso, M.G., McGladdery, S.E., East, I., and Subsinghe, R.E. (eds) (2001). Asia Diagnostic Guide to Aquatic Animal Diseases. FAO Fisheries Technical Paper No 402, Supplement 2. Rome, FAO, 240 pp.
16. Thoesen, J. C (Editor). 1994. Bluebook: Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens, AFS, Fish Health Section. 4th ed. Argent. B- BLUE-SPD.
17. Treves-Brown, K. 1989. Applied Fish Pharmacology. Aquaculture Series. Chapman & Hall.
18. Plumb. J. A. 1994. Health Maintenance of Cultured Fishes: Principal Microbial Diseases. Argent: B- HEAL-MCF.
19. Austin, B. and D. A. Austin. 1999. Bacterial Fish Pathogens: Diseases in Farmed and Wild Fish. 3rd ed. Ellis Horwood, England.

Department of Fisheries Management

Course No. FM 411
Course Title: Fisheries Management
Credit: 3

1. Introduction: History of fisheries management. Importance of life history data in fisheries management.
2. Protection against hazards: Fishways, screens and racks. Operation and maintenance. Habitat improvement devices for lentic and lotic water environments.
3. Management of natural population: Undesirable species and their control. Causes of declination of catch and biodiversity. Monitoring and controlling of fish stocks.
4. Fishery regulation: Purpose, theories, classification and application. Fish and wild life ordinance of Bangladesh.
5. Management problem: Problem and their mitigation measures. Co-management and community based management of waterbodies (rivers, haors, baors, beels, lakes, estuaries and bays).
6. Fisheries management policy of Bangladesh: History, principles and objectives of New Fisheries Management Policy (NFMP). Exclusive economic zone, international convention on sea and code of conduct.
7. Fisheries cooperative: Role, general principles, objectives and activities. Problems and mitigation measures
8. Fish market and marketing system: Types, marketing channels and transportation of fish and fishery products. Problems and mitigation measures.
9. Development of new fishing water: Objectives and basic principles.
10. Recreational fisheries: History and major recreational fishery resources. Management of recreational fisheries: Objectives, predation control, wetland protection and regulations. Future recreational fisheries development.

Course No. FM 412
Course Title: Fisheries Management
Credit: 1.5

Students shall be required to show a good knowledge of the topics included in the theoretical portion of the paper. They shall maintain a record of everything done in practical classes/ field trips in a practical note book to be signed and checked by the teacher (s) concerned. Viva-voce test will form an essential part of the practical examination.

1. Field trips to observe different habitats in and around BAU campus and identify possible improvement measures.
2. Exercise on controlling undesirable species**.**
3. Visit to DFO office to know how fishery regulation are being implemented.
4. Visit to a fishermen cooperative to know their activities.
5. Visit to a fish market to observe observe various activities related to fish marketing.
6. Visit to a selected haor to study various aspects of fisheries management practices.
7. Visit to a selected beel/floodplain to observe different aspects of fishery management.
8. Seasonal observation of a representative river fishery of Bangladesh (Old Brahmaputra river near BAU campus) to observe the fishing activities and livelihood of the fishermen.

Text books and references:

1. Ali, M.Y., 1997. Fish, water and people: Reflection on inland open water fisheries resources of Bangladesh. University Press Limited, Dhaka- 1000.
2. Anderson, L.G., 1977. The economics of fisheries management. The Johns Hopkins University Press, UK.
3. Aquero, A., Haque,M.S., Rahaman, A.K.A. and Ahmed, M. (eds.), 1997. Inland fisheries management. Department of Fisheries (DOF), Government of Bangladesh.
4. Baird, D.J.,Beveridge, M.C.M., Kelly, L.A. and Muir, J.F., 1996. Aquaculture and water resource management. Blackwell Science Ltd. UK.
5. Bennett, G.W., 1965. Management of artificial lakes and ponds. Reinhold publishing corporation, New York, Chapman and Hall Ltd. London.
6. Berkes, F., Mahon, R., McConney, P., Pollance, R. and R. Pomeroy, 2001. Managing small-scale fisheies: alternative directions and methods. International Development Research Centre, Canada.
7. Cowx, I.G. (ed.), 1995. Stock assessment in inland fisheries. Fishing News Books, Farnham, Surrey, UK.
8. Cowx, I.G., 2000. Management and ecology of river fisheries. Fishing News Books, UK.
9. Graaf, G.D., Born, B., Kamal, A.M. U. and Marttin, F., 2001. Floods fish and fishermen. The university Press Limited, Dhaka.
10. King, M., 1995. Fisheries bilolgy, assessment and management. Fishing News Books, Farnham, Surrey, UK.
11. Rounsefell, G.A. and Everhart, W.H., 1953. Fishery science: its methods and application. John Wiley and Sons. Inc. New York.
12. Shaw, S.A., 1990. Marketing: a practical guide for fish farmers. Fishing News Books, UK.
13. Templeton, R.G. (ed.), 1992. Fisheries Management. Fishing News Books, Farnham, Surey, UK.

Department of Fisheries Management

Course No. FM 413
Course Title: Fisheries Research Planning and Evaluation
Credit: 3

1. Introduction: Fisheries research- Goals, objectives, rationale and outcomes. Types of research, steps in solving a problem. Planning- Definition, rational planning, outcome, theory and approach. Evaluation- Objectives and functions.
2. Research planning and management techniques: National fisheries policy, national environmental policy, national water policy, Govt.'s five-year plan, identification of research needs, human resources need for fisheries research. Administrative, legislation, guidelines, zoning, capacity building, collaboration and policy formulation.
3. Fisheries research activities in Bangladesh and global perspective: Universities, Fisheries research institutes (GOs and NGOs). Fisheries research on global basis.

