



UNIVERSITY OF CALICUT

**Abstract**

General and Academic - Faculty of Science - Syllabus of BSc Aquaculture Programme (LRP Pattern) under CBCSS UG Regulations 2019 with effect from 2019 Admission onwards - Implemented- Orders Issued.

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**G & A - IV - J**

U.O.No. 8940/2019/Admn

Dated, Calicut University.P.O, 06.07.2019

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*Read:-*1. U.O.No. 4368/2019/Admn dated 23.03.2019

2. Minutes of the meeting of the Board of Studies in Aquaculture held on 15.06.2019

3. Item No. I.25 in the minutes of the meeting of Faculty of Science held on 27.06.2019

**ORDER**

The Regulations for Choice Based Credit and Semester System for Under Graduate (UG)Curriculum-2019 (CBCSS UG Regulations 2019) for all UG Programmes under CBCSS-Regular and SDE/Private Registration w.e.f. 2019 admission has been implemented vide paper read first above .

The meeting of Board of Studies in Aquaculture held on 15/06/2019 has approved the Syllabus of B Sc Aquaculture Programme (LRP Pattern) in tune with the new CBCSS UG Regulations with effect from 2019 Admission onwards, vide paper read second above.

The Faculty of Science at its meeting held on 27/06/2019 has approved the minutes of the meeting of the Board of Studies in Aquaculture held on 15/06/2019, vide paper read third above.

Under these circumstances, considering the urgency, the Vice Chancellor has accorded sanction to implement the Scheme and Syllabus of **BSc Aquaculture Programme** in accordance with new **CBCSS UG Regulations 2019**, in the University with effect from 2019 Admission onwards, subject to ratification by the Academic Council.

The Scheme and Syllabus of BSc Aquaculture Programme (LRP Pattern) in accordance with CBCSS UG Regulations 2019, is therefore implemented in the University with effect from 2019 Admission onwards.

Orders are issued accordingly. (Syllabus appended)

Biju George K

Assistant Registrar

To

The Principals of all Affiliated Colleges

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# UNIVERSITY OF CALICUT



## B.Sc. PROGRAMME IN AQUACULTURE

### SYLLABI

(Effective from 2019 Admission)



UNIVERSITY OF CALICUT

**Abstract**

General and Academic - CBCSS UG Regulations 2019 - Choice Based Credit Semester System - Regulations for all UG Programmes under CBCSS - Regular and SDE/Private Registration - w.e.f. 2019 admissions - Approved by the Academic Council - Implemented - Orders issued.

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**G & A - IV - J**

U.O.No. 4368/2019/Admn  
23.03.2019

Dated, Calicut University.P.O,

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- Read:-*1. U.O No. GA I/J2/3601/08(Vol.II) dated 19.06.2009  
2. U.O.No. 3797/2013/CU dated 07.09.2013  
3. Item No. 4 in the minutes of the meeting of Steering Committee on CBCSS UG 2014 held on 25.01.2019  
4. Item No. I.1 in the minutes of the special meeting of the Academic Council held on 28.02.2019

ORDER

Vide paper read as (1), Regulations of Choice Based Credit Semester System for UG curriculum was implemented from 2009 admission onwards under the University of Calicut, as per the directions of Governing Council of the Kerala State Higher Education Council and vide paper read as (2), the Modified Regulations of Choice Based Credit Semester System for UG Curriculum was implemented from 2014 admission onwards under the University of Calicut, as per the recommendations of Hridayakumari Committee appointed by the Govt. of Kerala.

As per paper read as (3), the meeting of Steering Committee on CBCSS UG 2014 finalised the CBCSS UG Regulations 2019 by incorporating the suggestions and recommendations of the meetings convened with various stakeholders in this regard.

The Academic Council in its special meeting held on 28.02.2019 has resolved vide paper read as (2) to approve the CBCSS UG Regulations 2019.

Sanction has, therefore, been accorded to implement the Regulations for Choice Based Credit and Semester System for Under Graduate (UG) Curriculum -2019 (CBCSS UG Regulations 2019) for all UG Programmes under CBCSS-Regular and SDE/Private Registration in the University of Calicut, w.e.f. 2019 admissions.

Orders are issued accordingly.

(The CBCSS UG Regulations 2019 is herewith appended)

Biju George K

Assistant Registrar

To

All affiliated Colleges/Institutions/Departments under the University of Calicut

Copy to:Director SDE/ PS to VC/PA to R/PA to CE/GA IV B,C & E Sections/GA I F Section/CHMK Library/SF/DF/FC

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## **Undergraduate Programme in Aquaculture (B.Sc. Aquaculture)**

Calicut University Regulations for Choice Based Credit and Semester System for Under-Graduate (UG) Curriculum 2019 (CBCSSUG Regulations 2019) are to be followed for admission, registration, examinations, internal and external evaluation and grading.

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## RULES AND REGULATIONS

### A. Core Courses

The total number of core theory courses is fourteen, one course each during the first four semesters, five courses during fifth semester, four in sixth semester and one elective course in the sixth semester. In the sixth semester there are three elective courses offered. An institution can choose any one of the following elective courses:

### B. Core Course Practicals

Practicals corresponding to each core course will be conducted during the corresponding semesters. There shall be three external practical examinations for the core course practicals. One external practical examination each shall be conducted for the following clusters of core course practical:

**Practical Paper I:** Core course I Practical & Core Course II Practical, Core course III Practical & Core course IV Practical [At the end of 4<sup>th</sup> Semester].

**Practical Paper II:** Core course V Practical, and Core course VI Practical [At the end of 6<sup>th</sup> Semester].

**Practical Paper III:** Core course VII Practical, and Core course VIII Practical [At the end of 6<sup>th</sup> Semester]

### C. Project

Project works will be carried out in fifth and sixth semesters. A group of students shall be given a combined project to minimize the work load on teachers. Each individual student should submit a copy of the project report duly attested by the supervising teacher and the Head of the Department. The evaluation of the project work shall be conducted at the end of the sixth semester along with the practical examination.

### D. Complementary Courses

The Compulsory complementary course for the BSc Aquaculture programme will be Zoology. The syllabus/Course offered by the University as per the recommendations of Boards of Studies in Zoology for UG complimentary courses shall be followed for the complimentary courses. The Elective complementary course will be Biochemistry the syllabi of which will be designed by the Board of Studies in Biochemistry.

### E. Open Courses

In the 5<sup>th</sup> semester, Aquaculture Main students shall opt for an open course offered by other Departments/streams. A Department offering Aquaculture Main courses may offer the following open courses to students other than Aquaculture main students:

AQC5 D01	Value Addition and Fishery Byproducts
AQC5 D02	Fish Preservation Techniques
AQC5 D03	Ornamental Fish Culture

### F. General Courses

As the BSc Aquaculture programme is a course in the 'language reduced pattern' (alternate stream), four common language courses are replaced by four General Courses (General Course – I; General Course - II; General Course - III; & General Course - IV). General Courses I & II are in 3<sup>rd</sup> semester and General Courses III & IV are in 4<sup>th</sup> semester. The syllabi of these four General Courses are common for the following BSc programmes in the 'language reduced pattern': Biotechnology, Biochemistry, Aquaculture and Plant Science and shall be prepared jointly by the UG Boards of Studies in these subjects.

### G. Examinations

There shall be university (theory) examinations at the end of each semester. Practical examinations shall be conducted by the university at the end of fourth and sixth semester. Project evaluation and viva-voce on the project shall be conducted along with the practical examination towards end of sixth semester. The question papers (for the Core Course Theory Practical papers and the Open Course Theory Paper) are to be set in English and the answers are to be written in English.

## H. Pattern of theory question papers

The external examination question paper is two types: - 4 credit papers in 80 marks external and 20 marks internal evaluation; 2/3 credit papers in 60 marks external and 15 marks internal valuation.

### Question paper Type 1 Scheme of examination

The external QP with 80 marks and internal evaluation is of 20 marks. Duration of examination is 2.5 hours. The pattern of external examination is as given below. The students can answer all questions in Section A & B. But there will be ceiling in each section.

#### Section A

Short answer type carries 2 marks each – 15 questions Ceiling -25

#### Section B

Paragraph/ problem type carries 5 marks each – 8 questions Ceiling -35

#### Section C

Essay type 10 marks (2 out of 4)  $2 \times 10 = 20$

### Question paper Type 2

#### Scheme of examination

The external QP with 60 marks and internal evaluation is of 15 marks. Duration of examination is 2 hours. The pattern of external examination is as given below. The students can answer all questions in Section A & B. But there will be ceiling in each section.

#### Section A

Short answer type carries 2 marks each – 12 questions

Ceiling -20

#### Section B

Paragraph/ problem type carries 5 marks each – 7 Questions

Ceiling -30

#### Section C

Essay type 10 marks (1 out of 2)

$1 \times 10 = 10$

## I. Practical examinations

The Cluster I and Cluster II Practical (External) Examinations shall be conducted at the end of 4th semester and the Cluster III and Cluster IV examinations shall be conducted at the end of 6th semester. There is no practical examination for elective papers. All practical examinations are of three hour duration. The external evaluation of practical examination shall be conducted by two examiners appointed by the university. The Board of Examiners shall decide the pattern of question papers for the practical examinations.

## J. Records

A duly certified record of practical exams should be submitted during the examination. The entire experiments mentioned in the practical syllabus are expected to be done and recorded. The criteria to be observed in the valuation of records are fixed and are appended below:

- Content should cover the entire practical works mentioned under individual courses.
- Neatness and scientific accuracy.
- Timely submission of record sheets.

## K – Submissions:

Every student has to submit the following duly certified by the department:

- Records as mentioned above.
- Detailed project report duly certified by the department (at the end of 6<sup>th</sup> Semester before practical examinations)
- Report on the field visit in the area of Aquaculture/Fisheries/Fish Processing/Seed Production.
- Report of Study Tour to Research Institutes/labs in the areas mentioned under item 'c' above.

### Ten Point Indirect Grading System

Percentage of Marks (Both Internal & External put together)	Grade	Interpretation	Grade point Average	Range of grade points	Class
95 and above	O	Outstanding	10	9.5 -10	First class with distinction
85 to below 95	A+	Excellent	9	8.5 -9.49	
75 to below 85	A	Very good	8	7.5 -8.49	
65 to below 75	B+	Good	7	6.5 -7.49	First Class
55 to below 65	B	Satisfactory	6	5.5 -6.49	
45 to below 55	C	Average	5	4.5 -5.49	Second class
35 to below 45	P	Pass	4	3.5 -4.49	Third Class
Below 35	F	Failure	0	0	Fail
Incomplete	I	Incomplete	0	0	Fail
Absent	Ab	Absent	0	0	Fail

## Guidelines for the Evaluation of Projects

### 1. PROJECT EVALUATION- Regular

- Evaluation of the Project Report shall be done under Mark System.
- The evaluation of the project will be done at two stages :
  - a) Internal Assessment (supervising teachers will assess the project and award internal Marks)
  - b) External evaluation (external examiner appointed by the University)
  - c) Grade for the project will be awarded to candidates, combining the internal and external marks.

3. The internal to external components is to be taken in the ratio 1:4. Assessment of

- different components may be taken as below.

<b>Internal (20% of total)</b>	<b>External (80% of Total)</b>	
<b>Components</b>	<b>Percentage of internal marks</b>	<b>Components</b>
Originality	20	Relevance of the Topic, Statement of Objectives
Methodology	20	Reference/ Bibliography, Presentation, quality of Analysis/ Use of Statistical Tools.
Scheme/ Organisation of Report	30	Findings and recommendations
Viva - Voce	30	Viva - Voce

4. External Examiners will be appointed by the University from the list of VI Semester Board of Examiners in consultation with the Chairperson of the Board.

