

**REVISED CURRICULUM
OF
FRESH WATER BIOLOGY**

Curriculum Development Project
Sponsored by
Ministry of Science and Technology
Islamabad

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CURRICULUM DIVISION, HEC

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PREFACE

Curriculum of a subject is said to be the throbbing pulse of a nation. By looking at the curriculum of a subject, one can judge the state of intellectual development and the state of progress of a nation. The world has turned into a global village, new ideas and information are pouring in a constant stream. It is, therefore, imperative to update our curricula by introducing the recent developments in the relevant fields of knowledge.

In exercise of the powers conferred by Sub-section (1) of section 3 of the Federal Supervision of Curricula Textbooks and Maintenance of Standards of Education Act 1976, the Federal Government vide Notification No.D773/76-JEA (Cur.), dated December 4, 1976, appointed Higher Education Commission as the Competent Authority to look after the Curriculum Revision Work beyond Class XII at Bachelor level and onwards to all Degrees, Certificates and Diplomas awarded by Degree Colleges, Universities and other Institutions of higher education.

In pursuance of the above decisions and directives, the Commission is continually performing curriculum revision in collaboration with the Universities. According to the decision of the 44th Vice-Chancellors' Committee, curriculum of a subject must be reviewed after every 3 years. For the purpose, various Committees are constituted at the national level comprising senior teachers nominated by the Universities. Teachers from local degree colleges and experts from user organizations, where required, are also included in these Committees.

The National Curriculum Revision Committee on Fresh Water Biology in its meeting held in May, 2002 at the H.E.C. Regional Centre, Karachi finalized the draft curriculum after due consideration of the comments and suggestions received from the Universities and Colleges where the subject under consideration is taught.

The Final draft prepared by the Curriculum Revision Committee duly approved by competent authority is being circulated for implementation by the Universities.

(PROF. DR. ALTAF ALI G. SHAIKH)
ADVISER (C&T)

August 2002

INTRODUCTION:

The final meeting of National Curriculum Revision Committee in Fresh Water Biology and Fisheries was held at Higher Education Commission Regional Office, Karachi from May 14-16, 2002 to finalize the draft Curriculum for B.Sc.(Hons), M.Sc. degree programme. The meeting was inaugurated by Dr. Iqbal A. Panhwar, Director General, Higher Education Commission, Regional Office, Karachi. Dr. Panhwar welcomed the participants of the meeting and assured them for all possible assistance and secretarial work/typing etc. so as to finalize the curriculum for the subject at graduate and Post-graduate level. The following attended the meeting.

1. Prof. Dr. S. Iftikhar Husain Jafri, Convener
Chairman,
Department of Fresh Water Biology and Fisheries,
University of Sindh,
Jamshoro
2. Prof. Dr. Abdus Salam, Member
Director
Institute of Pure and Applied Biology,
Bahauddin Zakaria University,
Multan
3. Prof. Dr. Muhammad Saeed Akhter, Member
Professor,
Department of Zoology,
University of the Punjab, Lahore
4. Mr. Muhammad Afzal, Member
Assistant Professor,
Department of Zoology & Fisheries,
University of Agriculture, Faisalabad
5. Dr. Samina Jalali, Member
Associate Professor,
Department of Biology,
Quaid-i-Azam University, Islamabad
6. Dr. Nasim Akhtar, Member
Chief Scientific Officer/ Deputy Director General
Animal Sciences Institute, NARC
Pakistan Agriculture Research Council,
Islamabad

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| 7. | Prof. Dr. Mubeena Usman,
Department of Botany,
University of Karachi,
Karachi. | Member |
| 8. | Prof. Dr. Mrs. Saiyida Nazneen Rizvi,
Department of Zoology,
University of Karachi,
Karachi. | Member |
| 9. | Prof. Dr. Syed Qaisar Abbas,
Urdu Science College,
Karachi | Member |
| 10. | Prof. Dr. Syed Makhdoom Hussain,
Director,
Centre of Excellence in Marine Biology,
University of Karachi,
Karachi. | Secretary |

The members of the committee discussed the draft Curriculum prepared in the first meeting held at HEC, Karachi from 3-5 January 2002. The committee has also gone through the course contents, which should constitute the basic requirement for B.Sc. (Hons) and M.Sc. degree and improve it and finalize the course contents after some additional changes in the light of recent development in this field. As the proposed curriculum imparts basic as well as applied training to the students, they will be better equipped to do research in the discipline of Fresh Water Biology and Fisheries to promote it according to the national needs. Since the curriculum development is a continuous process, it should be updated at frequent intervals in the light of recent development and in consultation of the experts in the field of Fresh water biology and Fisheries. It is expected that the proposed teaching will promote and popularize this discipline of Fisheries in Pakistan. The Chairman thanked the members of the committee for their contribution in developing and improving the courses and acknowledge the interest and support of Dr. Iqbal A. Panhwar, Director General in organizing and facilitating this meeting at HEC Karachi.

Secretary,

Prof. Dr. Syed Makhdoom Hussain,
Director,
Centre of Excellence in
Marine Biology,
University of Karachi, Karachi.