4. Research issues, strategies and vision: Ponds, reservoirs and lakes, floodplains and rivers, coastal waters, coral reefs and soft bottom shelves.
5. SWOT (strength, weakness, opportunities and threats) analysis for fisheries research: Ponds, reservoirs and lakes, floodplains and rivers, coastal waters, coral reefs and soft bottom shelves.
6. Research priority setting: Potential benefits, ability to utilize benefits, scientific potential, research capacity, feasibility.
7. Environmental impact assessment (EIA): Need for an EIA, steps in the EIA process, operational EIA.
8. Research project monitoring and evaluation: Definition, steps and scoring.
9. Preparation of fisheries research projects and report writing: Justification, objectives, economics, outcomes, scientific report writing and technology packaging.
10. Case study on fisheries research in Bangladesh

Text books and references:

1. Berkes, F., Mahon, R., McConny, P., Pollnac, R. and Pomeroy, R., 2001. Managing small-scale fisheries: Alternative directions and methods. International Development Research Centre, Singapore, 310 pp.
2. Clark, J.R., 1996. Coastal zone management handbook. Lewis Publishers, 694 pp.
3. Hamlisch, R., 1989. Methodology and guidelines for fisheries development planning with special reference to developing countries in the African region. Food and Agriculture Organization, Rome, 61 pp.
4. ICLARM, 1999. Aquatic resources research in developing countries: Data and evaluation by region and research system. ICLARM, Manila, Philippines, 131 pp.
5. Kay, R. and Alder, J., 1999. Coastal planning and management. Spon Press, London, 375 pp.
6. Liao, D.S., 1995. International cooperation for fisheries and aquaculture development. Proceedings of the 7th Biennial Conference of the International Institute of Fisheries Economics and Trade, Organized by National Taiwan University, International Institute of Fisheries Economics and Trade, Taiwan, 405 pp.

Department of Fisheries Technology

Course No. FT 411
Course Title: Quality Control of Fishery Products
Credit: 3

1. Introduction: Concept and purpose of quality assurance, importance of fish inspection and quality control programs, problems in quality assurance of fishery products.
2. Food laws and regulations: Food laws and competent authority, organization of quality control and official inspection system, regulatory standards for products and processing plants.
3. Quality assurance: Hygiene and safety aspects of quality control, standard sanitary operating system (SSOP) and standard operating system (SOP) in processing plant, inspection of fish and fishery products. Quality management information.
4. Process control: Hazard analysis critical control points (HACCP), inspection/test plans.
5. Methods of quality assessment: Organoleptic assessment of quality, biochemical and bacteriological methods of quality assessment
6. Raw material and finished products quality: Raw material collection system, maintenance of raw material quality and finished product quality.
7. Quality deterioration and defects in products: Chilled processed fish, frozen fish, smoked fish, dried and salted fish, canned fish, marinades and heat processed fish

Course No. FT 412
Course Title: Quality Control of Fishery Products
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a Practical Note Book to be signed and checked by teacher (s) concerned.

1. Study of sensory evaluation techniques: basic taste recognition test, basic colour recognition test, preference test and ratio profile.
2. Organoleptic, physical, biochemical and bacteriological evaluation of fresh, chilled and frozen fish and shellfish products.
3. Organoleptic, physical, biochemical and bacteriological evaluation of dried and salted dehydrated, salted and smoked products.
4. Determination of muscle proteins by biuret method and preparation of standard curve.
5. Studies on the stability of myofibrillar proteins by measuring ATPase activity, solubility and SDS-PAGE pattern of soluble protein fraction.
7. Samples collection of various products from processors, industries and market and assessment of their qualities by determining physical, organoleptic, bacteriological and microbial aspects.
8. Evaluation of gel-forming ability of the various surimi based products by determining rheological and biochemical parameters of fish products.
9. Group work and presentation about GMP, HACCP and ISO 9000.

Text books and references:

1. Rudolf Kreuzer (edited) 1971. Fish Inspection and quality control. Fishing News (books), Limited. London, EC4, England
2. Connell, J.J. 1985. Control of Fish Quality. Fishing News Book Ltd.
3. Bonnell, A.D. 1994. Quality assurance in seafood processing: A practical guide. Chapman & Hall, New York and London.
4. FAO 1994. Working Party on Fish Technology and Marketing. Proceeding of the workshop held at Cochin, India, 7-9 March. FAO Fisheries Report No. 514 Supplement. Indo Pacific Commission.

5. Huss, H,H, 1998. Fresh Fish-Quality and Quality Changes. FAO Fisheries Series No. 29, Rome

6. Pierson, M.D. and Donald, A. and Corlett, Jr. 1992. HACCP: Principles and Applications. An AVI Book, Published by Van Nostrand Reinhold, New York.
7. Kramer, A. and Twigg., B.A. 1966. Fundaments of Quality Control for the Food Industry. The Avi. Publishing Co. Inc., West port.
8. Michael T.M (Ed). 1988. Post-harvest Fishery Lossess. Proceeding of an International Workshop held April 12-16, 1997 at the University of Rhode Island, Kingston, RI. Published by ICMRD.
9. Reilly, P.I.J. and Parry, R.W.H. and Barile, L.E. (Ed) 1989. A proceeding of the international conference held at Bangkok, Thailand from November 13-17 on Post-harvest Technology, Preservation and Quality of Fish in South East Asia. International Foundation of Science.
10. Ross, M.H. 1993. Student Manual HACCP and Quality Control Programs. Kingsborough Community College, The City University of New York.
11. Wiryanti, J. and Madakia, H. (Ed). 1997. Improved Quality Control for Fresh and Frozen shrimp. ASEAN-CANADA Fisheries Post-harvest Technology Project-Phase II.
12. Wiryanti, J. and Madakia, H. (Ed). 1997. Improved Quality Control for the Handling and Processing of Fresh and Frozen Tuna at sea and on shore. ASEAN-CANADA Fisheries Post-harvest Technology Project-Phase II.
13. Watts, B.M. and Elias, L.G. 1989. Basic sensory methods for food evaluation. International Development Research Centre, Ottawa, Canada KIG 3H9
14. Botta, J.R. 1995. Evaluation of seafood freshness quality, VCH Publishers (UK) Ltd, United Kingdom