5. The Chairman of the VI semester examination should form and coordinate the evaluation teams and their work.

6. Internal Assessment should be completed 2 weeks before the last working day of VI Semester.

7. Internal Assessment marks should be published in the Department.

8. In the case of Courses with practical examination, project evaluation shall be done along with practical examinations.

9. The Chairman Board of Examinations, may at his discretion, on urgent requirements, make certain exception in the guidelines for the smooth conduct of the evaluation of project.

### 2. PASS CONDITIONS

- Submission of the Project Report and presence of the student for viva are compulsory for internal evaluation. No marks shall be awarded to a candidate if she/ he fails to submit the Project Report for external evaluation.
- The student should get a minimum P Grade in aggregate of External and Internal.
- There shall be no improvement chance for the Marks obtained in the Project Report.
- \* In the extent of student failing to obtain a minimum of Pass Grade, the project work may be re-done and a new Internal mark may be submitted by the Parent Department. External examination may be conducted along with the subsequent batch.



**Attendance:** A student shall be permitted to appear for the semester examination, only if he/she secures not less than 75% attendance in each semester. Attendance shall be maintained by the Department concerned. Condonation of shortage of attendance to a maximum of 10% in the case of single condonation and 20% in the case of double condonation in a semester shall be granted by University remitting the required fee. Benefits of attendance may be granted to students who attend the approved activities of the college/university with the prior concurrence of the Head of the institution. Participation in such activities may be treated as presence in lieu of their absence on production of participation/attendance certificate (within two weeks) in curricular/extracurricular activities (maximum 9 days in a semester). Students can avail of condonation of shortage of attendance in a maximum of four semesters during the entire programme (Either four single condonations or one double condonation and two single condonations during the entire programme) . If a student fails to get 65% attendance, he/she can move to the next semester only if he/she acquires 50% attendance. In that case, a **provisional registration** is needed. Such students can appear for supplementary examination for such semesters after the completion of the programme. Less than 50% attendance requires Readmission. Readmission is permitted only once during the entire programme.

### **Internal Assessment**

20% of the total marks in each course are for internal examinations. The marks secured for internal assessment only need to be sent to University by the colleges concerned. The internal assessment shall be based on a predetermined transparent system involving written tests, Class room participation based on attendance in respect of theory courses and lab involvement/records attendance in respect of Practical Courses.

Internal assessment of the project will be based on its content, method of presentation, final conclusion and orientation to research aptitude.

Components with percentage of marks of Internal Evaluation of Theory Courses are- Test paper 40%, Assignment 20%, Seminar 20% and Class room participation based on attendance 20%.

For practical courses - Record 60% and lab involvement 40% as far as internal is concerned. (if a fraction appears in internal marks, nearest whole number is to be taken)

For the test paper marks, at least one test paper should be conducted. If more test papers are conducted, the mark of the best one should be taken.

To ensure transparency of the evaluation process, the internal assessment marks awarded to the students in each course in a semester shall be notified on the notice board at least one week before the commencement of external examination. There shall not be any chance for improvement for internal marks. The course teacher(s) shall maintain the academic record of each student registered for the course, which shall be forwarded to the University by the college Principal after obtaining the signature of both course teacher and Head of the Department.

The Split up of marks for Test paper and Class Room Participation (CRP) for internal evaluation are as follows.

### Split up of marks for Test paper

Range of Marks in test paper	Out of 8 (Maximum internal marks is 20)	Out of 6 (Maximum internal marks is 15)
Less than 35%	1	1
35%- 45%	2	2
45% - 55%	3	3
55% - 65%	4	4
65% -85%	6	5
85% -100%	8	6

### Split up of marks for Class Room Participation

Range of CRP	Out of 4 (Maximum internal marks is 20)	Out of 3 (Maximum internal marks is 15)
50% ≤CRP <75%	1	1
75% ≤CRP <85%	2	2
85 % and above	4	3

## Course Structure for B.Sc. Programme in Aquaculture

Total Core Theory Courses: 14

Total Credits: 120

Total Core Practical Papers: 8

Total Marks: 3260

Evaluation: 80% External, 20% Internal

### Semester 1

Sl. No	Course	Course Code	Title	Hr./ Week	Credits	Marks
1	Common		Common English Course I	5	4	100
2	Common		Common English Course II	4	3	75
3	Common		Additional Language Course I	4	4	100
4	Core I	AQC1 B01	Biology of Fishes	2	3	75
5	Core (Pr) I	AQC1 B02 (P)	Biology of Fishes	2	-	-
6	I Comple.		Zoology I	2	2	75
7	I Comple. (Pr.)		Zoology Practical I	2	-	-
8	II Comple.		Biochemistry I	2	3	75
9	II Comple. (Pr.)		Biochemistry Practical I	2	-	-
			<b>Total</b>	<b>25</b>	<b>19</b>	<b>500</b>

### Semester 2

Sl. No	Course	Course Code	Title	Hr./ Week	Credits	Marks
1	Common		Common English Course III	4	4	100
2	Common		Common English Course IV	5	3	75
3	Common		Additional Language Course II	4	4	100
4	Core II	AQC2 B03	Freshwater Aquaculture	2	3	75
5	Core (Pr) II	AQC2 B04 (P)	Water and Soil Quality Parameters	2	-	-
6	I Comple.		Zoology 2	2	2	75
7	I Comple. (Pr.)		Zoology Practical II	2	-	-
8	II Comple.		Biochemistry II	2	3	75
9	II Comple. (Pr.)		Biochemistry Practical II	2	-	-
			<b>Total</b>	<b>25</b>	<b>19</b>	<b>500</b>

**Semester 3**

Sl. No	Course	Course Code	Title	Hr./ Week	Credits	Marks
1	General	A11	Biodiversity – Scope and Relevance	5	4	100
2	General	A 12	Research Methodology	5	4	100
3	Core III	AQC3B05	Fisheries and Population Dynamics	3	3	75
4	Core (Pr) III	AQC3 B06 (P)	Taxonomy, Fisheries and Fishing Technology	2	-	-
5	I Comple.		Zoology III	3	2	75
6	I Comple. (Pr.)		Zoology Practical III	2	-	-
7	II Comple.		Biochemistry III	3	3	75
8	II Comple. (Pr.)		Biochemistry Practical III	2	-	-
			<b>Total</b>	<b>25</b>	<b>16</b>	<b>425</b>

**Semester 4**

Sl. No	Course	Course Code	Title	Hr./ Week	Credits	Marks
1	General	A13	Natural Resource Management	5	4	100
2	General	A14	Intellectual Property Rights	5	4	100
3	Core IV	AQC4 B07	Brackishwater Aquaculture and Mariculture	3	3	75
4	Core (Pr) IV	AQC4 B08 (P)	Aquafarm Management	2	4*	100
5	I Comple.		Zoology IV	3	2	75
6	I Comple.(Pr)		Zoology Practical IV	2	4*	80
7	II Comple.		Biochemistry IV	3	2	75
8	II Comple (Pr)		Biochemistry Practical IV	2	1*	80
			<b>Total</b>	<b>25</b>	<b>24</b>	<b>685</b>

**Semester 5**

Sl. No	Course	Course Code	Title	Hr./ Week	Credits	Marks
1	Core V	AQC5 B09	Hatchery Technology of Aquatic Organisms.	3	4	100
2	Core VI	AQC5 B10	Fish Processing Technology and Quality Control.	3	4	100
3	Core VII	AQC5 B11	Fishing Methods.	2	3	75
4	Core VIII	AQC5 B12	Breeding and Rearing of Aquarium Fishes.	3	3	75
5	Core IX	AQC5 B13	Aquaculture Engineering and Biostatistics.	3	2	75
6	Core (Pr) V	AQC5 B14 (P)	Breeding and Rearing of Aquarium Fishes.	5	-	-
7	Core (Pr) VI	AQC5 B15 (P)	Fish Processing Technology.	2	-	-
8	Core (Project)	AQC5 B16 (Pr.)	Project work/Field Visit/Study Tour.	2	-	-
9	Open (Other Streams)	AQC5 D01	Value Addition and Fishery Byproducts.	3	3	75
		AQC5 D02	Fish Preservation Techniques.			
		AQC5 D03	Ornamental Fish Culture.			
<b>Total</b>				<b>26</b>	<b>19</b>	<b>500</b>

**Semester 6**

Sl. No	Course	Course Code	Title	Hr./ Week	Credits	Marks
1	Core X	AQC6 B17	Fish Genetics, Biotechnology and Bioinformatics.	3	4	100
2	Core XI	AQC6 B18	Fish Pathology and Health Management.	3	3	75
3	Core XII	AQC6 B19	Fishery Microbiology.	3	2	75
4	Core XIII	AQC6 B20	Fisheries Economics and Extension	2	2	75
5	Core (Pr) VII	AQC6 B21 (P)	Biostatistics and Computer Application.	5	4*	100
6	Core (Pr) VIII	AQC6 B22 (P)	Fishery Microbiology and Pathology	5	4*	100
7	Core (Project)	AQC6 B23 (Pr.)	Project work/Field Visit/Study Tour.	2	2	50
8	Core XIV - Core Open (Same Stream)	AQC6 B24 (E01)	Fish Biochemistry and Nutrition.	2	2	75
		AQC6 B24 (E02)	Limnology and Oceanography.			
		AQC6 B24 (E03)	Endocrinology and Reproductive Biology.			
<b>Total</b>				<b>25</b>	<b>23</b>	<b>650</b>

### Semester-wise Credit Distribution for B.Sc. Aquaculture Programme

Semester	Common courses			Core courses	Complementary courses		Open Course	Total
	English	Additional Language	General Courses		Zool	Bioch.		
I	4+3	4		3	2	3		19
II	4+3	4		3	2	3		19
III			4+4	3	2	3		16
IV			4+4	3+ 4*	2+4*	2+1*		24
V				4+4+3+3+2			3	19
VI				4+3+2+ 2+2 +4*+4* +2**				23
<b>Total</b>	<b>14</b>	<b>8</b>	<b>16</b>	<b>55</b>	<b>12</b>	<b>12</b>	<b>3</b>	<b>120</b>

\*Credits for Practical Examinations; \*\* Credits for project Work

Total Credits for the BSc Aquaculture Programme. ....	120
Credits for common courses .....	38
Credits for core courses including project & elective. ....	55
Credits for complementary courses... ..	24
Credits for open course .....	03

Credits for the complimentary course practical will be awarded at the end of the 4<sup>th</sup> semester.  
 Credits for the main course practical will be awarded at the end of the sixth semester.  
 Practical examinations shall be conducted by the University at 4<sup>th</sup> and 6<sup>th</sup> semesters

### Mark Distribution for B.Sc. Aquaculture Programme

English Courses	Theory	2 x 100 + 2 x 75	350	<b>350</b>
Add. Lan. Courses	Theory	2 x 100	200	<b>200</b>
General Courses	Theory	4 x 100	400	<b>400</b>
Core Courses (incl. core elective)	Theory	3 x 100	300	<b>1475</b>
		11 x 75	825	
	Practical	3 x 100	300	
	Project	1 x 50	50	
Open Course (from other Streams)	Theory	1 x 75	75	<b>75</b>
Comp. Courses	Theory	8 x 75	600	<b>760</b>
	Practical	2 x 80	160	
<b>TOTAL</b>				<b>3260</b>

# B.Sc. Aquaculture Programme

## Core Courses (Theory)

Sl.No.	Code	Name	Hr/Wk	Credit
1	AQC1B01	Biology of Fishes	2	3
2	AQC2B03	Freshwater Aquaculture	2	3
3	AQC3B05	Fisheries and Population Dynamics	3	3
4	AQC4B07	Brackishwater Aquaculture and Mariculture	3	3
5	AQC5B09	Hatchery Technology of Aquatic Organisms	3	4
6	AQC5B10	Fish Processing Technology and Quality Control.	3	4
7	AQC5B11	Fishing Methods.	2	3
8	AQC5B12	Breeding and Rearing of Aquarium Fishes	3	3
9	AQC5B13	Aquaculture Engineering and Biostatistics.	2	2
10	AQC6B17	Fish Genetics, Biotechnology and Bioinformatics	3	4
11	AQC6B18	Fish Pathology, and Health Management	3	3
12	AQC6B19	Fishery Microbiology	3	2
13	AQC6B20	Fisheries Economics and Extension	2	2
14 (Opt any one)	AQC6 B24 (E01)	Fish Biochemistry and Nutrition	2	2
	AQC6 B24 (E02)	Limnology and Oceanography	"	"
	AQC6 B24 (E03)	Endocrinology and Reproductive Biology	"	"
<b>TOTAL</b>			<b>37</b>	<b>41</b>



## Core Course I

<b>Course Code</b>	<b>: AQC1 B01</b>
<b>Title</b>	<b>: Biology of Fishes</b>
<b>Hrs/week</b>	<b>2</b>
<b>No. of Credits</b>	<b>3</b>

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### Aim:

To impart an in-depth knowledge on the biology of aquatic organisms used in aquaculture practices.