Convener,

Prof. Dr. Syed Iftikhar Husain Jafri,
Chairman,
Department of Fresh Water Biology
& Fisheries,
University of Sindh, Jamshoro

**COURSE OF STUDIES FOR B.SC. (PASS) DEGREE IN COLLEGES IN
FRESH WATER BIOLOGY AND FISHERIES.**

Candidates having passed H.Sc. Part II examination (Pre-medical) from any recognized board are eligible for admission to this programme. Besides the compulsory subjects, the candidates seek admission in B.Sc programme have to offer three optional subjects. For those candidates who desire to offer Fresh Water Biology and Fisheries as one of the optional subjects shall have to choose two other optional from Group I and the other from Group II as under:

Group-I: Botany/Zoology
Group-II: Chemistry/Functional Math/Statistics.

Following is the breakup of the courses;

1st year: One theory paper of 100 marks and one practical of 50 marks
2nd year: Two theory papers of 100 marks each and two practical of 50 marks each.

B.Sc. (Pass) Total Marks: 100+50, 100+50, 100+50=450

B.Sc. (Pass) Part-I

Paper-I (Theory) : Introductory Fresh Water Biology: 100 Marks

- a. Brief description of freshwater resources of Pakistan, types of Fresh Water habitat and their zonation
- b. Classification of living fishes into major subdivisions, description of important food fishes of Pakistan
- c. Digestive, Respiratory, Circulatory, Excretory, Nervous Systems, Structure of skin, sense organs and skeleton of cartilaginous fish (type: Dogfish) and a bony fish (type: Rahu, Labeo, Rohita)
- d. Differentiation between various Thallophytes, occurrence structure and reproduction of Cyanophyta (type: Oscillatoria), occurrence structure and reproduction of Chlorophyta (type: Chlamydomonas), general classification of Algae and its economic importance.

Laboratory-I: Fresh Water Biology and Fisheries. 50 Marks

- a. Study of external and internal features of Dogfish and Rahu.
- b. Study of representative fresh water fishes and food fishes
- c. Study of various common fresh water algae and aquatic plants

B.Sc. (Pass) Part-II 2nd year:

Paper-II (Theory) : Fresh Water Ecology: 100 Marks

- a. Basic principles of Ecology, habitat and ecological niches, eco system, food chain, trophic levels, biochemical cycles
- b. Adaptive features of hydrophytes, account of common aquatic plants, their importance and role in fresh water eco system, control of aquatic feeds.
- c. Common zooplankton and phytoplankton, their role in aquatic food chain.
- d. Feeding adaptations and feeding habits of local food fishes
- e. Migration in fishes with special reference to Palla of Indus river
- f. Nature of Lotic and Lentic waters, brief description of physiochemical factors of water, impact of pollution on aquatic life

Laboratory-II: Fresh Water Ecology: 50 Marks

- a. study of any fresh water ecosystem
- b. collection and identification of aquatic plants
- c. study of common zoo and phytoplankton
- d. analysis of physical and chemical properties of water

Paper-III (Theory): Fish Culture: 100 Marks

- a. designing, construction, preparation and management of fish farms, collection, transport of smrd and stocking of ponds, brief description of Monoculture and polyculture of fish
- b. common fishing methods practiced in Pakistan
- c. methods for handling, processing and preservation of fish, such as drying, salting, curing, smoking and freezing
- d. general account of By-products of Fish Industry
- e. common diseases of fish in ponds and their control measures

Laboratory-III: Fish Culture:

50 Marks

- a. visit to a fish farm and study of its various installations
- b. study of boats and nets used for fishing in Pakistan
- c. collection and identification of cultureable species of fish
- d. study of common fish diseases and parasites of Pakistan

Books Recommended:

1. Ichthyology by K.F.Lagler
2. Fresh Water Fishery Biology by S.S.Ali
3. Text book of Limnology by Kole
4. Algae by Vishishta
5. Aqua-culture by Bardach
6. A manual of fresh water aqua-culture by Santhanasan
7. Limnology by Goldman
8. Vertebrate Zoology by Prashad
9. Basic concepts of Ecology by S.S.Ali
10. Ecology by Odum
11. History of fishes by Norman
12. Aquatic Weed Management by Jhon
13. Introduction to Fishes by Bhumrah and Juneja

SCHEME OF STUDIES FOR B.SC. (HONS) 3 YEARS

Courses of studies in Fresh Water Biology and Fisheries

The department offers teaching programmes leading to the degrees in the subject of Fresh Water Biology and Fisheries leading to B.Sc. (Hons.), and M.Sc.

B.Sc. (Hons) Degree Programme:

B.Sc. (Hons) in Fresh Water Biology: Duration 3 years, six semester. CH: 81+12=93, Total marks: 3300+600= 3900

Candidates having passed H.Sc. Part II examination from any recognized Board of Secondary Education or equivalent course (Pre-medical) are eligible for admission to this programme. Candidate seeking admission in B.Sc. (Hons) degree in Fresh Water Biology will have to complete following courses:

1. Compulsory subjects: English, Islamic Studies and Pakistan Studies
2. Two elective/minor subjects: Zoology is compulsory
3. Any one of the following subjects:

Chemistry/Biochemistry/Physiology/Functional Math/Botany

Major subject: Include 14 Courses and comprehensive Viva Voce exam.

Following is the year wise breakup of the courses for six semesters, credit hours and distribution of marks.