Department of Aquaculture

Course No. AQ 413
Course Title: Ornamental Fish Culture
Credit: 3

1. Introduction: History and importance of ornamental fish culture. Important ornamental fish species (indigenous and exotic), natural habitats, present status and prospect of ornamental fish culture in Bangladesh.
2. Aquarium preparation: Types and size of the aquaria, preparation, aeration, filtration (chemical and biological), water exchange, photosynthesis, and decomposition.
3. Selection of aquarium fish: Species selection, transportation of fish, stocking, introduction of suitable communities, acclimatization and release of fish into the aquarium.
4. Maintenance of the aquarium: Aeration, water exchange, maintenance of biological filters, handling of ornamental fish, pruning and manuring aquarium plants, removing dust and sediments and disinfecting the aquarium.
5. Food and feeding: Live food, balanced artificial feed, feeding regime, waste removal.
6. Seed production of ornamental fish: Brood selection, conditioning, spawning and fry rearing of guppy, swordtail, gold fish, koi-carp, zebra fish, angel fish and other local and exotic ornamental fish species.
7. Health management of ornamental fishes: Common diseases of ornamental fish and their prevention and control.
8. Popularization of ornamental fish keeping: Display, demonstration, training and exhibition.

Text books and references:

1. G.E. Hervey, and J. Hems. 1965. Freshwater tropical fishes. Spring Books. London, UK.
2. Mills, D. 1992. Tropical Aquarium Fishes, How to keep freshwater fish. Chancellor Press, London, UK.
3. Petrovicky, I. 1993. The illustrated guide to Tropical Aquarium fishes. Chancellor Press, London, UK.
3. Islam, M. A. 1985. Macher Pokurer Pani, Bangla Academy, Dhaka.
4. Islam, M. A. 1985. Macher Roog, Bangla Academy, Dhaka.
5. Grzimek, B and Ladiges, W (Editors). 1973. Grzimek's animal life encyclopedia. Van Reinhold Company, UK.
6. Roberts, R.J. 1989. Fish Pathology (2nd Ed.). Baillere Tindall, London, UK.

Department of Fisheries Management

Course No.: FM 415
Course Title: Aquatic Pollution and Toxicology
Credits: 3

1. Introduction: Importance, lethal and sub-lethal effects.
2. Aquatic pollution: Types of pollution. Sources and their impacts on aquatic plants, aquatic animals and human beings. Prevention and control measures.
3. Industrial pollution: Sources and types of industrial pollution. Major polluting industries. Toxic effects of pollutants from tanneries, textiles and chemical industries on freshwater and marine waters.
4. Agricultural pollution: Pollution due to intensification of agriculture (fertilizers, insecticides and pesticides). Impact on aquatic animal and human health. Prevention and control strategies.
5. Heavy metals: Lethal and sub-lethal effects of heavy metals on aquatic biota; Effects on domestic animals and public health.
6. Aquatic Toxicity: Factors influencing toxicity. Toxicity testing.
7. Algal toxins: Implications on aquatic food webs; Mode of action of toxins in seafood poisoning; paralytic shellfish poisoning (PSP), diarrhetic shellfish poisoning (DSP), ciguatera fish poisoning (CFP), pfiesteria toxin and domoic acid. Measurement of toxins from different groups of toxic algae; Economic and social effects of algal toxin and control strategy.

Text books and references:

1. Calow, P. (ed.), 1995. Handbook of Ecotoxicology. Vols 1 & 2. Blackwell Scientific Publication, Inc., Cambridge, UK.

2. Forbes, V.E. and Forbes, T.L., 1994. Ecotoxicology in Theory and Practice. Chapman and Hall Publishers, London, UK.
3. Furness, R.W. and Rainbow, P.S. (eds.), 1990. Heavy Metal in the Marine Environment. CRC Press, Inc., Florida. 256 pp.
4. Furness, R.W. and Rainbow, P.S. (eds.), 1993. Ecotoxicology of Metals in Invertebrates. Lewis Publishers, Florida. 461 pp.
5. Islam, M.A., 1994. Toxic Chemicals and Hazardous Wastes: Bangladesh Context. Department of Environment, Dhaka. 96 pp.
6. Moriarty, F., 1993. Ecotoxicology: The Study of Pollutants in Ecosystems. Academic Press, London. 289 pp.
7. Pillay, T.V.R., 1992. Aquaculture and the Environment. Fishing News Books, UK. 189 pp.
8. Rand, G.M. and Petrocelli, S.R. (eds.), 1985. Fundamentals of Aquatic Toxicology. Hemisphere, Washington, D.C.
9. United Nations Environment Program, 1992. Chemical Pollution: A global review. A joint publication of the International Register of Potentially Toxic Chemicals and the Global Environment Monitoring System's Monitoring and Assessment Centre. UNEP, Nairobi, Kenya. 106 pp.
10. Vymazal, J., 1995. Algae and Element Cycling in Wetlands. CRC Press, Inc., Florida. 689 pp.