### Course Outcome:

1. Classify fishes and shellfishes.
2. Understand and illustrate fish anatomy and physiology.
3. Understand the methods used in fish growth study.
4. List, define and classify fish migration.

## Course Content

### **Module 1: General Characteristics of Fishes**

(Hrs 6)

General characters of fishes, adaptations for swimming, body forms, fins. Structure and function of skin and mucous layer. Different types of scales and its modifications. Coloration in fishes. Bioluminescence in fishes. Sense organs in fishes – organs of smell, taste buds, lateral line system. Ampullae of Lorenzini etc. Specialized organs in fishes – electric organs and toxins in fishes.

Questions from section A (2 Marks) = 20

Questions from Section B (5 Marks) = 8

Questions from Section C (10 Marks) = 2

### **Module 2: Food and Growth**

(Hrs 6)

Feed and feeding habits – herbivores, carnivores and omnivores. Feeding adaptations methods employed in the study of gut content analysis volumetric, gravimetric etc. Age and growth – Techniques used in the study – use of scales and otoliths, length frequency analysis. Equations used for deriving growth rates.

Questions from section A (2 Marks) = 10

Questions from Section B (5 Marks) = 8

Questions from Section C (10 Marks) = 2

### **Module 3: Reproduction and Migration**

(Hrs 6)

Reproduction – ovary and testes, structure, development of primary and secondary sexual characteristics. Sexual dimorphism in fishes. Maturation and spawning in fishes, factors affecting maturation and spawning. Fecundity, condition factor, size at first maturity. Oviparous, viviparous and ovoviviparous fishes. Parental care and breeding migration in fishes. Migration in fishes –anadromous and catadromous, homing, instinct and orientation.

Questions from section A (2 Marks) = 20

Questions from Section B (5 Marks) = 10

Questions from Section C (10 Marks) = 3

**Module 4: Digestion, Respiration and Circulation** (Hrs 6)

Digestive system – General morphological feature of digestive system in fishes.

Respiratory system – general description, aquatic respiration, respiratory gases, gaseous exchange, oxygen transport. Adaptations for air breathing in fishes.

Cardiovascular system – General features of heart and blood circulation, circulatory system and oxygen transport in fishes.

Questions from section A (2 Marks) = 10

Questions from Section B (5 Marks) = 5

Questions from Section C (10 Marks) = 2

**Module 5: Endocrinology and Excretion** (Hrs 6)

Endocrine organs in fishes. Hormones and their role in control of reproduction in fishes.

Endocrine system in crustacean and molluscs. Role of hormones in reproduction and moulting in crustacean. Excretion and osmoregulation. Nitrogenous excretion freshwater and marine fishes. Water and salt balance.

Questions from section A (2 Marks) = 10

Questions from Section B (5 Marks) = 10

Questions from Section C (10 Marks) = 3

**Module 6: Taxonomy** (Hrs 6)

Principles of zoological classifications, binomial nomenclature of commercially important fishes, crustaceans and molluscs.

Questions from section A (2 Marks) = 30

Questions from Section B (5 Marks) = 10

Questions from Section C (10 Marks) = 2

**Internal Evaluation****Assignments**

1. Bioluminescence in fishes.
2. Lateral line system in fishes.
3. Osmoregulation in fishes.
4. Electricity in fishes.
5. Migration in fishes
6. Prepare a checklist of indigenous fishes of western ghats
7. Economically important shell fishes

**Projects**

1. Determination of breeding season of a fish.
2. Determination of age of a fish by using scales.
3. Find out GSI of a given fish.
4. Estimation of ova diameter of fish.
5. Collection of indigenous fishes with ornamental value
6. Collection and identification of important shrimp species

**Seminar topics**

1. Coloration in fishes.
2. Toxins in fishes.
3. Growth in fishes.
4. Breeding migration.
5. Ovoviviparity in fishes.

## **Suggested reading**

### **Core reading**

1. Moyle,P.B. and Cech,J.J. Fishes – An Introduction to Ichthyology
2. Norman,J.R. A History of Fishes.
3. Bagenal. Methods of Fish Production in Freshwaters
4. Nicholski, G.V. Ecology of Fishes.
5. Lagler. Ichthyology.
6. Matty. Fish Physiology.
7. Francis Day. Fishes of India.
8. Munro,I.S.R. The Marine and Freshwater Fishes of Ceylon.
9. CMFRI. The Commercial Molluscs of India.

### **Supplementary Reading**

1. Purchon,R.D. The Biology of Mollusca.
2. Dorothy E Bliss. The Biology of Crustacea.
3. Nelson,J.S. Fishes of the World
4. Berg,L.S. Classification of Fish Both Recent and Fossil.

### **Advanced Reading**

1. Wootton,R.J. Fish Ecology.
2. FAO Identification Sheets for Fishery Purposes\_

## **Suggested reading**

### **Core reading**

10. Moyle,P.B. and Cech,J.J. Fishes – An Introduction to Ichthyology
11. Norman,J.R. A History of Fishes.
12. Bagenal. Methods of Fish Production in Freshwaters
13. Nicholski, G.V. Ecology of Fishes.
14. Lagler. Ichthyology.
15. Matty. Fish Physiology.
16. Francis Day. Fishes of India.
17. Munro,I.S.R. The Marine and Freshwater Fishes of Ceylon.
18. CMFRI. The Commercial Molluscs of India.

### **Supplementary Reading**

5. Purchon,R.D. The Biology of Mollusca.
6. Dorothy E Bliss. The Biology of Crustacea.
7. Nelson,J.S. Fishes of the World
8. Berg,L.S. Classification of Fish Both Recent and Fossil.

### **Advanced Reading**

1. Wootton,R.J. Fish Ecology.
2. FAO Identification Sheets for Fishery Purposes.

**Course : Core course II**

**Course Code : AQC2 B03**

**Title : Freshwater Aquaculture**

**Hrs/week 2**

**No. of Credits: 3**

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**Aim:**

To expose the students to basics of aquaculture practices and prospects of aquaculture as a science, and art of management.

**Course Outcomes:**

1. Explain basic aquaculture practices.
2. Understand biological, chemical and environmental concepts pertaining to aquatic environment.
3. List aquaculture institutions and their activities.
4. Investigate the problems of water and soil quality parameters in aquaculture.
5. List major species used in freshwater aquaculture.

**Course Content**

**Module 1: Introduction**

(Hrs 6)

Scope and significance of aquaculture, comparison of aquaculture with capture fisheries. Different aquaculture systems. Global and Indian Scenario of Aquaculture. Criteria for the selection of species, common species cultured. Freshwater cultivable fishes.

Questions from section A (2 Marks) = 10      Questions from Section B (5 Marks) = 8  
Questions from Section C (10 Marks) = 1

**Module 2: Pond Ecology**

(Hrs 6)

General concepts of ecology, productivity, carrying capacity, food chain and food web. Ecology of culture ponds. Nutrient cycles -- Nitrogen , Phosphorous and Carbon. Laws of limiting factor. Significance and important groups of phytoplankton, zoo plankton and benthos in culture ponds. nutrient dynamics, algal blooms.

Questions from section A (2 Marks) = 20      Questions from Section B (5 Marks) = 10  
Questions from Section C (10 Marks) = 3

**Module 3: Pisciculture**

(Hrs 6)

Selection of site, Nursery rearing and stocking ponds, Preparation of ponds– Fertilizations and manuring, Liming, Different methods for the eradication of weed fishes, predators, aquatic insects and aquatic weeds, stocking and post stocking management, harvesting. Management of water and soil quality parameters. Culture of air breathing fishes. Culture of cold water fishes in India.

Questions from section A (2 Marks) = 20      Questions from Section B (5 Marks) = 5  
Questions from Section C (10 Marks) = 2

**Module 4: Culture of Prawns and Mollusc**

(Hrs 6)

Cultivable species of freshwater prawns and their biology – culture of *Macrobrachium rosenbergii*, Culture of cray fish. Important freshwater molluscs of Kerala – Biology and culture of *Lamellidens marginalis*. Freshwater pearl culture – Present status of freshwater pearl culture and production in India.

Questions from section A (2 Marks) = 20

Questions from Section B (5 Marks) = 4

Questions from Section C (10 Marks) = 2

**Module 5: Aquaculture for stable environment**

(Hrs 3)

Sewage fed fish culture, sewage treatment– Sewage cum fish culture in India. Fish in relation to public health – Larvivores fishes and mosquito eradication using fishes. Recent development in integrated farming – Rice cum fish culture, Duck cum fish culture, Poultry cum fish culture and Pig cum fish culture. Organic aqua farming. Fish culture in cages and pens. Running water fish culture. Aquaponics, Integrated Multitrophic Aquaculture (IMTA)

Questions from section A (2 Marks) = 25

Questions from Section B (5 Marks) = 8

Questions from Section C (10 Marks) = 3

**Module 6: R & D in Aquaculture**

(Hrs 3)

Organizations involved in freshwater aquaculture research and development - CIFA, NBFGR, NACA, SEAFDEC, ADAK, FFDA

Questions from section A (2 Marks) = 5

Questions from Section B (5 Marks) = 2

Questions from Section C (10 Marks) = 1

**Internal Evaluation****Assignments**

1. History of Aquaculture- Students should trace the origin of aquaculture in China to its spread throughout Egypt, Japan, Europe and the United States.
2. Compare and contrast various fish production systems used commercially throughout the world.
3. Identify the various components and functions of fresh water recirculation aquaculture systems.
4. Identify the various species of aquatic animals that are cultivated in controlled environments.
5. Ecology of aquaculture ponds

**Projects**

1. Investigate the morphology, anatomy and physiology of a typical fish.
2. Nutritional requirements of various species of fish- Achieve a balance between the amounts of food necessary to foster optimum growth while maintaining good water quality.
3. Observe and record fish behaviour- Students will learn to identify signs of stress and differentiate them from normal behaviour.
4. Monitor water quality factors such as temperature, pH, dissolved oxygen and nitrite level.
5. Investigate the components of an aquatic food chain.
6. Production of Indian major carps in culture systems.
7. Profit analysis of ornamental fish breeding unit.