B.Sc. (Hons) I

1st Semester

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
Eng. 300	English (Compl.I)	02	100
P.S. 302	Pakistan Studies (Compl.I)	01	40
FBF 310	Ichthyology-I (Theory)	03	100
FBF 311	Ichthyology-I (Lab.)	01	50

2nd Semester

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
Eng. 301	English (Compl.II)	02	100
L.S. 303	Islamic Studies (Compl.)	01	60
FBF 312	Hydrobiology (Theory)	03	100
FBF 313	Hydrobiology (Lab.)	01	50
1st Year Total		14	600

B.Sc.(Hons)II**1st Semester**

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
Eng. 400	English (Compl.III)	02	100
FBF 410	Ichthyology-II (Theory)	03	100
FBF 411	Ichthyology-II (Lab.)	01	50
FBF 412	Fishery Technology (Theory)	03	100
FBF 413	Fishery Technology (Lab.)	01	50

2nd Semester

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
Eng. 401	English (Compl.IV)	02	100
FBF 414	Fish Biology (Theory)	03	100
FBF 415	Fish Biology (Lab.)	01	50
FBF 416	Pond Fish Culture (Theory)	03	100
FBF 417	Pond Fish Culture (Lab.)	01	50
2nd Year Total		20	800

B.Sc.(Hons)III**1st Semester**

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
FBF 500	Fish Systematics (Theory)	03	100
FBF 501	Fish Systematics (Lab.)	01	50
FBF 502	Ecology (Theory)	03	100
FBF 503	Ecology (Lab.)	01	50
FBF 504	Zooplankton (Theory)	03	100
FBF 505	Zooplankton (Lab.)	01	50
FBF 506	Phytoplankton (Theory)	03	100
FBF 507	Phytoplankton (Lab.)	01	50

2nd Semester

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
FBF 508	Fish Anatomy (Theory)	03	100
FBF 509	Fish Anatomy (Lab.)	01	50
FBF 510	Limnology (Theory)	03	100
FBF 511	Limnology (Lab.)	01	50
FBF 512	Fresh Water Invertebrates (Theory)	03	100

FBF	513	Fresh Water Invertebrates (Lab)	01	50
FBF	514	Aquatic Bacteria & Fungi (Theory)	03	100
FBF	515	Aquatic Bacteria & Fungi (Theory) (Lab.)	01	50
FBF	516	Comprehensive Viva Voce	03	100
Third Year Total			35	1300

B.Sc.(Hons)-I (Optional) (For students of other Departments):

1st Semester

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
FBF 350	Ichthyology (Theory)	02	100
FBF 351	Ichthyology (Lab.)	01	50

2nd Semester

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
FBF 352	Aquatic Ecology (Theory)	02	100
FBF 353	Aquatic Ecology (Lab.)	01	50
Ist Year Total		6	300

B.Sc.(Hons)-II (Optional)

1st Semester

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
FBF 450	Fish Farming (Theory)	02	100
FBF 451	Fish Farming (Lab.)	01	50

2nd Semester

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
FBF 452	Fishing Techniques (Theory)	02	100
FBF 453	Fishing Techniques (Lab.)	01	50
		6	300

B.Sc. (Hon): Duration of degree : 3 years. In 6 semesters.

Total C.H: 81 + 12 = 93

Total marks: 3300 + 600 = 3900

M.Sc. Programme (After B.Sc. (Hons)):

Candidates having B.Sc.(Hons.) degree in Fresh Water Biology and Fisheries from any recognised university are eligible for admission. Duration: one year comprising of two semesters. The courses and distribution of marks for this programme will be the same as given for M.Sc.

M.Sc. Final**1st Semester**

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
FBF 600	Algalogy (Theory)	03	100
FBF 601	Algalogy (Lab.)	01	50
FBF 602	Biology of Fish Growth Theory)	03	100
FBF 603	Biology of Fish Growth (Lab.)	01	50
FBF 604	Water Pollution (Theory)	03	100
FBF 605	Water Pollution (Lab.)	01	50
FBF 606	Aquaculture (Theory)	03	100
FBF 607	Aquaculture (Lab.)	01	50

2nd Semester

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
FBF 608	Aquatic Macrophytes and Management (Theory)	03	100
FBF 609	Aquatic Macrophytes and Management (Lab.)	01	50
FBF 610	Fisheries Biology (Theory)	03	100
FBF 611	Fisheries Biology (Lab.)	01	50
FBF 612	Fishery Technology (Theory)	03	100
FBF 613	Fishery Technology (Lab.)	01	50
FBF 614	Fish Culture (Theory)	03	100
FBF 615	Fish Culture (Lab.)	01	50
FBF 616	Comprehensive Viva Voce	03	100

SCHEME OF STUDIES FOR M.SC.

M.Sc. (Pass) Degree Programme:

It consists of two years duration comprising four semesters. Candidates having B.Sc.(Pass) degree with Fresh Water Biology, Zoology or Botany as one of the subjects, from any recognized institution, shall be eligible for admission to this programme. The courses and distribution of marks for the first two semesters of M.Sc.(Prev.) will be the same as that of B.Sc.(Hons) Part-III (except Viva Voce) which will be taken at the end of fourth semester. The breakup of the courses and distribution of marks for the last two semesters (2nd year) will be as under:

M.Sc. (Previous)

1st Semester

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
FBF 500	Fish Systematics (Theory)	03	100
FBF 501	Fish Systematics (Lab.)	01	50
FBF 502	Ecology (Theory)	03	100
FBF 503	Ecology (Lab.)	01	50
FBF 504	Zooplankton (Theory)	03	100
FBF 505	Zooplankton (Lab.)	01	50
FBF 506	Phytoplankton (Theory)	03	100
FBF 507	Phytoplankton (Lab.)	01	50