Level - IV, Semester - II

Department of Fisheries Biology and Genetics

Course No. FBG 421
Course Title: Hatchery Management
Credit: 3

1. Introduction: Course goals, objectives and outcomes. Relevance of the course to other fishery courses. Importance of fish hatchery. Present status of hatchery in Bangladesh. Its role to meet the present fish seed requirement.
2. Fish hatchery: Site selection- soil and water quality, communication, market demand, transport and marketing facilities. Essential component: Hatchery proper (spawning and incubation facilities), brood rearing ponds, nursery ponds etc. Layout of a typical carp hatchery and a shrimp hatchery.
3. Hatchery management (operational issues):Technical considerations: Rotation, species and age Manpower: Technical, skilled and unskilled. Economic considerations: Budgeting, cost-benefit analysis and economic viability.
4. Brood stock management: Present brood management practices and impact of brood management on fish production. Brood rearing: Includes detailed brood rearing strategy Wild and hatchery reared brood management system. Selective breeding.
5. Hatchery operation: Water quality monitoring, water supply and treatment, treatment of water for reuse and water pollutant.
6. Spawning and egg handling: Natural and artificial spawning methods, control of spawning and egg incubation.
7. Types of Incubators: Hatching trays, catfish troughs, hatching jars, circular incubator, bottle hatchery hapa and vertical tray incubators. Advantages and disadvantages.
8. Larvae and fry rearing: Initial feeding, feeding frequency and feed particle size, larval feed. Pond preparation for fry nursing: One stage and two stage fry rearing.
9. Transportation of live fishes: Importance., conditioning, equipment for live fish transportation; traditional versus modern transportation systems.

Course No. FBG 422
Course Title: Hatchery Management
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a Practical Note Book to be signed and checked by teacher(s) concerned.

Viva voce test will form an essential part of the Practical Examinations.

1. Lay out of typical fish and shrimp hatchery.
2. Selection of breeders, handling and their management:
   (a) Sex determination and selection of the ready-to-spawn breeders.
   (b) Dose calculation of inducing agents, injection, stripping and fertilization.
3. Use of incubators for hatching of eggs:
   (a) Incubation of fertilized eggs in different types of incubators.
   (b) Study of fertilization, hatching and survival rates.
4. Field visit to commercial fish and shrimp hatcheries

Text books and references:

1. Wedemeyer,G.A., 2002. Fish Hatchery Management. American Fisheries Society Publication.
2. Jhingran, V. G. and Pullin, R.S.V., 1985. A Hatchery Manual for the Common, Chinese and Indian Major Carps. Asian Development Bank and International Centre for Living Aquatic Resources Management, Manila, Philippines.
3. Haylor G., 1998. A Fish Hatchery Manual for Africa. Pisces Press Ltd., Stirling, Scotland.
4. Billard R., 1995. Carp: Biology and Culture. Praxis Publishing, Chichester, U.K.
5. Hickling, C. F., 1962. Fish Culture. Faber and Faber, London.
6. Huet, M., 1972. Text Book of Fish Culture: Breeding and Cultivation of Fish. Fishing News Books Ltd. Faroham, Surrey. England.
7. Black K.D. and Pickering, A.D., 1998. Biology of Famed Fish. Sheffield Academic Press Ltd. Sheffield, England.
8. Al- Hajj, A. B. and Farmer, A.S.D., 1984. Shrimp Hatchery Manual. Safut. Kuwait Institute for Institute for Scientific Research.
9. BAFRU (Bangladesh Agricultural and Fisheries Resources Unit), 1990. A Guide to Shrimp and Prawn Hatchery Techniques in Bangladesh. Stirling, Scotland, BAFRU/ Institute of Aquaculture.
10. Lee C.S.,M.S.Su and Liao, I.C., 1991. Finfish Hatchery in Asia (Proceedings of Finfish Hatchery in Asia'91.Tungakang Marine Laboratory, Taiwan.
11. Woynarovich E. and Horvath, L., 1984 The Artificial Propagation of Warm-water Finfishes, a manual for extension. FAO Fisheries Technical Paper 201.

Department of Aquaculture

Course No. AQ 421
Course Title: Fish Feed Technology
Credit: 3

1. Importance: A brief review on nutritional requirements of cultivable fish and shellfishes.

2. Feedstuffs: Significance of animal versus plant foodstuffs. Conventional, unconventional and novel feedstuffs as applied in aquaculture (manufacture and processing, chemical and physiological properties, feeding value, recommended inclusion levels and legal aspects).
3. Feedstuffs of Bangladesh origin: Feedstuffs available with respect to cost and continuity of supply, variation to proximate composition, nutrient bioavailability and palatability.
4. Antinutritonal / toxic factors: Antinutrients in plant feedstuffs including the mode of action and processing methods to reduce their toxic effects. Adventitious toxic factors of plant and animal origin.
5. Non-nutrient components of feeds: Water, binders, fibre, antioxidants, feeding stimulants, pigments, antibiotics and growth promoters.
6. Feed formulations: Criteria for feedstuff selection, basic problems with plant feedstuff selection. Pearson's square hand formulation, spreadsheet formulation and. least-cost feed formulations for semi-intensive and intensive culture of fish and crustaceans.
7. Commercial aquaculture feed types: Starter, fry, fingerlings, grow-out, and product quality feed. Forms of feeds. Feed processing and manufacture - pre-processing of raw materials. Types of machinery and commercial feed manufacturing process.
8. Farm-made aqua-feed: Classification of on-farm feeds ingredients, processing equipment and options. Farm made aquafeed and feeding strategies in Bangladesh - importance, availability of ingredients, on-farm feed formulation and feed manufacturing. Feeding strategies - problems and constraints.
9. Larval and broodstock feed: First feed, weaning feed, starter feed, encapsulated diets. Special diets for broodstock prior to spawning.
10. Feed storage and quality control: Deteriorative changes in feedstuffs and feeds during storage. Quality control and preventive measures.
11. Feeding regimes: Relation between natural and supplementary and stocking density. Feeding levels and feeding frequency. Compensatory feeding. Different methods of feed presentation for fish and crustaceans aquaculture.

Course No. AQ 422
Course Title: Fish Feed Technology
Credit: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a practical note book to be signed and checked by teacher (s) concerned. Viva voce test will form an essential part of the practical examination.