**Suggested Seminar topics**

1. Various types of traditional aquaculture systems

2. Common indigenous ornamental fishes of India with special reference to Kerala
3. Nutrient cycles in aquaculture ponds- Carbon, nitrogen, phosphorous
4. Pre-stocking management in aquaculture ponds
5. Report on vision and mission and activities of major aquaculture research institutes.
6. Organisational set up and aquaculture promotion activities of CIFA
7. Activities of FFDA

### **Suggested reading**

#### **Core reading**

1. Rath,A.K. Freshwater Aquaculture,
2. Santhanam, et.al. a Manual of Freshwater Aquaculture
3. Pillay,T.V.R. Aquaculture – Principles and Practices
4. Jhingran,V.G. Fish and Fisheries of India
5. Jhingran,V.G and Sehgal,K.L. Coldwater Fisheries of India.
6. Bardach, Rhyther and McLarney. Aquaculture
7. Huet, M. Textbook of Aquaculture.
8. Rogen, Pallin and Shehadeh. Integrated Agriculture and Aquafarming Farming system.
9. Boyd,C.E. Water Quality in Warmwater Fish Ponds
10. Moyle,P.B. and Cech,J.J. Fishes – An Introduction to Ichthyology

#### **Supplementary Reading**

1. Shepherd,J and Bromage, N. Intensive Fish Farming
2. Pillay,T.V.R. Advances in Aquaculture
3. Beveridge. Cage Culture

#### **Advanced Reading**

1. Stickney,R.R. Principles of Warmwater Aquaculture

#### **Web resources**

1. FAO <http://www.fao.org/fishery/topic/4340/en>
  2. NACA <http://www.enaca.org/>
  3. VUAT <http://www.vuatkerala.org/static/eng/advisory/fisheries/index.htm>
  4. Aquaculture/Pond Dynamics <http://pdacrsp.oregonstate.edu/pubs/>
  5. Wikipedia <http://en.wikipedia.org/wiki/Aquaculture>
  6. Fish farming <http://www.fishfarming.com/>
  7. ICAR <http://www.icar.org.in/indiafishvoice/intro.html>
  8. CIFA <http://www.cifa.in/tech.htm>
  9. Aquaculture articles: <http://aquafind.com/articles/aquaculture.php>
  10. Aquaculture Articles <http://www.aquarticles.com/>
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<b>Course</b>	<b>: Core Course III</b>
<b>Course code</b>	<b>: AQC3 B05</b>
<b>Title</b>	<b>: Fisheries and Population Dynamics.</b>
<b>Hrs/week</b>	<b>3</b>
<b>No. of Credits</b>	<b>3</b>

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**Aim:**

To create general awareness about fisheries and population dynamics.

**Course Outcomes:**

1. To develop basic knowledge about marine and inland fishery resources
2. To create awareness about relevant fisheries stock assessment methods

**Course Content**

**Module 1: Riverine and Coldwater Fisheries** (9 Hrs.)

Inland fish production in India- Riverine fisheries – major river systems in India– riverine ecology- capture fisheries, fishing methods, major species captured, recent statistics of catches. Cold water fisheries- major species – rivers supporting cold water fisheries.

Questions from section A (2 Marks) = 15                      Questions from Section B (5 Marks) = 5  
 Questions from Section C (10 Marks) = 3

**Module 2: Reservoir and Estuarine Fisheries** (9 Hrs.)

Reservoir fisheries- Major reservoirs in India- reservoir ecology, capture fisheries, fishing methods, major species captured. Measures for increasing production from reservoirs in India and abroad. Estuarine fisheries- definition and classification of estuaries- capture fisheries, fishing methods, major species captured.

Questions from section A (2 Marks) = 15                      Questions from Section B (5 Marks) = 6  
 Questions from Section C (10 Marks) = 3

**Module 3: Marine Fisheries- Pelagic Resources** (9 Hrs.)

Marine fishery resources in India- important fishing zones including wedge bank, maritime states. Major pelagic resource groups– sardines, mackerel, anchovies, ribbon fishes, tuna, seer fishes etc. Methods of fishing - Recent catch statistics of pelagic fisheries.

Questions from section A (2 Marks) = 20                      Questions from Section B (5 Marks) = 8  
 Questions from Section C (10 Marks) = 4

**Module 4: Marine Fisheries- Demersal and Deep Sea Resources** (9 Hrs.)

Major demersal resource groups- elasmobranchs, cephalopods, silver bellies, flat fishes, crabs, sciaenids, pomfrets, bombay duck, prawns, lobsters, molluscan resources etc. Methods of fishing, recent catch statistics. Fishery of mud banks. Major deep sea resources - fishes, shrimps, lobsters – status of deep sea fishing in India. Chartered fishing in India- policies and problems. Marine fish production in India. - Estimated fishery resources – inshore – offshore - deep sea resource.

Questions from section A (2 Marks) = 14                      Questions from Section B (5 Marks) = 8  
 Questions from Section C (10 Marks) = 3

**Module 5 : Population Dynamics**

(9 Hrs.)

Stratified random sampling for estimation of fish landing. Concept of stock, recruitment, growth rate and mortality rate. Over fishing - maximum sustainable yield and maximum net economic yield. Conservation and regulation of fishing pressure - closed season, mesh size regulations, sanctuaries. Important fishing regulations.

Questions from section A (2 Marks) = 12

Questions from Section B (5 Marks) = 8

Questions from Section C (10 Marks) = 2

**Module 6: Fisheries Administration**

( 9Hrs )

Different organizations and institutes involved in fisheries and aquaculture research and development – FAO, ICLARM, INFOFISH, BOBP. Institutes under ICAR, CSIR and Ministry of Agriculture and Commerce. Aquaculture Authority of India and National Fisheries Development Board. State organizations- Matsyafed, BFFDA, ADAK, FIRMA and State and Central Fisheries Department. Indian Fisheries ACT and other Acts enacted by the Kerala Govt.

Questions from section A (2 Marks) = 20

Questions from Section B (5 Marks) = 12

Questions from Section C (10 Marks) = 3

**Internal evaluation****Assignments**

1. Prepare an assignment on status of marine capture fisheries in India
2. Trends in exploitation of selected marine and inland fishes
3. Current status and future prospects of development of deep sea fishery in India
4. FAO code of conduct of responsible fisheries – an overview

**Projects**

1. Survey in marine fish landing centres
2. Survey in riverine or reservoir fish landing centres
3. Status of exploited fishery in selected backwaters/ estuaries/ rivers
4. Enumeration of fishing vessels and gears operated in inland and marine sectors

**Seminar Topics**

1. Development of suitable management measures to ameliorate problems in riverine fishery
2. Trends in fishery exploitation in selected maritime states
3. Various fishing regulations in India
4. By-catch reduction, importance, development of devices



## **Suggested reading**

### **Core reading**

1. Bal,D.V. and Rao,K.V. Marine Fisheries
2. Samuel,C.T. Marine Fisheries in India.
3. Kurien,C.V. and Sebastian,V.O. Prawns and Prawn Fisheries of India.
4. Talwar.P.K. and Kacker,R.K. Commercial Sea Fishes of India.
5. CMFRI Bulletin No.36 Tuna Fisheries of the Exclusive Economic Zone of India.
6. Jhingran,V.G. Fish and Fisheries of India.
7. Saigal,K.L. and Jhingran.V.G. Cold Water Fisheries of India.
8. CMFRI. Bulletin No.42 Shell Fish Resources and Farming.
9. CMFRI. Bulletin Cephalopod Resources of the EEZ of India.
10. Marine Fisheries Information Service (MFIS) CMFRI Publications, Monthly.
11. Devaraj,M. Fish Population Dynamics Course Manual.
12. Pauly,D. Some Simple Methods for the Assessment of Fish Stocks.
13. Sreekrishna, Y. and Shenoy L. (2001) Fishing Gear and Craft Technology, Indian Council of Agricultural Research, New Delhi.

### **Supplementary & Advanced Reading**

1. FAO (1997) Fisheries management. FAO Technical Guidelines for Responsible Fisheries. No. 4. Fishery Resources Division and Fishery Policy and Planning Division, FAO. Rome: 82p.
2. FAO (1995) Code of Conduct for Responsible Fisheries, FAO, Rome: 41 p.
3. FAO (1997) Inland fisheries. FAO Technical Guidelines for responsible Fisheries. No. 6 Fisheries Department, FAO, Rome: 36 p

<b>Course</b>	<b>: Core Course IV</b>
<b>Course code</b>	<b>: AQC4 B07</b>
<b>Title</b>	<b>: Brackishwater Aquaculture and Mariculture</b>
<b>Hrs/week</b>	<b>3</b>
<b>No. of Credits</b>	<b>3</b>

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**Aim:**

To provide an understanding about the operation of costal aquaculture farms and mariculture practices

**Course Outcomes:**

1. Understand the biology of the species used for costal aquaculture and mariculture.
2. Illustrate brackish water aquaculture practices
3. Discuss the methods of various mariculture practices
4. Critique the environmental impact of aquaculture.
5. Theorize shrimp culture practices.

**Course Content**

**Module 1: Introduction** ( 9 Hrs)

Introduction and present status of brackish water farming in India. Brackish water as a medium for aquaculture - ecological factors – abiotic and biotic factors. Selection of site. Traditional practices in India – paddy field prawn filtration in Kerala and Bhasabadha fisheries in West Bengal.

Questions from section A (2 Marks) = 15

Questions from Section B (5 Marks) = 5

Questions from Section C (10 Marks) = 2

**Module 2: Brackishwater Finfish Culture** ( 9 Hrs)

Selection of cultivable species in brackish water systems, their biology and culture practices – monoculture and polyculture of – *Chanos chanos*, *Mugil cephalus*, *Etroplus suratensis*, *Oreochromis mossambicus*. Culture of carnivorous fishes – *Lates calcarifer*. Nursery, rearing and grow out in ponds, cages and pens.

Questions from section A (2 Marks) = 12

Questions from Section B (5 Marks) = 6

Questions from Section C (10 Marks) = 5

**Module 3: Crustacean Culture** ( 9 Hrs)

Species of shrimps cultured in brackish water and their biology – *Penaeus mondon*, *Feneropenaeus indicus* and *Penaeus vannamei*. Systems of shrimp farming. Species of crabs cultured and their biology, crab culture techniques, prospects in India. Culture of lobsters – experimental culture and prospects in India.

Questions from section A (2 Marks) = 18

Questions from Section B (5 Marks) = 7

Questions from Section C (10 Marks) = 3

**Module 4: Mariculture**

( 9 Hrs)

Various ecological subdivisions of the sea. Different designs of open sea farming structures – construction of cages – bioengineering problems and solutions – scope of open sea farming in India. Important fin fishes cultured in the open seas.

Questions from section A (2 Marks) = 20

Questions from Section B (5 Marks) = 6

Questions from Section C (10 Marks) = 2

**Module 5: Molluscan Culture and Seaweed Culture**

( 9 Hrs)

Molluscan culture – species of edible oysters, mussels and clams cultured, culture techniques used for farming edible oysters and mussels. Important species of pearl oysters and method of artificial pearl production. Culture of seaweeds, common cultivated species, culture techniques and harvesting. Present status and recent developments in mariculture.

Questions from section A (2 Marks) = 30

Questions from Section B (5 Marks) = 12

Questions from Section C (10 Marks) = 6

**Module 6: Aquaculture and Environment**

( 9 Hrs)

Environmental impact of brackishwater and coastal aquaculture- effluent discharge, eutrophication, chemical residues including antibiotics, destruction of natural habitat including paddy field and mangroves. Salinity intrusion. Coastal zone management and CRZ. Regulation of coastal aquaculture and aquaculture authority of India. Introduction of exotics, genetic erosion of indigenous stock.