2nd Semester

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
FBF 508	Fish Anatomy (Theory)	03	100
FBF 509	Fish Anatomy (Lab.)	01	50
FBF 510	Limnology (Theory)	03	100
FBF 511	Limnology (Lab.)	01	50
FBF 512	Fresh Water Invertebrates (Theory)	03	100
FBF 513	Fresh Water Invertebrates (Lab.)	01	50
FBF 514	Aquatic Bacteria & Fungi (Theory)	03	100
FBF 515	Aquatic Bacteria & Fungi (Lab.)	01	50

M.SC. FINAL**1st Semester**

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
FBF 600	Algalogy (Theory)	03	100
FBF 601	Algalogy (Lab.)	01	50
FBF 602	Biology of Fish Growth(Theory)	03	100
FBF 603	Biology of Fish Growth (Lab.)	01	50
FBF 604	Water Pollution (Theory)	03	100
FBF 605	Water Pollution (Lab.)	01	50
FBF 606	Aquaculture (Theory)	03	100
FBF 607	Aquaculture (Lab.)	01	50

2nd Semester

<u>Course No.</u>	<u>Subject</u>	<u>Credit Hours</u>	<u>Marks</u>
FBF 608	Aquatic Macrophytes and Management (Theory)	03	100
FBF 609	Aquatic Macrophytes and Management (Lab)	01	50
FBF 610	Fisheries Biology (Theory)	03	100
FBF 611	Fisheries Biology (Lab.)	01	50
FBF 612	Fishery Technology (Theory)	03	100
FBF 613	Fishery Technology (Lab.)	01	50
FBF 614	Fish culture (Theory)	03	100
FBF 615	Fish culture (Lab.)	01	50
FBF 616	Comprehensive Viva Voce	03	100

CURRICULUM FOR DEGREE OF B.SC. (HONS)

B.Sc (Hons.) Part-I

Semester- I

Course No. FBF 310 (Ichthyology-I) 100 marks 3 C.H.

Introduction to Ichthyology, history of Ichthyology, classification of fishes and their diversity, morphology, forms and locomotion, integumentary, skeletal, digestive, circulatory, respiratory, excretory; reproductive, nervous systems and sense organs of a cartilaginous fish.

Course No. FBF 311 (Practical) 50 marks 1 C.H

Museum study of cartilaginous fish

Study of external features in detail of a Cartilaginous fish

Dissection of dogfish so as to study its various systems
Study of skeletal structures of Dogfish

Books Recommended:

1. Lagler, KF. Ichthyology 1984
2. Norman & Greenwood: A history of fishes
3. Ashley and Chiasson: Laboratory Anatomy Of Shark & Perch
4. Parshad, S.N: Chordate Zoology
5. Nikol'skii, Special Ichthyology, 1991

Semester- II

Course No. FBF 312 (Hydrobiology) 100 Marks 3 C.H.

Freshwater ecosystem (abiotic and biotic components) habitats and ecological niche, biogeochemical cycles, physicochemical properties of water.

Introduction to algae, major types of fresh water algae and aquatic plants, their classification and characteristics Influence of aquatic vegetation, control measures of aquatic weeds and algal blooms; economic importance of algae and plants, diversity in aquatic fauna.

Course No. FBF 313(Practical) 50 marks 1 C.H.

Sampling, identification and study of aquatic plants
Study of important types of freshwater algae, preparation of temporary slides.
Study of important freshwater zoo and phytoplankton
Analysis of physical and chemical properties of water.

Books Recommended:

1. Moss, B. Ecology of Freshwaters. Man and Medium, Past to Future
3rd Edition, 1998
2. Jeffries, M. and D. Mills, Freshwater Ecology: Principles and
Applications, 1992
3. Mishra, S.R., Aquatic Ecology, 1990
4. Moss, Brian, Ecology of Fresh Waters, 1988
5. Macan, T.T., Freshwater Ecology, 1980
6. Brown, Ecology of Freshwater, 1980
7. D.A. Johanson, Plant Microtechniques, 1968

B.Sc: (Hons.) Part-II

Semester -I

Course No. FBF 410 (Ichthyology-II) 100 marks 3 C.H.

Morphology, skeletal, integumentary, digestive. respiratory, circulatory,
urinogenital reproductive, nervous system and sense organs of a Bony fish.
Osmoregulation in fishes. Breeding habits and parental care in fishes; types of
eggs, Fish migration, Behavior and communication.

Course No. FBF 411(Practical) 50 marks 1 C.H.

Study of external features of a bony fish and its dissection so as to study its
various systems Study and preparation of various types of fish scales

Study of prepared fish tissues and museum study

Books Recommended:

1. Lagler, KF. Ichthyology 1984
2. Norman J.R & Greenwood P.H: A history of fishes 1975
3. Ashley and Chiasson: Laboratory Anatomy Of Shark & Perch
4. Parshad, S.N: Chordate Zoology
5. Nikol'skii, Special Ichthyology, 1991

Course No. FBF 412 (Fishery Technology) 100 marks 3 C.H.

Fishing methods, gears and crafts of Pakistan. Post harvest handling, transportation. Processing technology and product development of fish and shellfish. Fishery by products.

Course No. FBF 413 (Practical) 50 marks 1 C.H.