1. Quick test for feedstuffs evaluation:
a) Bulk density measurement
b) Non-protein nitrogen in fish meal
c) Rancidity test for animal products and oilseed meals
d) Estimation of proportion of ingredients in feed mixture by floatation technique.
2. Formulation of a supplemental and balanced feed using square technique for semi-intensive and intensive aquaculture respectively.
3. Formulation of experimental diets replacing dietary fish meal using a potential plant protein source available in Bangladesh.
4. Formulation of a least cost diets using spreadsheet method or linear programming.
5. Analysis of prepared diets for their proximate composition.
6. Determination of water stability of pelleted feeds.
7. Determination of nutrient digestibility of a diet through feeding trial using chromic oxide as an external marker in the diet.
8. Determination of fish growth parameters such as weight gain, specific growth rate, food conversion ratio, protein efficiency ratio, apparent net protein utilization and energy retention through laboratory trial using a prepared diet.
9. Survey of feeding practices and feed resources in a rural fish-farming village and cost benefit analysis of cost of production.
10. Visit to a commercial feed manufacturing plant.

Text books and references:

1. Hertramptf, J.W. and F. Piedad-Pascual (2000). Hand book on ingredients for aquaculture feeds. Kluwer Academic Publishers, London, 573p.
2. Goddard, S. (1996). Feed management in intensive aquaculture. Chapman and Hall, New York, 194p.
3. DeSilva, S.S and T. A. Anderson, (1995). Fish Nutrition in Aquaculture. Chapman & Hall, London, 318pp.
4. AOAC (1990). Official Methods of Analysis. 15th ed. Association of official analytical chemists. Washington DC.
5. Guillaume, S. kaushik, P. Bergot and R. Metailler (2001). Nutrition and Feeding of Fish and Crustaceans. Springer-Praxis Publishing, UK.,408pp.
6. Tacon, A.G.J. (1990). Standard methods for the Nutrition and Feeding of Farmed Fish and Shrimp. Vol. I-II. Argent Laboratories Press, Redmond, Washington, USA. 454 pp.
7. New, M.B. (1987). Feeds and Feeding of fish and shrimp. ADCP/REP/87/26. UNDP/FAO, Rome, 275pp.
8. Steffens, W. (1989). Principles of Fish Nutrition. Ellis Horwood, 384pp.
9. Halver, J.E. (1989). Fish Nutrition (2nd Edition). Academic Press, 388 pp.
10 Tacon, A.G.J. (1993). Protein Sources for use in Warm Water Aquaculture Feeds. FAO Technical Paper.
11. Gohl, B. (1981). Tropical Feeds. FAO Animal Production and Health Series No. 12. 528pp.
12. Liener, I.E. (1980). Toxic Constituents of Plant Foodstuffs. Academic Press, 520pp.
13. ADCP (1980). Fish Feed Technology. ADCP/REP/80/11 UNDP/FAO. Rome, 395pp.
14. ADCP (1980). Fish Feeds and Feeding in Developing Countries. ADCP/REP/ 83/18, ADCP/FAO, 97pp.
15. Khajarern, J., D., Sinchermsiri and U. Kanto (1987). Manual of feed microscopy and quality control. 2nd Edition. Americam Soybean Association.

Course No. AQ 423
Course Title: Integrated Aquafarming
Credit: 3

1. Introduction: Concept of integrated aquafarming, its importance, present status and prospects.
2. Integrated systems: Rationale of complex and multi-component integrated systems, categories of complex integrated systems - plant-fish; plant-animal-fish; animal- animal-fish; waste-fish-plant and human waste-fish-plant.
3. Integrated system environment: Action of wastes on ponds, autotrophic and heterotrophic pathways, role of fish in integrated systems, waste loading and environmental quality. Water quality in integrated systems.
4. Waste management: Management of wastes in waste fed ponds. Processing of additional wastes and utilization of processed wastes.
5. Resource assessment in integration: Effect of the 'value of resources' on integration, economics of using wastes in aquaculture, methodology for economic analysis of integrated farming system, integrated use of land and water, energy budgeting and nutrient transfer efficiency.
6. Economic and social considerations: Integrated farming in economic development, insecurity of land tenure, users conflict and multiple ownership of land, price of credit, risks and marketing of integrated products.

Text books and references:

1. Little, D. and J. Muir. 1987. A Guide to Integrated Warm Water Aquaculture, University of Stirling, Scotland, U. K. 238 pp.
2. Edmods, P., K. E. MeCoy and C. Chantachaeng. 1986. Pilot small-scale crop/livestock/fish farm. AIT, Bangkok, Thailand. 131pp.
3. Ruddle, K. and G. Zhong. 1988. Integrated Aquaculture in South China. Cambridge University Press, Cambridge, U. K.
4. Anonymous. 1997. Training on Integrated Fish Farming to Thana Fisheries Officer, Fisheries Research Institute, Mymensingh.
5. Edwards, P., R. S. V. Pullin and J. A. Granter. 1988. Research and education for development of integrated crop-livestock-fish farming in tropics. ICLARM Stud. Rev., Manilla, Philippines, ICLARM, No.16. 53 pp.
6. Edwards, P., D. C. Little and H. Demaine (eds.). 2002. Rural Aquaculture, CABI Publishing, CAB international, Wallingford, Oxon OX10 8DE, U. K.358 pp.
7. Islam, M. A. 1985. Nana Deshe Macher Chash. Bangla Academy, Dhaka. 352 pp.
8. Islam, M. A. 1988. Shomudra Upakule Macher Chash. Bangla Academy, Dhaka.
9. Islam, M. A. 2001. Aquaculture. Bangla Academy. Dhaka. 352 pp.
10. Muir, J. F. and R. J. Robert. 1982. Recent Advances in Aquaculture. Vol.3 Beckenmen U. K. Croon Helm, London. 420 pp.
11. Pillay, T. V. R. 1992. Aquaculture and Environment. Fishing News Books Ltd. Onsey Mead, Oxford OX2 OEL, England.
12. Pullin, R. S. V. and Z. H. Shehadeh (eds.). 1980. Integrated agriculture aquaculture farming systems. ICLARM conf. Proc., 4. Manilla, Philippines.
13. Tetangco, M. H. (ed.) 1980. Integrated crop-livestock-fish farming, series No. 16, Food and Fertilizer Technology Center, Taiwan, Republic of China.