Questions from section A (2 Marks) = 30

Questions from Section B (5 Marks) = 15

Questions from Section C (10 Marks) = 4

**Internal Evaluation****Assignments**

1. Planning and designing of brackish water fish farms
2. Culture of milk fish, Chanos chanos
3. Culture of mussels in India
4. Culture prospects of lobsters in India

**Projects**

1. Economics of prawn filtration field
2. Management practices adopted in a tiger prawn farm
3. Management practices adopted in an edible oyster cultured system
4. A survey of the different feeds given in shrimp farms.

**Seminar topics**

1. Induced pearl production
2. Culture of mullets
3. Semi – intensive culture of tiger prawns
4. Selection of site for brackish water aqua farms
5. Pen culture

## **Suggested reading**

### **Core reading**

1. Pillay T.V.R - Aquaculture – Principles and practices
2. Chen, L.C. – Aquaculture in Taiwan
3. Milne P H. – Fish and Shell fish farming in coastal waters
4. Iverson E.S. – Farming the edge of the sea
5. Bandach, Rhyster V McLarney – Aquaculture
6. Jhingwa V.A – Fish and Fisheries of India
7. Kurian,C.V and Sebastian V.O. – Prawn and Prawn fisheries of India

### **Supplementary Reading**

1. Pillay TVR – Advances in Aquaculture
2. Pillay TVR – Coastal Aquaculture in the Indo-Pacific

### **Advanced Reading**

1. Heut M. – Text book of fish culture
2. Sheperd and Bromage N. – Intensive Fish Farming

**Course** : Core course V  
**Course code** : AQC5 B09  
**Title** : Hatchery Technology of Aquatic organisms.  
**Hrs/week** 3  
**No. of Credits** 4

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**Aim:** To impart a basic knowledge on the operation of commercial hatcheries.

### **Course Outcomes**

1. Understand the current methodology and various techniques of commercial seed production.
2. Appraise basic knowledge on the spawning, larval rearing and feeding of the commercially important species.
3. Catalogue and theorize seed transportation methods.
4. List and explain the facilities for commercial hatcheries.

### **Course Content**

#### **Module 1: Carp Hatcheries** (9 Hrs )

Hatchery management-seed production of carps. Hypophysation of Indian major carps and exotic carps, history of hypophysation. Pituitary gland. Collection and preservation of gland. Other ovulating agents. Brood stock management, sexing, dosage for injection, mechanism of ovulation. Development of carp eggs, different carp hatcheries. Nursery rearing of carp seed.

Questions from section A (2 Marks) = 16      Questions from Section B (5 Marks) = 10  
Questions from Section C (10 Marks) = 4

#### **Module 2: Carp Production System** (9 Hrs )

Production of common carp seeds, breeding techniques, Sundanese, Tjimindi, Rantjapaku and Central Sumatra methods. Methods followed in China and India. Transport of fish seed and broodfishes. Causes of mortality during transport, techniques of transport, open and closed systems, methods of transportation, use of anaesthetics. Bundh breeding- types, techniques and problems.

Questions from section A (2 Marks) = 20      Questions from Section B (5 Marks) = 10  
Questions from Section C (10 Marks) = 3

#### **Module 3: Seed Production of other Fishes** (9 Hrs )

Seed production and nursery rearing of trout, air-breathing fishes, mullets, tilapia, pearl spot, sea bass, and groupers.

Questions from section A (2 Marks) = 20      Questions from Section B (5 Marks) = 8  
Questions from Section C (10 Marks) = 8

#### **Module 4: Seed Production of Crustaceans and Molluscs** (9 Hrs )

Seed production and nursery rearing of Penaeids and *Macrobrachium*. Different systems followed. Various components, general facilities and equipments needed. Hatchery operations of oysters, clams, crabs, lobster. Preparation of artificial sea water.

Questions from section A (2 Marks) = 30      Questions from Section B (5 Marks) = 10  
Questions from Section C (10 Marks) = 10

**Module 5: Live Feeds for Larvae**

(9 Hrs)

Culture of fish food organisms. Major phytoplankton groups- microalgal culture, laboratory methods- isolation, media preparation, kinds of culture- pure, crude, mass culture. Mass culture of *Chaetoceros*. *Artemia* – different strains, hatching, decapsulation, Production of *Artemia* cyst.

Questions from section A (2 Marks) = 25

Questions from Section B (5 Marks) = 8

Questions from Section C (10 Marks) = 4

**Module 6: Hatchery Management**

(9 Hrs.)

Components and general design of hatcheries. Selection criteria for broodstock and brood stock management. Water quality monitoring and management. Quarantine and disease management in hatcheries. Quality assessment of seeds.

Questions from section A (2 Marks) = 20

Questions from Section B (5 Marks) = 8

Questions from Section C (10 Marks) = 4

**Internal Assessment****Assignments**

1. Site selection and facilities required for a shrimp hatchery.
2. Traditional methods in fish seed production.
3. Inducing agents in fish breeding.
4. Prospects of live feed culture in India.

**Projects**

1. Evaluation of live feed potential of a common zooplankton.
2. Hatchery production in a nearby hatchery-methods and production.
3. Collection and identification of larval forms of penaeid and non penaeid prawns.
4. Survey of different feeds used in different hatcheries.

**Seminar topics**

- 1 Brood stock collection, maintenance and seed production of *Macrobrachium*.
- 2 Natural seed resources of finfish and shellfish.
- 3 Methods of packing and transportation.
- 4 Nursery rearing of finfish and shell fish.
- 5 Chemicals used in live fish transportation.

**Suggested Reading****Core reading**

1. Chodar SL Hypophysation in Indian Major Carps
2. CMFRI Spl. Bul. Hatchery Operation of Penaeid Shrimps
3. Venkataraman GS The Cultivation of Algae
4. MPEDA Sea Fishes
5. CMFRI sp Bul Artificial Reefs and Sea Farming Techniques

## Supplementary Reading

- |                |                                     |
|----------------|-------------------------------------|
| 1. Jhingran VG | Fish and Fisheries of India         |
| 2. Raymond EG  | Plankton and Productivity of Oceans |
| 3. Boney AD    | Phytoplankton                       |

## Advanced Reading

1. Pillay, TVR and Kutty MN Principles and Practices of Aquaculture
2. Harvey BJ and Hoar WS Principle and Practice of Induced Fish Breeding
3. Woyanarovich E and Horrath L The Artificial Propagation of Warm Water Fishes- Manual for Extension.

**Note:** Field visit to observe the hatchery operation shall be made along with the theory classes in order to get a solid idea about the hatchery operation of different aquatic organisms.

**Course : Core Course VI**

**Course code : AQC5 B10**

**Title : Fish Processing Technology and Quality Control**

**Hrs/week 3**

**No. of Credits 4**

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**Aim:**

To provide a basic idea about the post harvest technology of fishery products

**Course Outcomes:**

1. Understand post harvest handling methods.
2. List and explain various methods involved in post harvest technology.
3. Explain storage and marketing of fishery products.

**Course Content**

**Module 1: Introduction**

(9 Hrs)

Principles of fish preservation. Importance of hygiene and sanitation in fish handling. Quality of water and ice in fish handling and processing. Common equipments and utensils used in the processing plant. Preparation of ice. Different types of ice used in the seafood industry and their merits. Preservation by refrigerated seawater and chilled sea water.

Questions from section A (2 Marks) = 20

Questions from Section B (5 Marks) = 10

Questions from Section C (10 Marks) =5

**Module 2: Freezing and Canning**

(9 Hrs)

Fundamental principles involved in chilling and freezing of fish and fishery products. Various freezing methods. Freezing of shrimps and fishes. Preparation of fish fillets. Changes during the cold storage of fish and fishery products. Principles involved in canning of fish. Different stages of canning of Tuna. Retortable pouch processing. Constant pressure autoclave, F- value. Spoilage of canned products. Cut open test and commercial sterility.

Questions from section A (2 Marks) = 25

Questions from Section B (5 Marks) = 10

Questions from Section C (10 Marks) = 5

**Module 3: Drying, Smoking and Freeze-drying**

(9 Hrs)

Principles of smoking, drying and salting of fish, factors affecting drying. Traditional drying/ curing methods. Different types of drying. Drying of fish and prawns. Packing and storage of dried products. Spoilage of dried products. Preventive measures. Standards for dry fish products. Cold smoking. Principles of freeze drying. Accelerated freeze drying and packing of freeze dried products. Modern methods of preservation by irradiation and modified atmospheric storage.

Questions from section A (2 Marks) = 30

Questions from Section B (5 Marks) = 20

Questions from Section C (10 Marks) = 5

**Module 4: Quality Control & Assurance**

(9 Hrs)

Different types of spoilage in fishery products – chemical, physical and biological spoilage. Quality control – basic concepts, Salient features of sea food quality. Risk factors in sea food- biotoxins, physical, chemical and biological hazards. HACCP, SSOP, GMP.



Methods of evaluating fish freshness and quality – organoleptic, sensory, physical, chemical, microbiological and instrumental methods. Sampling systems followed in processing plants for testing the quality.

Questions from section A (2 Marks) = 30

Questions from Section B (5 Marks) = 14

Questions from Section C (10 Marks) = 6

### **Module 5: Value Addition and By-Products**

(9 Hrs.)

Value addition in sea food. Advantages of value addition. Fish mince and Surimi. Analog and fabricated products. Preparation of coated fishery products. Battered and breaded products. Preparation of products viz. fish/prawn pickle, fish wafers, fish soup powder, fish protein hydrolysate, fish stacks, fillets, marinated products.

Fish meal, fish protein concentrate, shark fin rays, fish maws, isinglass, fish liver oil, fish body oil, fish hydrolysates, chitin, chitosan, glucosamine hydrochloride, squalene, pearl essence, ambergris, gelatin, beche-de-mer, fish silage, fish ensilage and seaweed products.

Questions from section A (2 Marks) = 40

Questions from Section B (5 Marks) = 8

Questions from Section C (10 Marks) = 6

### **Module 6: Packing and Cold Storage**

(9 Hrs)

Functions of packing. Different types of packing materials and its quality evaluation. Packing requirements for frozen and cured products. Statutory requirements for packing. Labeling requirements. Different types of cold storages. Requirements in retail outlet. Insulated and refrigerated vehicles. Distribution of frozen products by cold chain.

Questions from section A (2 Marks) = 25

Questions from Section B (5 Marks) = 10

Questions from Section C (10 Marks) = 4

## **Internal Evaluation**

### **Assignments:**

1. Problem facing in the canning industry.
2. smoking is not considered as a best method of preservation.
3. Accelerated freeze dried products
4. Drying of fish.

### **Projects**

1. Canning of fresh waterfish
2. Various products from sea weed
3. Preparation of shrimp flavour for fresh water prawn

### **Seminar topics**

1. Present status of fish processing in India
2. Popularisation of canned products
3. Problem in the preparation of Accelerated freeze dried products

## **Suggested reading**

### **Core reading**

1. K.Gopakumar, Fish Processing Technology, ICAR, New Delhi
2. T.K. Govindan, Fish Processing Technology Oxfor& IBH Publication Co.
3. K.K. Balachandran Fish Canning – Principles & Practices.
4. Borgstrom, G. Fish as Food.
5. K.K. Balachandran, Postharvest Technology in Fish and Fishery Products.
6. Moorjani, M.V. Fish Processing in India.
7. Connell, J.J. Advances in Fishery science and Technology.
8. CIFT. Manual of Quality Control in Fish and Fishery Products.
9. Gopakumar, K. Fish Packaging Technology

### **Supplementary Reading :**

1. A.M.Martin, Fisheries – Processing Chapman & Hall, Madras
2. Ed.G.M.Hall – Fish Processing Technology Chopra & Hall. Madras.