Study of fishing gears of Pakistan,
Submission of report:

- a) Visit to fish processing and fish meal factory
- b) Visit to fish landing centres

Books Recommended:

1. Burgess, Fish Handling and Processing
2. Ali, S.S. , Freshwater Fishery Biology 1999 Naseem Book Depot, Hyderabad
3. Regenstein, T.M. and C.E. Regenstein Introduction to Fish Technology CBS Pub. N. Delhi, India.

Semester-II

Course No. FBF 414 (Fish Biology) 100 marks 3 C.H.

Food and feeding habits of fish; methods of qualitative and quantitative analysis of food Age and growth studies in fish, growth models, Length-weight relationship condition factor

Marking and tagging of fish, methods of estimating population size, mortality rates

Course No. FBF 415 (Practical) 50 marks 1 C.H.

Analysis of gut contents. Assessment of age and growth with the help of scale, operculum and otolith. Computation of length-weight relationship, condition factor and population estimation.

Books Recommended:

1. Lagler, K.F., Ichthyology 1984 John Willy, London.
2. Ricker., W.E., Methods of Assessment of Freshwater Fish Production
3. Everhart et al., Principles of Fishery Science

Course No. FBF 416 (Pond Fish Culture) 100 marks 3 C.H

Criteria of site selection, designing, construction of pond, liming, fertilization, stocking, feeding and maintenance of fish ponds. Criteria for selection of fish species for culture. Introduction to integrated fish farming.

Course No. FBF 417 (Practical) 50 marks 1 C.H.

Study of important food fishes of Pakistan, methods of their identification with the help of key, Collection of organic, inorganic and composite fertilizers and fish feed ingredients.

Submission of report: Visit to fish farms and installations.

Books Recommended:

1. Arrignon, J., Management of Freshwater Fisheries, Oxford & IBH Pub. 1999
2. Boyd, C.E. Graig, T., Pond Aquaculture Water Quality Management, Kilmner Academic Pub. 1998
3. Mead, J.W., Aquatculture Management, Chapman and Hall Inc. N.York, 1998
4. Parker, R., Aquaculture Science, Delmar Pub., N.York, 1994
5. Reddy, M.S. and K.R.S, Sambasiva Rao, A Text Book of Aquaculture, Discovery Pub. N.Delhi, 1999.
6. Ali, s.S. Fresh Water Fishery Biology 1999 Naseem Book Depot. Hyderabad, Pakistan.

3. Hellanby, Animal Life in Freshwaters
4. Pannak, Freshwater Invertebrates of United States

Course No. FBF 514 (Aquatic Bacteria And Fungi) 100 marks 3 C.H.

Introduction to aquatic bacteria and fungi, general characteristics and classification of freshwater bacteria and fungi; type study: of a bacteria (*Aeromonas*) and a fungi (*Saprolegina*) isolation and culture techniques, economic importance and their role in fresh water ecosystem. Bacterial and fungal fish diseases and methods of their control.

Course No. FBF 515 (Practical) 50 marks 1 C.H.

Study of permanent slides of bacteria and fungi. Diagnosis of diseased fish. Culture and isolation of pathogenic bacteria.

Books Recommended

1. Austin, B., Bacterial fish pathogens, 1987
2. Alexopoulos, C.J., Muns, C.W. and Black Well, Introductory Mycology, 4th ed. N.York 1996
3. Ellis, M.B., Dematiaceous Hypomycetes, 1971
4. Ellis, B.B., More Dematiaceous Hypomycetes, 1976
5. Inglis, V., Bacterial Disease of Fish
6. Pelezer, M.J., Chon, C.C.S and Kreig, N.Q., Microbiology Concept and Application, McGraw Hill, N.York, 1993
7. Carmichael, J.W., W.B. Kendrick; I.L. Connors and L. Sigler, Genera of Hyphomycetes, 1980

Course No. FBF 353 (Practical) 50 marks 1 C.H.

Study of important types of aquatic plants.
Study of permanent slides of representative types of algae. Preparation of temporary mounts of algae, sampling techniques of plankton and zooplankton.

Books Recommended:

1. Network of, Integrated Fish Farming in, 1990
2. Mishra, S.R., Aquatic Ecology, 1990
3. Jefferies, M., Freshwater Ecology, 1977
4. Patterson, D., Free Living Freshwater, 1977
5. Macan, T.T., Freshwater Ecology, 1980

B.Sc. (Hons.) Part -II (Optional)

Semester- I

Course No. FBF 450 (Fish Farming) 100 Marks 2 C.H.

Farming related biology of important food fishes of Pakistan; An account of important fish and shellfish fisheries of Pakistan.
Criteria for site selection, designing, construction, manuring, liming, stocking, harvesting and maintenance of fish ponds.

Course No. FBF 451 (Practical) 50 Marks 1 C.H.

Collection and identification of important food fishes of Pakistan.
Study of various types of Shell fish.
Submission of report: Visit to a fish farm.

Books Recommended:

1. Parker, R., Aquaculture Science, Delmar Pub., N.York, 1994
2. Arrignon, J., Management of Freshwater Fisheries, Oxford & IBH Pub. 1999.
3. Boyd, C.E. Graig, T., Pond Aquaculture Water Quality Management, Kilmer Academic Pub. 1998
4. Mead, J.W., Aquaculture Management, Chapman and Hall Inc. N.York, 1998
5. Parker, R., Aquaculture Science, Delmar Pub., N.York, 1994
6. Reddy, M.S. and K.R.S, Sambasiva Rao, A Text Book of Aquaculture, Discovery Pub. N.Delhi, 1999

Semester-II

Course No. FBF 452 (Fishing Techniques) 100 Marks 2.C.H.