Department of Fisheries Management

Course No. FM 421
Course Title: Oceanogrphy and Marine Biology
Credit: 3

1. Introduction: Ocean, seas, straits, gulfs, bays – terminology and geographical locations. Origin and history of the oceans. Development of the oceanography. Topography of the ocean bottom- continental shelf, continental slope, continental rise, abyssal plain, seamounts etc. Classification of marine environment. Difference between coastal and oceanic environment.
2. Oceanic sediments: Importance, sources and classification. Transportation and distribution of sediments. Factors influencing marine sedimentation. Arrangement of sediments in the sea.
3. Oceanic tides, waves and currents: Tide, wave and current producing forces. Influence of tides, waves and currents on marine environment and fisheries. Major surface currents of the oceans and upwelling.
4. Properties of seawater: - Temperature, light, salinity, dissolved gases and major nutrients. Factors influencing distribution of nutrient elements. Role of different physicochemical factors on marine organisms.
5. Fisheries oceanography: Utilization of oceanographic knowledge in locating new fishing areas/grounds, identification and location of unused fishery resources, information for improving fishing tactics, and fishery forecasting.
6. Marine communities: Classification and distribution of phytoplankton and zooplankton. Seasonal succession of phyto- and zooplankton. Phytoplankton-zooplankton interrelationships and their relations to fish production. Harmful algal blooms and causes of such bloom. Definition and importance of ichthyoplankton, benthic communities and seaweed.
7. Marine environment and pollution: Petroleum hydrocarbon, chlorinated hydrocarbon and heavy metal pollution, and their impact on marine ecosystem.

Course No. FM 422
Course Title: Oceanography and Marine Biology
Credit: 1.5

Students shall be required to show a good knowledge of the topics included in the theoretical portion of the paper. They shall maintain a record of everything done in practical classes/ field trips in a practical note book to be signed and checked by the teacher (s) concerned. Viva-voce test will form an essential part of the practical examination.

1. Acquaintance with different oceanographic equipment.
2. Study of some physico-chemical parameters of seawater.
3. Collection, preservation, identification, counting and estimation of phytoplankton, zooplankton, ichthyoplankton from coastal and marine waters.
4. Collection of coastal flora and fauna.
5. Analysis of phytoplankton pigments.
6. Identification of some seaweeds.
7. Analysis of marine sediments.
8. Field trips to the coastal areas of Bangladesh.

Text books and references:

1. Barnes, R.S.K. and Hughes, 1988. An Introduction to Marine Ecology. Fishing News Books, Oxford.
2. Boney, A.D., 1974. Phytoplankton. 118 pp.
3. Castro, P. and Huber, M.E., 1992. Marine Biology. Wm. C. Brown Publishers, Oxford. 592 pp.
4. Casro, P. and Huber, M.E., 1997. Marine Biology. WCB/McGraw-Hill. 450 pp.
5. Cousteau, J., 1996. Atlas of the Oceans. Reed International Books Ltd., London. 200 pp.
6. Davis, C.C., 1955. The Marine and Freshwater Plankton. Michigan State University Press, East Lansing, Michigan.
7. Garrison, T., 1995. Essentials of Oceanography. Wadsworth Publishing Company, London. 351pp.
8. Harrison, P. and Parsons, T., 2000. Fisheries Oceanography. Fishing News Books, Oxford. 304pp.
9. Hock, C., Mann, D.G. and Jahns, H.M., 1998. Algae: an introduction to phycology. Cambridge University Press, UK. 627 pp.
10. Jamurs, P.A., 1993. Concepts in Biological Oceanography: an interdisciplinary primer. Oxford University Press, Oxford. 348 pp.
11. Laevastu, T. and Hayes, M.L., 1981. Fisheries Oceanography and Ecology. Fishing News Books, Oxford. 199 pp.
12. Laevastu, T., 1993. Marine Climate, Weather and Fisheries: The effects of weather and climate changes on fisheries and ocean resources. Fishing News Books, Oxford. 204 pp.
13. Mann, K.H. and Lazier, J.R.N., 1996. Dynamics of Marine Ecosystems: Biological – Physical Interactions in the Oceans. Fishing News Books, Oxford. 400 pp.
14. Mridha, S., 1995. Bangopasagar: Samudra Bijnan (Bay of Bengal: Oceanography). Bangla Academy, Dhaka. 261 pp.
15. Newell, G.E. and R.C. Newell, 1977. Marine Plankton: a practical guide. The Anchor Press Ltd., Essex. 244 pp.
16. Parsons, T.R., Takahashi, M. and Hargrave, B., 1984. Biological Oceanographic Processes. Pergamon Press. Oxford. 330 pp.
17. Pickard, G.L. and Emery, W.J., 1990. Descriptive Physical Oceanography: An Introduction. Pergamon Press. Oxford. 320 pp.
18. Pillai, N.R., 1990. Marine Biology and Ecology. Himalaya Publishing House, Delhi, India. 107pp.
19. Sarker, M.N., Status of the red seaweeds in Bangladesh. Marine Fisheries Survey, Management and Development Project, Cox's Bazar, Bangladesh.
20. Summerhayes, C.P., Ballard, R.D. and Thorpe, S.A., 1999. Oceanography. Fishing News Books. Oxford. 352 pp.
21. Tomas, C.R. (ed.) 1997. Identifying Marine Phytoplankton. Academic Press, California. 858 pp.