### **Advanced Reading**

- 1) Wheatson, F.W. and Lawson, T.B. Processing Aquatic Food Products

<b>Course</b>	<b>: Core Course VII</b>
<b>Course code</b>	<b>: AQC5 B11</b>
<b>Title :</b>	<b>Fishing Methods</b>
<b>Hrs/week</b>	<b>3</b>
<b>No. of Credits</b>	<b>3</b>

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**Aim:**

To get an understanding on capture of fishes, major fishery byproducts and production of value added commodities.

**Course Outcomes:**

1. Illustrate and explain various fishing crafts
2. Understand operation of various fishing gears
3. Demonstrate fish finding devices.

**Course Content**

**Module 1: Introduction**

Introduction, principle and evolution of fishing methods and gear. Introduction to Marine environment. Responsible fisheries, CCRF, Safety at sea.

Questions from section A (2 Marks) = 8

Questions from Section B (5 Marks) = 3

Questions from Section C (10 Marks) = 1

**Module 2: Fishing Crafts**

(6 Hrs.)

Different types of fishing crafts in India- inland and marine– traditional, motorized and mechanized. Recent statistics of each category- country crafts, trawlers, gill netters, purse seiners, long liners, trollers, deep sea vessels.

Questions from section A (2 Marks) = 20

Questions from Section B (5 Marks) =8

Questions from Section C (10 Marks) = 2

**Module 3: Fishing Gears**

(6 Hrs.)

Classification and description of modern fishing gears.- Active Gears - Design and operation of – trawls, purse seines, ring seines, beach / shore seine, boat seine, pole and line, squid jigs, trolling. Passive Gears - Design and operation of- gill nets, long lines, hooks, traps, stake net, dol net, chinese dip nets, cast nets. Destructive fishing methods like electrical fishing, poisoning and use of dynamits. Prohibited fishing practices. Factors affecting the design of fishing gears and fish catching methods.

Questions from section A (2 Marks) = 35

Questions from Section B (5 Marks) = 10

Questions from Section C (10 Marks) =4

#### **Module 4 : Fishing Craft and Gear materials**

Fishing craft materials – traditional and modern. Introduction to boat building materials - wood, steel, FRP, ferro-cement, aluminum etc. Introduction to netting materials - natural and synthetic fishing gear materials. Yarn numbering systems. Fishing accessories.

Questions from section A (2 Marks) = 18      Questions from Section B (5 Marks) = 8  
Questions from Section C (10 Marks) = 2

#### **Module 5: Fish Aggregating Devices and Artificial Reefs. (6 Hrs.)**

Fish aggregating devices and artificial reefs. Light fishing and Lantern fishing. Impact of artificial reefs and on fish stock.

Questions from section A (2 Marks) = 15      Questions from Section B (5 Marks) = 4  
Questions from Section C (10 Marks) = 2

#### **Module 6: Fish Finding Devices and Conservation. (6 Hrs.)**

Introductory information on echo-sounder, sonar, net sondae, global position systems, remote sensing, potential fishing zones. Code of conduct of responsible fishing- Turtle Exclusion Devices (TED)- By-catch Reduction Devices (BRD).

Questions from section A (2 Marks) = 25      Questions from Section B (5 Marks) = 8  
Questions from Section C (10 Marks) = 3

#### **Internal evaluation**

#### **Assignments**

1. Prepare an assignment on status of marine capture fisheries in India
2. FAO code of conduct of responsible fisheries – an overview
3. Trawl ban in Kerala
4. Purse Seining in Kerala
5. Preparation of Shark Fin Ray

#### **Projects**

1. Survey in of different fishing gears used in Cochin Fishing Harbour
2. Survey in riverine or reservoir fish landing centres
3. Status of different gears used in selected backwaters/ estuaries/ rivers
4. Enumeration of fishing vessels and gears operated in inland and marine sectors
5. Preparation of Chitin

#### **Seminar Topics**

1. Development of suitable management measures to ameliorate problems in Marine Fisheries.
2. Trends in fishery exploitation in selected maritime states
3. Various fishing regulations in India
4. By-catch reduction, importance, development of devices
5. Surumi as a value added product.

## **Suggested reading**

### **Core reading**

1. Boopendranath, M.R., Meenakumari, B., Joseph, J., Sankar, T.V., Pravin,P., and Edwin, L. (Eds.)2002 Riverine and Reservoir Fisheries of India, Society of Fisheries Technologists (India), Cochin.
2. Brandt. A. v. (1984) Fish catching methods of the world. Fishing News Books Ltd., London: 432 p.
3. George V.C. (1971) An account of the inland fishing gears and methods of India. Spl. Bull.No.1.CIFT
4. Hameed, M.S. and Boopendranath, M.R. (2000) Modern Fishing Gear Technology, Daya Publishing House, Delhi:186 p.
5. Klust, G. (1982) Netting materials for fishing gear, FAO Fishing Manual, Fishing News Books (Ltd).,Farnham, 192p.
6. Sainsbury, J.C. (1986) Commercial fishing methods- An introduction to vessels and gear. Fishing News Books, Oxford: 208pp
7. Sreekrishna, Y. and Shenoy L. (2001) Fishing gear and craft technology, Indian Council of Agricultural Research, New Delhi.

### **Supplementary & advanced reading**

1. Gulland, J.A.1974, Guidelines for Fishery Management, IOFC Dev. 74-36 FAO Rome
2. FAO (1997) Fisheries management. FAO Technical Guidelines for Responsible Fisheries. No. 4. Fishery Resources Division and Fishery Policy and Planning Division, FAO. Rome: 82p.
3. FAO (1995) Code of Conduct for Responsible Fisheries, FAO, Rome: 41 p.
4. FAO (1997) Inland fisheries. FAO Technical Guidelines for Responsible Fisheries. No. 6 Fisheries Department, FAO, Rome: 36 p.
5. Kreuzer,R. Fishery Products.
6. Borgstrom,G .Fish as Food

### **Advanced Reading**

- 1) Suzuki,T. Fish and Krill Protein: Processing Technology

<b>Course</b>	<b>: Core Course VIII</b>
<b>Course Code</b>	<b>: AQC5 B12</b>
<b>Title</b>	<b>: Breeding and Rearing of Aquarium Fishes</b>
<b>Hrs/week</b>	<b>3</b>
<b>No. of Credits</b>	<b>3</b>

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**Aim:**

To impart basic understanding for operating an ornamental fish farm and to obtain knowledge on seed production of aquarium fishes.

**Course Outcomes:**

1. Explain potential ornamental fishes and their breeding habits
2. Understand the various management practices for breeding and rearing of ornamental fishes
3. Study aquarium setting and aquarium accessories involved.
4. List and explain the significance of nutrition.
5. List and explain aquarium fish diseases.

**Course Content:**

**Module 1: Introduction** (6 Hrs)  
 Introduction to aquarium, ornamental fishes and aquarium accessories. World aquarium trade and present status. Types of aquaria. Oceanarium. Design and construction of a beginner's aquarium. Water quality requirements and management.  
 Questions from section A (2 Marks) = 15      Questions from Section B (5 Marks) = 8  
 Questions from Section C (10 Marks) = 4

**Module 2: Aquarium Management** (6 Hrs)  
 Setting up of aquarium – under gravel filter, pebbles, plants, drift wood, ornamental objects and selection of fishes. Cleaning the aquarium; maintenance of water quality. Control of snail and algal growth. Handling, care and transportation of fish. Temperature acclimation, oxygen packing.  
 Questions from section A (2 Marks) = 25      Questions from Section B (5 Marks) = 10  
 Questions from Section C (10 Marks) = 3

**Module 3: Freshwater Ornamental Fishes** (6 Hrs)  
 Species of ornamental fishes; their taxonomy and biology- Live bearers, Gold fish and koi, Gourami, Barbs and Tetras, angel fish, cichlids. Maturation, secondary sexual characters, breeding habits, spawning, parental care. Larval rearing. Important freshwater plants – their taxonomy and morphology, multiplication of aquarium plants – different methods.  
 Questions from section A (2 Marks) = 35      Questions from Section B (5 Marks) = 12  
 Questions from Section C (10 Marks) = 8

**Module 4: Commercial Production of Freshwater Ornamental Fishes** (6 Hrs)  
 Commercial production of goldfish, live bearers, gouramies, barbs and tetras, angel fish. Mass production of aquarium plants. Indigenous ornamental fishes of Kerala (major

species, distribution, significance and threats). Seed production of Miss Kerala.  
Questions from section A (2 Marks) = 22                      Questions from Section B (5 Marks) = 10  
Questions from Section C (10 Marks) = 7

### **Module 5: Marine Ornamental Fishes**

(6 Hrs)

Marine ornamental fishes – Major marine ornamental fish resources of India. Breeding of marine ornamental fishes. Setting of marine aquarium. Reef aquarium and live rocks. Other ornamental organisms – anemones, worms, lobsters, shrimps, octopus, starfish.  
Questions from section A (2 Marks) = 25                      Questions from Section B (5 Marks) = 10  
Questions from Section C (10 Marks) = 5

### **Module 6: Nutrition and Disease**

(6 Hrs)

Nutritional requirements of aquarium fishes. Different kinds of feeds. Culture of fish food organisms; Feeding methods. Use of pigments for colour enhancement. Identification of common parasites infecting ornamental fishes. Study of bacterial, viral, fungal diseases of ornamental fishes and their control and prophylaxis (brief account only).

Questions from section A (2 Marks) = 35                      Questions from Section B (5 Marks) = 12  
Questions from Section C (10 Marks) = 5

## **Internal Evaluation**

### **Assignments**

1. Common Marine Aquarium fishes, their collection.
2. Fish transportation methods.

### **Projects**

1. Try locally available materials as nutrient source for line feed culture (like naive of cow, cow dung, vermin wash etc.)
2. Collect and identify locally available aquatic organisms that can be used line feed.
3. Construct filters/aerators using locally available materials (bottle, PVC Pipe).
4. Try breeding of ornamental fishes..

### **Seminar topics**

1. Problems in maintenance of home aquaria.
2. Preparation of different types of feeds for aquarium fishes
3. Rules and regulations in the collection and export of ornamental fishes

## **Suggested reading**

### **Core reading**

1. Biswas. S.P., J.N.Das, U.K.Sarkar and Lakra W.S. 2007 Ornamental fishes of North East India : An Atlas : NBFGR
2. Marine Aquarium keeping : The Sciences, Animals and Art. John Wiley & Sons, New York
3. Ramachandran.A, Breeding, Farming and Management of Fishes, CUSAT
4. Madhusoodanakurup etal – Ornamental Fish - Breeding, Farming and Trade CUSAT.
5. Jhingran,V.G. Fish and Fisheries of India.
6. Bijukumar,A. Rearing of Aquarium Fishes.

- 7 Rath,A.K. Freshwater Aquaculture,
- 8 Santhanam, et.al. a Manual of Freshwater Aquaculture

**Supplementary Reading :**

1. Murthi.V.S. 2002 Marine ornamental Fishes of Lakshadweep CMFRI, Special publication 72

**Advanced Reading**

1. Butting.B., Holthus, P.S. Dalding,S. 2003, Marine Aquarium Industry and conservation.
2. Oliver, K 2003. World trade in ornamental species
3. Marine Ornamental species; collection and preservation.
4. Fish Disease and Disorders, CAB international, Oxford.