Common fishing gears and crafts with special reference to Pakistan. Various methods of fish handling, transportation, processing and preservation. By-products of fish industry

Course No. FBF 453 (Practical) 50 Mark 1. C.H.

Submission of report:

Study of common fishing gears and crafts of Pakistan.
Visit to fish processing plants and fish harbors.

Books Recommended:

1. Burgess, Fish Handling .and Processing
2. Ali, S.S. , Freshwater Fishery Biology 1999

Books Recommended:

1. Jeffries M. and D. Mills, Freshwater Ecology: Principles and Applications, CBS Pub. N.Delhi 1992.
2. Kaul, B.L., Advances in fish and Wildlife Ecology and Biology, Daya Pub., N.Delhi 1999

Course No. FBF 504 (Zooplankton) 100 marks 3 C.H.

Introduction to zooplankton, taxonomic classification, general characters of Cladocera (Type: Daphnia), general characters of Copepoda (Type: Cyclops), species composition of zooplankton. in lakes, horizontal, vertical and seasonal distribution, diurnal vertical migration of zooplankton, cyclomorphosis, phytoplankton and zooplankton relationship, importance of zooplankton in food chain of an aquatic ecosystem

Course No. FBF 505 (Practical) 50 marks 1 C.H.

Sampling, preservation and study of zooplankton from various water bodies. Qualitative and quantitative study.
Preparation and study of permanent mounts of zooplankton.

Books Recommended:

1. Agarwal, S.C., Limnology, APH Pub., N.Delhi, 1999
2. Graham, Jo, Plankton and Fisheries, 1982
3. Davis, Marine in Fresh Water Plankton

Course No. FBF 506 (Phytoplankton) 100 marks 3 C.H.

Introduction to phytoplankton, classification and species composition of Phytoplankton in Fresh waters, blooms of diatoms, green and blue green algae, dinoflagellates. Qualitative and Quantitative analysis of phytoplankton and their periodicities. Factors influencing phytoplankton productivity (light, temperature, pH), estimation of primary productivity. Inter-action of phytoplankton with other organisms.

Course No. FBF 507 (Practical) 50 marks 1 C.H.

Sampling and identification of phytoplankton.

Estimation of primary productivity
Study of temporary and permanent mounts of phytoplankton

Course No. FBF 514 (Aquatic Bacteria And Fungi) 100 marks 3 C.H.

Introduction to aquatic bacteria and fungi, general characteristics and classification of freshwater bacteria and fungi; type study: of a bacteria (Aeromonas) and a fungi (Saprolegina) isolation and culture techniques, economic importance and their role in fresh water ecosystem. Bacterial and fungal fish diseases and methods of their control.

Course No. FBF 515 (Practical) 50 marks 1 C.H.

Study of permanent slides of bacteria and fungi. Diagnosis of diseased fish. Culture and isolation of pathogenic bacteria.

Books Recommended

1. Biswas, K.P., Textbook of Fish Fisheries, 1992
2. Austin, B., Bacterial fish pathogens, 1987
3. Austin, B., Marine Microbiology, Cambridge University Press, N.York, 1988
4. Alaxopouls, C.J., Muns, C.W. and Black Well, Introductory Mycology, 4th ed. N.York 1996
5. Ellis, M.B., Dematiscious Hypomycetes, 1971
6. Ellis, B.B., More Dematious Hypomycetes, 1976
7. Inglis, V., Bacterial Disease of Fish
8. Pelezer, M.J., Chon, C.C.S and Kreig, N.Q., Microbiology Concept and Application, McGraw Hill, N.York, 1993
9. Carmichael, J.W., W.B. Kendrick; I.L.Conners and L. Sigler, Genera of Hyphomycetes, 1980

Books Recommended:

1. Mead, J.W., Aquaculture Management, Chapman and Hall Inc. N.York, 1998
2. Pillay, T.V.R., Aquaculture. Principles and Practices, Fishing News Book, 1999
3. Parker, R., Aquaculture Science, Delmar Pub., N.York, 1994
4. Reddy, M.S. and K.R.S, Sambasiva Rao, A Text Book of Aquaculture, Discovery Pub. N.Delhi, 1999
5. Shephard, J., Intensive fish farming, 1992
6. Brown, L., Aquaculture for, 1993
7. Network of, Integrated fish farming in, 1990
8. Sinha, V.R., Aquaculture productivity, 1984
9. Pillay, T.V., Advances in Aquaculture, 1979
10. Barnabe, G., Aquaculture, 1994
11. Huet, M. Text Book of Fish Culture, 1986

Semester -II**Course No. FBF 608 (Aquatic Macrophytes and Management)****100 Marks 3 C.H.**

Introduction to macrophytes, characteristics, classification of common macrophytes, methods of preservation and identification; quantitative analysis of plants by quadrat, plotless, and Bitterlich techniques; concept of cover, abundance and productivity; influence of vegetation on aquatic biota; brief account of vegetation of saline and marshy areas; economic uses of plants, control measures of aquatic weeds in ponds, lakes and reservoirs.

Course No. FBF 609 (Practical)**50 Marks 1 C.H**

Sampling techniques, preservation and identification of aquatic plants

Exercises relating to quantitative analysis of plants.