Department of Agricultural Extension

Course No. AgExt 427
Course Title: Agricultural Extension
Credit: 3

1. Introduction: Characteristics of rural society and fisheries situation in Bangladesh; Meaning of agricultural extension and its philosophy, principles, phases, functions and objectives; Need for extension work for fisheries development in Bangladesh; Gradual growth of extension work in Bangladesh with special reference to fisheries development.
2. Organization for Extension Work: Main features of an extension organization; Categories of personnel constituting an extension service; Qualifications and responsibilities of different categories of personnel in the extension service; Principles of supervision and coordination in extension work.
3. Education, Motivation and Learning: Meaning, types and purposes of education. Concept of Need, motivation and learning; Maslow's need theory; Laws of learning and their implications for extension work. Criteria for effective learning.
4. Communication in Extension: Meaning and importance of Communication in extension work for fisheries development; Communication process and its elements; Barriers to communication and possible solution.
5. Extension Teaching Methods and Teaching-aids: Steps in extension teaching; Meaning, classification, procedures, advantages and limitations of different extension teaching methods; Individual methods, group methods and mass methods; Projected and non-projected visual and audio-visual aids-their classification, importance and use.
6. Innovation-Decision Process and Transfer of Technologies: Meaning of diffusion, elements in the diffusion process, models of innovation-decision process; Innovativeness and adopter categories, Rejection and discontinuance of innovations; Factors affecting the transfer of technologies in fisheries development.
7. Leadership: Concept and types of group; Importance of leadership in group work; Kinds of leadership-authoritarian and democratic; Role of professional and local leaders; Selection and training of local leaders; Recognition for good leadership.
8. Programme Planning and Evaluation in Extension: Concept, importance, principles and procedures of programme planning for fisheries development; Participation for programme planning; Principles, types and procedures for evaluation of programmes.
9. Extension Problems and Programmes for Fisheries Development: Current extension programmes and approaches for fisheries development in Bangladesh; Problems of extension work for fisheries development and their possible solutions.
10. Rural Youth in Extension Work: Present condition of rural youth in Bangladesh; Needs and interests of rural youths; Past and present programmes for development of rural youth in Bangladesh; Youth Programmes in other countries; Involvement of rural youth for development of fisheries and related agricultural development activities.
11. Office Management: Meaning of office management; Features of office management, functions of office management, factors in increasing efficiency in office management.

Course No. AgExt 428
Course Title: Agricultural Extension
Credit 1.5

1. An orientation to different organizations related to agricultural and fisheries development.
2. Preparation of questionnaire/interview schedule for collection of data from the villages.
3. Survey of fisheries condition and preparation and presentation of survey report.
4. Preparation of extension programme for fisheries development in an area, preparation of annual plan and calendar of work.
5. Preparation and use of extension communication materials and visual aids; leaflet, poster, flash cards, flip charts.
6. Practice of techniques facilitating participation of people in group: Lecture, small group discussion, Phillips-6 method, symposium, panel discussion, brain-storming, role playing demonstration.
7. Preparation of Training programme and practice training.
8. Extension Field trip rural areas/Upazila Headquarters to observe rural development activities in the field situation with special emphasis on fisheries.
9. Use and handling of audio-visual aids.
10. Procedure and use o some participatory rural techniques: Social maps, transeet walks, and problem census.

Text books and references:

1. Bhuiya, M.H. 1988. *Krishi Samprasaran Parichiti,* Dhaka Jamuna Printers.
2. Bhuiya, M.H. and M.A.M. Miah. 1998. *Extension Psychology,* Krishi Lekhak Forum, Dhaka: Colourline Printers.
3. Dahama, O.P. and O.P. Bhatnagar. 1980. *Education and Communication for Development. 2nd. edn.* New Delhi : Oxford and IBH Publishing Co. Pvt. Ltd.
4. Kamath, M.C. (editor) 1961. *Extension Education in Community Development.* Directorate of Extension. New Delhi: Ministry of Food and Agriculture, Govt. of India.
5. Kashem, M.A. 1992. *Samprasaran Bijnan* (Extension Science). Dhaka: The Bangladesh Packing Press.
6. Kelsey, L.D., C.C. Heame. 1963. *Cooperative Extension Work*. 3rd edition, Comstock Publishing Associates, New York: Ithaca.
7. Ray, G.L. 1996. *Extension Communication and Management*. 3rd edn. Calcutta: Naya Prokash.
8. Samanta, R.K. (ed.). 1990. *Development Communication for Agriculture.* New Delhi: B.R. Publishing Corporation.
9. Van den Ban, A.W. and H.S. Hawkins. 1996. *Agricultural Extension*. 2nd ed. London: Blackwell Science Ltd.

Department of Fisheries Biology and Genetics

Course No. FBG 423
Course Title: Principles of Molecular Biology and Biotechnology
Credit: 3

1. Introduction: Course goals, objectives and outcomes.
2. Overview of molecular biology and biotechnology: Scope of molecular biology and biotechnology. Application of biotechnology. Scope of biotechnology for stock improvement.
3. Macromolecules: Chemical structure of the major classes of macromolecules- Proteins, and Nucleic acids, DNA replication.

4. Gene expression: Protein synthesis, transcription, the genetic code and translation.
5. DNA Technology: Restriction endonucleases; properties of restriction endonucleases, restriction mapping, general plan of protein coding genes, creation of recombinant DNA molecules.
6. Gene cloning: Cloning vectors, plasmid and cosmid vectors; reverse transcription and creation of DNA library, creation of genomic DNA library, cloning restriction fragments in plasmids;
7. Molecular techniques: Electrophoresis; Southern blotting; Northern blotting; Polymerase Chain Reaction (PCR).
8. Molecular markers in fisheries and aquaculture: DNA fingerprinting (RFLP analysis), mtDNA RFLP analysis; AFLP; RAPD and microsatellite markers.
9. Production of transgenic fish: Creation of a gene construct, methods of gene transfer. Application of genetic engineering technique to produce fish with enhanced growth, disease resistance and cold tolerance.
10. Chromosome manipulation: production of polyploid, gynogenetic and androgenetic fish; production of monosex population.