<b>Course</b>	<b>: Core Course IX</b>
<b>Course Code</b>	<b>: AQC5 B13</b>
<b>Title</b>	<b>: Aquaculture Engineering and Biostatistics</b>
<b>Hrs/week</b>	<b>2</b>
<b>No. of Credits</b>	<b>2</b>

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**Aim:** To inculcate engineering and statistical knowledge as applied to aquaculture industry in students

**Course Outcomes:**

1. Familiarize with engineering aspects of aquafarms and hatcheries.
2. Generate knowledge on statistics as applied to biology.
3. Depict/design farm and hatchery layouts.

**Course Content:**

**Module 1: Farm Engineering.** (6 Hrs)

Criteria for the selection of site for aquaculture – freshwater, brackishwater and marine aquaculture. Surveying – chain survey, plane table survey, leveling. Calculation of earthwork for the construction of ponds. Types of soil, soil sampling methods, prevention of erosion.

Questions from section A (2 Marks) = 15    Questions from Section B (5 Marks) = 10

Questions from Section C (10 Marks) = 5

**Module 2: Farm Design and Equipment** (6 Hrs)

Design of freshwater and brackishwater farms. Project formulation and layout. Different components of aquafarms – peripheral dikes, secondary dikes, feeder canals, sluice gate and monks. Various farm equipment. Role of aeration in culture ponds. Paddle wheel aerators aspirators, compressors and blowers. Pumps in aquaculture, different type of pumps.

Questions from section A (2 Marks) = 20    Questions from Section B (5 Marks) = 8

Questions from Section C (10 Marks) = 4

**Module 3: Hatchery facilities** (6 Hrs)

Components and design of shrimp hatcheries – various components and infrastructure facilities required. Various hatchery equipment including aeration devices and pumps. Mechanical and biological filters.

Questions from section A (2 Marks) = 20    Questions from Section B (5 Marks) = 5

Questions from Section C (10 Marks) = 34

**Module 4: Basic Statistics** (6Hrs)

Methods of data collection. Sampling methods. Frequency distribution, tabulation and diagrammatic representation of data.

Questions from section A (2 Marks) = 12    Questions from Section B (5 Marks) = 8

Questions from Section C (10 Marks) = 2

## **Module 5: Measures of Central Tendency**

(4 Hrs)

Arithmetic mean, median, mode, geometric mean and harmonic mean. Range, mean deviation, standard deviation and coefficient of deviation- calculation and its application. Skewness and kurtosis. regression and correlation.

Questions from section A (2 Marks) = 18      Questions from Section B (5 Marks) =7  
Questions from Section C (10 Marks) = 3

## **Module 6: Tests of significance**

(6 Hrs)

Application of probability. Permutation and combination. Distribution- normal, binomial and poisson. Testing hypothesis, null hypothesis and level of significance. Chi-square test. . Analysis of variance.

Questions from section A (2 Marks) = 15      Questions from Section B (5 Marks) = 5  
Questions from Section C (10 Marks) = 2

## **Internal Evaluation**

### **Assignments**

1. Sampling methods in fisheries.
2. Diagrammatic representation of the fisheries and aquaculture production data.
3. Study of designing of commercial farms and hatcheries.

### **Projects**

1. Morphometric measurements of fishes and correlation of body measurements
2. Length-weight analysis of common fishes and prawns
3. Estimation of landing of fishes and she fishes from nearby fish landing centre.
4. Visit to nearby farms/hatcheries and preparation of comparative reports on their design and working.
5. Earthwork calculation and soil sample analysis.

### **Seminar topics**

1. Equipments required in farms and hatcheries.
2. Tests of significance and their application in aquaculture/fisheries.
3. Engineering aspects of site selection for hatcheries and coastal farms.
4. Development of secondary data from primary data.

### **Suggested readings Core reading**

1. Gupta,S.C. and Kapoor,V.K: . Fundamentals of Applied Statistics.
2. Snedecor and Cochran,W.G. : Statistical Methods.

### **Supplementary Reading**

1. Bose et. al: Coastal Aquaculture Engineering.
2. Wheaton F W : Aquaculture Engineering

**Course : Core Course X**

**Course Code : AQC6 B17**

**Title : Fish Genetics, Biotechnology, and Bioinformatics**

**Hrs/week 3**

**No. of Credits 4**

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**Aim:**

To provide basic idea of fish heredity and genetics, recent advances in biotechnology and bioinformatics relevant to aquaculture

**Course Outcomes:**

1. State the principles of genetics and depict the hereditary mechanism in cultured species
2. Understand the state of the art techniques in biotechnology as applied to aquaculture industry.
3. List the biological databases.
4. Summarize the application of genetics, biotechnology, molecular biology and bioinformatics in aquaculture.

**Course Content**

**Module 1: Fundamentals of cell Biology (9Hrs)**

Structure of cell: prokaryotic and eukaryotic cell. Subcellular organelles and Nucleus, chromosomes, mitochondria, chloroplast, ribosomes, endoplasmic reticulum, golgi complex, lysosomes, microfilaments, microtubules and intermediate filaments, glyoxysomes and peroxysomes (Brief description only). Cell division – Mitosis and meiosis.

Questions from section A (2 Marks) = 40      Questions from Section B (5 Marks) = 14

Questions from Section C (10 Marks) = 4

**Module 2: Basic Genetics (9 Hrs)**

Introduction- Genetics, Mendel's law of inheritance. Gene interactions. Chromosome structure and types. Dominance relationships -complete, incomplete and co-dominance, multiple alleles, linkage. Chromosomal aberrations: Monosomy, trisomy. Mutations and mutagens. Translocations, inversions, duplications, deletions.

Questions from section A (2 Marks) = 30      Questions from Section B (5 Marks) = 8

Questions from Section C (10 Marks) = 4

**Module 3: Selection and Hybridisation (9 Hrs)**

Genetic selection- types of selection and significance. Principles of breeding- selective hybridisation, intra-specific and inter-specific hybridisation. Hybrid vigor, and inbreeding depression. Practical application of genetics in aquaculture. Sex determination in fishes.

Questions from section A (2 Marks) = 26      Questions from Section B (5 Marks) = 12

Questions from Section C (10 Marks) = 3

**Module 4: Aquaculture Biotechnology**

(9 Hrs)

Recombinant DNA technology, determinants of DNA replication, cloning, vectors, transformation, DNA hybridisation. Tissue culture. PCR. Use of PCR for the detection of white spot syndrome in shrimp. Biotechnological tools for aquaculture, gene manipulation in fish, transgenic fish production. Chromosome manipulation in fish and shell fishes- triploidy, polyploidy, gynogenesis, androgenesis. Monosex production, super male and super female fish production techniques. Synthetic hormone production for induced breeding. Cryopreservation.

Questions from section A (2 Marks) = 40

Questions from Section B (5 Marks) = 24

Questions from Section C (10 Marks) = 6

**Module 5: Marine Biotechnology**

(9 Hrs)

Scope of marine biotechnology, general application of molecular biological techniques to the marine sciences. Marine toxins. Industrial chemicals and pharmaceuticals from marine sources. Tissue culture in sea weed and pearl production.

Questions from section A (2 Marks) = 20

Questions from Section B (5 Marks) = 12

Questions from Section C (10 Marks) = 3

**Module 6: Bioinformatics**

(9 Hrs)

Scope and relevance. Types of Biological data bases – (Nucleotide, protein, organismal and biodiversity databases) – examples and uses of each category of data bases. Genomics and Proteomics (Definition and scope only). Fisheries databases and websites: FISHBASE, NACA, ICLARM, FAO.

Questions from section A (2 Marks) = 24

Questions from Section B (5 Marks) = 8

Questions from Section C (10 Marks) = 2

**Internal Evaluation****Assignments**

1. Transgenic fishes for aquaculture
2. Vaccination in aquaculture
3. Sex reversal in Tilapia
4. Tissue culture production of pearl
5. Sampling methods in fisheries
6. Diagrammatic representation of the fisheries and aquaculture production data
7. Data mining in fisheries.
8. Genome sequence of fishes using bioinformatic tools.

**Projects**

- 1 Current trends in drug recovery from marine environment.
- 2 A collection of reports of biotechnological research in India
- 3 Preparation of a list of marine bioactive compounds
- 4 Genome sequencing of fishes/other aquatic organisms using bioinformatics tools.

## **Seminar topics**

- 1 Application of biotechnology in mariculture
- 2 Monosex production in tilapia
- 3 Sex reversal in species for aquaculture.
- 4 fish hybridisation in India
- 5 Bioinformatics as applied to Indian Fish germplasm

## **Suggested readings**

### **Core reading**

1. Karinasagar I, Karunasagar I and Reily A. Aquaculture Biotechnology
2. Varun Mehta. Fisheries and Aquaculture biotechnology
3. Pandian TD, Kumar A and Prasad K. Aquaculture and Biotechnology
4. Lopes L.- Gene transfer in aquatic organisms
5. Singleton – Elementary Genetics
6. Gjedrem T- Genetics in aquaculture
7. Jin Xiong 2006: Essential bioinformatics, Cambridge University Press, Replika Press Pvt. Ltd.
8. Attwood DJ and Arry Smith Introduction to Bioinformatics; Pearson education
9. David W. Mount (2004) Bioinformatics – sequence and Genome analysis; TBS Publishers and Distributers.
10. Genes : Benjamin Lewin, Pearson education Inc. upper Siddle River NJ. ISBN 0-13- 123826-4
11. Molecular Biology of gene: Watson Hopkins, Benjamin Cummings
12. Cell and Molecular biology: Gerald Karp, John Wiley & Son Inc. New York ISBN 0-471-38913-7
13. Lehninger's principles of Biochemistry -: D. L. Nelson and M. M. Cox , Worth Publishers, 41 Madisons Avenue New York, USA ISBN 0-333-94657-X

### **Supplementary Reading**

1. Sandhya Mitra- Genteics
2. Varma and Agarwal- Genetics
3. Rath RK- Freshwater Aquaculture
4. Ignacimuthu S(2005) Basic Bioinformatics; Narosa Publishing House.
5. Teresa K. Attwood, David J., Parsy- Smith and Samiron Phukan, 2009. Introiduction to Bioinformatics, Pearson Education Inc.

### **Advance Reading**

1. NBFGR- Training manual for DNA finger printing
2. Gupta PK- Elements of Biotechnology
3. Padhi BR – Genetics and Aquaculture
4. Dov Stekel (2005) Microrray Bioinformatics; Cambridge university press.
5. Dan E Krane and Michael L Rayner 2010: Fundamental Concepts of Bioinformatics. Pearson Education Inc.

**Course** : **Core Course XI**  
**Course Code** : **AQC6 B18**  
**Title** : **Fish Pathology, and Health Management**  
**Hrs/week** : **3**  
**No. of Credits** : **3**

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**Aim:**

To equip the students for the health management in aquaculture farms and to provide a basic understanding of various types of diseases encountered in aquaculture and also to provide understanding on the principles of aquaculture engineering.

**Course Outcome:**

1. Understand the various types of diseases among the cultivable fishes, to learn and apply methods of control and precaution of diseases.
2. Study the tools for diagnosis, and disease management strategies available today.
3. Explain the role of environment as an important player in infectious diseases.

**Course Content**

**Module 1: Protozoan Diseases** (3 Hrs)

Introduction to fish diseases – pathology and parasitology – Definition and categories of diseases – Disease and environment. Protozoan diseases (finfish) – Ichthyophthiriasis, Costiasis, whirling diseases, trypanosomiasis. Shrimp diseases – Microsporidiosis, Gregaria disease, ecto-comensal protozoan.