Books Recommended:

1. Helmut Muhlberg. 1982. The complete guide to water plants. E.P. publishing limited. pp, 1-380.
2. Nazir, A and M. Younus. 1979. Aquatic plants of Lahore. Pak. Associa. for the advancement of science, Lahore. pp, 1-141.

3. Prescott, G.W. 1969. How to know aquatic plants. W.M.C. brown publishing company publishers, Dubuq, Iowa. pp, 1-171.
4. Biswas, K and C.C. Calder. 1965. Hand book of common water and marsh plants of India and Burma. Govt. Press N. Delhi. 216 pp.
5. Charudatten, R. 1982. Biological control of weed with plant pathogen. John Wiley & Sons.
6. Haslam, M.1978. River plants. The macrophytic vegetation of water courses. Cambridge University Press, Cambridge. 396 pp.
7. Vansteenis, C.G. G.J. 1981. Pheophytes of the world. Sijthoff and Noordhoff. The Nether land. 470 pp.
8. Gupta, O.P. 1987. Aquatic weed management. Today and tomorrow printers and publishers, N. Delhi 247.
9. Cook, C.D.K. 1996. Aquatic and wetland plants of India. (Reprinted 1987) William Dawson and sons, London. 778 pp.

Course No. FBF 610 (Fisheries Biology) 100 Marks 3 C.H.

Inter-relationships between biotic and abiotic environment of fish, recruitment natality and mortality, population dynamics, food and feeding behaviour , reproduction, fecundity and reproductive behaviour. Fundamental links in the life cycles of the fishes and their migration. Fishery statistics: Standard error, standard deviation, variance, analysis of variance, probability, correlation regression, chi-square test and t- test.

Course No. FBF611 (Practical) 50 Marks I C.H

Analyses of gut contents of fish. Population estimation, determination of fecundity

Books Recommended:

1. Gulland, J.A., Fish Population Dynamics, 1988
2. Lagler, K.F. Ichthyology, 1984. John Wiley & Sons, USA.
3. Ali, S.S. Freshwater fishery biology, 1999. Naseem Book Depot, Hyderabad
4. Schereck, C.B. and B.B. Moyle, Methods for Fish Biology, American Fisheries Society,1990.
5. Nikol's kii, , Special Ichthyology, 1991.
6. Yadev, B.N., Fish and Fisheries, 1990.
7. Bome, Q., Biology of fishes, 1982.
8. Gulland, J.A., Fish Population Dynamics, 1988

Course No. FBF 612 (Fishery Technology)**100 Marks****3 C.H**

Capture fishery and its role in world food production, reasons for decline and development potential. Stock assessment techniques. Various fishing methods, account of fishing gears and crafts, their selectivity efficiency catch per unit effort (CPU); Methods of fish handling and processing (drying, salting, smoking, canning, freezing), Fish by-products (fish meals, fish body oil, fish glue etc). Marketing strategies.

Regulation of fishing; enactment of fishery legislation with special reference to Pakistan. fisheries administration and organization.

Course No. FBF 613 (Practical)**50 Marks****1 C.H.**

Fish stock assessment of lake.

Study of nets (composition, design and operation) Method of gear selectivity and efficiency.

Submission of report:

Visit to fish landing and marketing centers.

Visits to fishmeal, fish curing and fish freezing plants. Fish stock assessment of lake.

Books Recommended:

1. Burgess, Fish Handling and Processing.
2. Ali, S.S. Freshwater Fishery Biology, 1999, Naseem Book depot, Hyderabad.
3. Regenstein, J.M. and C.E. Regenstein. Introduction to fish technology, 1997. CBS. Pub. N. Delhi, India.
4. Joe, M and Carrie, M. Introduction of fish Technology, 1997. Chapman and Hall, USA.
5. Govindan. Fish Processing Technology, 2000.
6. Windsor, M. and Barlow, S. Introduction to fishery by-products, 1981. Fishing news Books Ltd., England

M.SC. (PROPOSED ELECTIVE SUBJECTS)

Course No. FBF:620 (Fish Health Management) 3 C.H.

Significance of fish health and disease implications in aquaculture. Health vulnerability under various levels of farming systems. Symptoms and disease diagnostics. Environment-disease relationship. Stress and Nutrition-related disease. Pathogenicity and disease prognosis in culturable fishes. An account of viral, bacterial, fungal and algal diseases. Parasites and vector-borne organisms and allied health problems. Fish health management through physical, biological and chemical instruments/means.

Course No. FBF: 621 (Practical) 1 C.H.

Diagnostic evaluation of skin, gills, fins and viscera, pathological examination of fish. Collection, preservation, isolation of pathogens.

Books Recommended:

1. Huet & Marcel, Text Book of Fish Culture, 1996
2. Lucky, Methods for the Diagnosis, 1997
3. Ingolia, V., Bacterial disease of fish, 1986
4. Untergasser, Hand book of fish disease, 1994
5. Chakarbarti, Disease of cultivable fishes, 1990
6. Akhtar, N. & Rab, Status of Fish Disease in Pakistan, (NACA Pub.) 1989
7. Bilqees Fatima Mjeeb, Machli Ki Imraziat, 1990
8. Akhtar, N., FAO Proceeding on Strategic Planning for Fisheries Worker in Pakistan, 2002
- 9.

Course No. FBF: 622 (Fish Nutrition) 3 C.H.