Text books and references:

1. Freifelder, D., 1987. Molecular Biology (2nd Edition). Jones and Bartlett Publishers, Inc
2. Gupta, P.K., 2000. Genetics (3rd edition). Rastogi Publications.
3. Ranga, M.M., 2000. Animal Biotechnology. Agrobios (India).
4. Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J., and Jayaraman, K., 1996. Concept in Biotechnology. University Press (India) Ltd.
5. Turner, P.C., McLennan, A.G., Bates, A.D., and White, M.R.H., 1998. Instant Notes in Molecular Biology. Viva Books Pvt. Ltd. New Delhi. Mumbai. Chennai.
6. Twyman, R.M. and Wisden, W. (Consultant Editor), 1998. Advanced Molecular Biology. Viva Books Pvt. Ltd. New Delhi. Mumbai. Chennai.
7. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., and Watson, J.D., 1994. Molecular Biology of the Cell. Garland Publishing Inc.
8. Tave, D., 1996. Genetics for Fish Hatchery Managers (3rd edition) Van Nostrand Reinhold, New York
9. Mostafa, S. (ed.), 1999. Genetics in Sustainable Fisheries Management. Fishing News Books.
10. Hoelzel, A.R., 1998. Molecular Genetics Analysis of Populations: A Practical Approach. Oxford University Press.
11. Hew, C.L. and Flecther, G.L., 1992. Transgenic Fish. World Scientific. Singapore. New Jersey. London. Hong Kong.
12. Hochachka, P.W. and Mommsen, T.P., 1993. Biochemistry and Molecular Biology of Fishes. Elsevier Science Publishers, Amsterdam.
13. Bolsover, S.R., Hyams, J.S., Jones, S., Shephard, E.A., and White, H.A., 1997. From Genes to Cells. USA Publishers.
14. Meyers, R.A., 1995. Molecular Biology and Biotechnology. VCH Publishers, New York.
15. Glick, B.R. and Pasternak, J.J., 1994. Molecular Biotechnology. ASM Press, Washington DC.

Department of Aquaculture

Course No. AQ 425
Course Title: Fish Immunology
Credit: 3

1. Introduction to Fish Immunology: Terminology. Role of immunity in preventing infectious diseases.
2. Non-specific immunity in fish: Physical factors - mucus, skin, gills and intestinal tract. Humoral factors - transferrin, interferon, lysozyme, complement, acute phase proteins. Cellular factors - macrophages and granulocytes; inflammation and melano-macrophage centre (MMC).
3. Fish blood cells: Characters and immune functions, phagocytes, lymphocytes and thrombocytes.
4. Specific immunity of fish: Mechanisms of immunoglobilin formation and their role in specific immunity; B and T Lymphocytes, helper and killer cells.
5. Environmental factors in fish health: Immunological aspects - immunoassays, immunostimulation, immunosuppression, immunoreversion and immunomodulators.
6. Antibody probes: Polyclonal and monoclonal antibodies; hybridoma technology and preparation of monoclonal and polyclonal antibody.
7. Principles of immunodiagnoses: Application of antibody probes in diagnosis and control of fish diseases. Immunodiagnostic techniques - slide agglutination, agglutination titrations, enzyme labelled antibody technique (ELAT), indirect fluorescent antibody technique (IFAT), enzyme-linked immunosorbent assay (ELISA); immunohistochemistry (IHC) and Western blot analysis.
8. Immunisation and Vaccination: Active and passive immunisation; types of vaccine and vaccination. Commercial fish vaccines, use of adjuvant and immunostimulants, effectiveness of a vaccine, advantages of vaccination over chemotherapy, prospects of vaccine development.

Text books and references:

1. Anderson, D. P. 1974. Fish Immunology: A book in the series of Disease of fishes. F. H. publications, Inc. Ltd. Great Britain.
2. Ellis, A. 1988. Fish Vaccination. Urgent Publishers, USA.
3. Iwame, G. and T. Nakanishi (eds). 1996. The Fish Immune System. Academic press.
4. Broch, D. and M.T. Modigan . 1991. Biology of Microrsanisnas (6th Ed.). Prentice–Hall International editions.
5. Brooks, G.F., J.S Butel, and L.N. Ornston. 1991. Medical Microbiology (19th Ed.), International edition. A large Medical book, Prentice Hall International Inc.
6. Fudeabers, H.H. D.P. Stites, J.L. Caldwell and J. V. Wells. 1980. Basic and Clinical Immunology (3rd Ed.). Maruzen Asian Edition.
7. Karunasagar, I and I. Karunasagar (eds) 1999. Aquaculture and Biotechnology. Science Publishers, Inc., USA.
8. Mowat, N and M. Rweyemamu (eds). 1997. Vaccine Manual: The production and quality control of vaterinary vaccines for use in developing countries. FAO Animal Production and Health series No 35, Rome.
9. Robrts, R.J (ed). 1989. Fish Pathology (2nd Ed.). Bailliere Tindall, London.

10. Roitt, I.M. 1983. Essential Immunology (4th ed. reprinted). Blackwell Scientific Publication, Butler and Tannen Ltd. Frome, Great Britain
11. Saunders W.B. 1994. Dorland's Illustrated Medical Dictionary, Philadelphia.
12. Stolen, J.S., T.C. Fletcher, D.P. Adrerson, B.S. Rohrson, W. B. Van Muiswinkel 1993. Techniques in Fish Immunology. Fish Immunology Technical Communication 1 (FITC 1), 2nd Ed.. SOS publication, USA.
13. Tizard, I. 1987. Veterinary Immunology: An Introduction (3rd ed.), W.B. Saunders Company, Philadelphia, USA.