Nutrition of fish, digestion and absorption, feeding types, energy requirements, energy losses. carbohydrate, protein, fat, vitamin and mineral requirements of fish. Other diet components: fiber, hormones, antibiotics, antioxidants pigments, binders, feeding stimulants, anti-nutrients and toxins. Diet formulation and processing: formulating diets, ingredients, feed processing. Fish feeding: species, form and size, feeders, feeding rates, feeding practices, special purpose feeding, feeding in cage culture, time of first feeding.

Course No. FBF: 623 (Practicals)**1 C.H.**

1. Proximate composition of fish feed ingredients and diets.
2. Estimation of gross energy of feed.
3. Formulation of fish feed by using statistical packages.
4. Preparation of fish feed and methods of feed storage.

Books Recommended:

1. Parker, R., Aquaculture Science, Delmar Pub., Washington D.C. 1994
2. N.R.C., Nutrient Requirements of Fish, National Academy of Sciences, 1993
3. Pillay, T.V.R., Aquaculture, Fishing News Book, U.K. 1999
4. Halver, J., Fish Nutrition, 1989

Course No. FBF: 624 (Bio Statistics)**3 C.H.**

Collection: arrangement, classification, diagrammatic representation of data; Simple statistics of dispersion (range, mean, mode, median, variance, standard deviation, standard error, coefficient of variation); Concept of degree of freedom; probability and normal distribution curve. Comparing means of two samples, confidence limits of mean; Chi-square distribution, Z-distribution, F-distribution; Correlation; Simple multiple regression; Analysis of variance, statistical designing, random, and multifactorial.

Course No. FBF: 625 (Practical)**1 C.H.**

Exercise in various statistical analyses and interpretation of data. Multifactorial designing.

Books Recommended:

1. Jim Fowler, Lou Cohen and Phil Jarvis, Practical Statistics for Field Biology (2nd ed.)
John Wiley & Sons, 1998
2. Jerrold H. Zar, Bio-Statistical Analysis, 1998
3. Harvey Motulsky, Intuitive Bio-statistics, 1995
4. Sokal, R.R. and Rohlf, F.J., An Introduction to Bio-statistics, W.H. Freeman Co. 1987
5. Mather, K., Statistical Analysis in Biology, Chapman and Hall, U.K. 1960

Course No. FBF: 626 (Fish Physiology)**3.C.H.**

Digestion, structure and function of digestive tract, nutrition, metabolism, energy utilization. Respiration excretion and cardiovascular systems. Role of endocrim system. Reproductive physiology.

Course No. FBF: 627 (Practical)**1 C.H.**

Blood Picture (Blood Smears, RBC, Leukocytes, Lymphocyte)
Hb by Sahali's apparatus, rate of respiration
Study of various stages of Gametogenesis

Course No. FBF: 628 (Advanced Aquaculture) Marks:100**C.H.3**

Comparative account of basis of farming and underlying principles in various aquaculture(open and closed) sub systems such as ponds, man made reservoirs, raceways, cages and rafts. Extensive-intensive level of farming and Carrying Capacity and means of increasing Carrying Capacity. Polyculture vs monoculture and sustainability issues in these farming scenario. Water budgeting in pond and raceways. Recent trends in shell fish, cyprinid, cichlids, salmonids farming technology. Advancement in seed production technology. Use of biotechnology in aquaculture. Flavour problem in fish culture.

Course No. FBF: 629 (Practicals)**1 C.H.**

Submission of report:
Extensive farming
Semi extensive farming
Intensive farming of trout
Pond, reservoirs and race way
Integrated fish farming

Books Recommended:

1. Sinha, V.R., Aquaculture productivity, 1984
2. Pillay, T.V., Aquaticulture: Principles, 1990
3. Rath, R.K., Freshwater Aquaculture, 1994
4. Meade, Aquaculture Mangement, 1991
5. Gillert, Aquaticulture, Vol.1, 1990

RECOMMENDATIONS

1. Future Proposed Courses:

- Titles:
1. Paleolimnology
 2. Limnography
 3. Biotechnology in Aquaculture
 4. Chemical Biology of Fishes
 5. Environmental Biology of Fishes
 6. Aquatic Entomology
 7. Malacology

2. Recommendation:

1. The committee has finalized the courses of B.Sc. (Hons) and M.Sc. Degree program in Fresh Water Biology and Fisheries after a thorough discussion. However it is suggested that before the final printing of this curriculum the first draft may please be sent to Prof. Dr. S. Iftikhar Husain Jafri, Convener of the committee for its proof reading.
2. The committee strongly feels that this curriculum, as proposed is the first step towards the continuation of the process so a list of additional courses has been suggested by committee to be considered in future development of this discipline.
3. The committee strongly recommends that the discipline of Freshwater Biology and Fisheries should also be initiated in other universities of the country to meet the growing demand of experts to cater the need of fish farming industry.
4. The committee feels that the dearth of scientific manpower in this discipline exists in the country and therefore goal-oriented training programmes of human resources are required to fill this void.
5. The committee recommends that persons with M.Sc. Fresh Water Biology and Fisheries/ M.Sc. Zoology with specialization in Fisheries Limnology be given preference for employment in both public and private sector in fisheries related industry.
6. Finally the committee proposes that adequate facilities to conduct these courses be provided to the respective Universities. Refresher Courses in the discipline may be regularly conducted to train teachers with modern advancements in the field.