Questions from section A (2 Marks) = 25 Questions from Section B (5 Marks) = 10

Questions from Section C (10 Marks) = 4

**Module 2. Bacterial Diseases** (3 Hrs)

Bacterial disease (finfish) – furunculosis, columnaris, bacterial gill disease, gill rot, Entero redmouts, Edwardsiellosis, vibriosis, tail and fin rot, EUS. Shrimp disease – brown spot, black gill, filamentous bacterial disease, luminous vibriosis.

Questions from section A (2 Marks) = 30 Questions from Section B (5 Marks) = 10

Questions from Section C (10 Marks) = 2

**Module 4: Fungal and Viral Diseases** (6 Hrs)

Fungal diseases (finfish) – Saprolegniosis, Brachiomyxosis, Ichthyophthiriasis, Lagenidium diseases – Fusarium disease. Viral diseases (finfish) – IPN, IHN, Viral Hemorrhagic Septicemia, Spring Viremia of carps, CCVD, Carp lymphocystis – Major shrimp viral diseases – *Baculovirus penaeii*, Monodon Baculovirus, Baculoviral midgut necrosis, IHHNV, Hepatopancreatic parvo like virus, Yellow head baculovirus, white spot baculovirus.

Questions from section A (2 Marks) = 40 Questions from Section B (5 Marks) = 15

Questions from Section C (10 Marks) = 5

**Module 5: Nutritional deficiency and Immunology** (6 Hrs)

Nutritional pathology – lipid liver degeneration, deficiency diseases due to vitamin A, D, E, K, B-Complex, C, pantothenic acid, folic acid, biotin, choline, minerals. Aflatoxin and dinoflagellates. Antibiotic and chemotherapeutic agents. Nutritional cataract. Genetically and environmentally induced diseases. Immunology, defence mechanism in fish and shell fish, Application and development of vaccines, Diagnostic tools – microscopy, immune

detection DNA/RNA techniques.

Questions from section A (2 Marks) = 30      Questions from Section B (5 Marks) = 15

Questions from Section C (10 Marks) = 4

### **Module 6: Health Management**

(6 Hrs)

General preventive methods and prophylaxis against the occurrence of diseases. Good pond management practices- Eco-friendly and sustainable aquaculture. Quarantine. Methods of pathological examination of fish and infectious diseases. Production of disease-free seeds. Evaluation criteria of healthy seeds. Good Feed management for healthy organisms. Zero water exchange. Probiotics in health management.

Questions from section A (2 Marks) = 40      Questions from Section B (5 Marks) = 12

Questions from Section C (10 Marks) = 4

### **Internal Evaluation**

#### **Assignments**

1. Bacterial diseases in shrimps
2. Diseases of cultural carps
3. Methods of vaccines and vaccination

#### **Projects**

1. Collection of protozoan parasites of fish
2. Collection of different diseased fishes from farm
3. Collection and identification of carped parasites
4. Collection and identification of digenetic parasites

#### **Seminar topics**

1. EUS in Kerala
2. Internal defence mechanism
3. Organs associated with immunity in fishes
4. Immune mechanism in crustaceans

### **Suggested reading**

#### **Core reading**

1. R. Ramachandran Nair Encyclopedia of fish disease –
2. K.P. Biswas Prevention and control of fish and Prawn diseases –
3. B.K. Mishra, P. Swain, P.K.Sahoo, B.K.Das, N.Sarangi. Disease management in FW Pisciculture –
4. Wheaton, F.W. Aquacultural Engineering
5. Bose et al. Coastal Aquacultural Engineering

#### **Supplementary Reading**

1. Sinderman C.J. Principle diseases of Marine fish and shell fish
2. Schaperclaus Fish Disease.

#### **Advanced Reading**

1. Roberts R.J. Fish Pathology..
2. Post, G. Text Book of Fish Health.

<b>Course</b>	<b>: Core Course XII</b>
<b>Course code</b>	<b>: AQC6 B19</b>
<b>Title</b>	<b>: Fishery Microbiology.</b>
<b>Hrs/week</b>	<b>3</b>
<b>No. of Credits</b>	<b>2</b>

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**Aim:**

To develop basic understanding about microbiology with special reference to culture environment so as to better manage the culture ponds and the products.

**Course Outcomes:**

1. Study the various microorganisms
2. Understand the microbiology of culture pond
3. Explain the role of microbes in nutrient cycling in a pond
4. Theorize health significant bacteria in culture pond
5. Explain perishability of seafood and the importance of better time/temperature management of aquaculture produce

**Course Content**

**Module 1: Introduction**

(9 Hrs.)

History and development of microbiology – Contributions of Louis Pasteur, Koch and Winogradsky – Different members of the microbial community – General characteristics of bacteria, fungi, viruses, algae and protozoans.

Questions from section A (2 Marks) = 22      Questions from Section B (5 Marks) = 8  
 Questions from Section C (10 Marks) = 3

**Module 2. Microbial structure Biology.**

( 6 Hrs.)

Microscopy – general principles and application of bright field, dark field, phase contrast and electron microscopy. Ultrastructure of prokaryotic cell – structure and function of bacterial cell wall, plasma membrane, capsule, flagella and endospore. Structure of fungi and yeast cell. Ultrastructure of virus – classification of viruses, Life cycle bacteriophages - lytic and lysogenic cycle.

Questions from section A (2 Marks) = 30      Questions from Section B (5 Marks) = 20  
 Questions from Section C (10 Marks) = 6

**Module 3: Aquatic Microbiology**

(9 Hrs.)

Microflora of aquatic environment, Isolation and cultivation of microorganisms from water and sediment. Different culture techniques. Nutrition and growth of bacteria – different types of media for isolation of bacteria and fungi. Prokaryotic growth – characteristic features of bacterial growth curve – Effect of environmental factors on growth.

Questions from section A (2 Marks) = 22      Questions from Section B (5 Marks) = 10  
 Questions from Section C (10 Marks) = 5



**Module 4: Aquaculture Microbiology**

(9 Hrs.)

Microbiology of culture pond – role of autotrophic and heterotrophic microorganisms in culture pond. Nutrient regeneration in pond, role of microbes in biogeochemical cycles – Nitrogen, phosphorus and sulphur cycles. Autochthonous and allochthonous microorganisms in culture pond.

Questions from section A (2 Marks) = 34

Questions from Section B (5 Marks) = 14

Questions from Section C (10 Marks) = 6

**Module 5: Health significant bacteria in culture ponds.**

(6 Hrs)

Health significant bacteria in culture ponds - Cultural characteristics, biology and epidemiology of *E. coli*, pathogenic vibrios, *Salmonella*, *Aeromonas hydrophila*, *Listeria monocytogenes* and Pseudomonads.

Questions from section A (2 Marks) = 20

Questions from Section B (5 Marks) = 10

Questions from Section C (10 Marks) = 3

**Module 6: Fish Microbiology.**

(9 Hrs.)

Perishability of seafood – Fish as an excellent medium for growth of microorganisms. Spoilage microflora of fish and shellfish. Intrinsic and extrinsic factors affecting spoilage. Filter feeding and associated health risk with bivalve shellfish – depuration of bivalves.

Questions from section A (2 Marks) = 28

Questions from Section B (5 Marks) = 12

Questions from Section C (10 Marks) = 4

**Internal Evaluation****Assignments**

1. Contributions of Pasteur, Robert Koch and Segei Winogradsky
2. Effect of environmental factors on growth of bacteria
3. Microbial spoilage of fish

**Projects**

1. Isolation of bacteria and fungi from pond water and sediment
2. Estimation of microscopic algae in culture pond
3. Depuration of shellfish and the resultant decrease in bacterial load of shellfish
4. Setting up of a Winogradsky column

**Seminar topics**

1. Ultrastructure of prokaryotic cell
2. Types of culture media
3. Extrinsic and intrinsic factors affecting spoilage of seafood
4. Life cycle of bacteriophages

**Suggested reading****Core reading**

1. Pelzar, Reid & Chan – Microbiology
2. Prescott, Harley & Klein – Microbiology
3. Adelogerg, Ingra & Wheates – Introduction to Microbial World
4. Anon. Productivity in Aquatic Bodies.
5. Chincheste, C.O. and Graham, H.D. Microbial Safety of Fishery Products.
6. Amerine, M.A. and Pangborn, R.M. Principles of Sensory Evaluation of Foods.

**Advanced Reading**

- 1) Suzuki, T. Fish and Krill Protein: Processing Technology

**Course : Core course XIII**

**Course Code : AQC 6B20**

**Title : Fisheries Economics and Extension.**

**Hrs/week 2**

**No. of Credits 2**

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**Aim:** To know the economic analysis of various fishing, farming and processing activities.

**Objectives:**

1. Study basic economic principles.
2. Understand the methods of business management.
3. List the methods of Aquaculture extension and institutes/agencies concerned.
4. Explain export procedures/policies.

**Course Content**

**Module 1: Introduction and Basics of Business (6 Hrs)**

Economics- definition, meaning and scope of economics with reference to fisheries. Basic concepts of economics- goods, services, wants, utility. Demand and supply, value price, individual demand and market demand, elasticity of demand, law of diminishing marginal utility.

Questions from section A (2 Marks) = 18      Questions from Section B (5 Marks) = 6  
Questions from Section C (10 Marks) = 2

**Module 2: Business Management**

Nature and scope of business, meaning, definition, characteristics and functions of business. Requisites of a successful business, essential qualities of a good business man, Principles of management – characteristics, objective and levels of management. Functions of management – planning, organization, leading, staffing, direction, motivation, co-ordination and control. Types of management - marketing management, financial management, production management, administrative management, personal management and industrial relations. Different economic systems in operation- capitalism, communist economy and mixed economy. Classification of companies- sole, proprietorship, partnership, co-operative society, charter companies, public corporations and registered companies.

Questions from section A (2 Marks) = 40      Questions from Section B (5 Marks) = 18  
Questions from Section C (10 Marks) = 5

**Module 3: Marketing and Economic Analysis (6 Hrs)**

Marketing – Introduction, basic marketing functions, consumer behavior and demand concepts, different types of market, identifying and selecting markets, regulation of markets, advertising and sales promotion, organizing market surveys and test marketing of a new product. Fish marketing – prices and price determination of fishes. Marketing institutions – Primary institutions- producer

fishermen, fishermen cooperatives and fisheries corporations. Secondary institutions – merchant middlemen, agent middlemen and speculative middlemen. Methods of economic analysis of business organizations – pay-back period, average rate of return, discounting method, net present value method, benefit cost ratio method and internal rate of return.

Questions from section A (2 Marks) = 25      Questions from Section B (5 Marks) = 12

Questions from Section C (10 Marks) = 4

#### **Module 4: Fisheries Economics**

(6 Hrs)

Aquaculture economics – Application of economic principles to culture operations. Various inputs. Production function - the laws of returns, returns to scale. Average, marginal and total revenues. Pricing-various factors influencing the price of a product. its assumptions in aquaculture analysis. Least cost combination of inputs, laws of variable proportions. Cost and earnings of aquaculture systems – carp culture, different shrimp farming systems and hatcheries. Cost and earnings of mechanized and non mechanized fishing units and freezing plants. Socio- economic conditions of fishermen in India and Kerala. Contributions of fisheries to the national economy.

Questions from section A (2 Marks) = 40      Questions from Section B (5 Marks) = 13

Questions from Section C (10 Marks) = 5

#### **Module 5: Export of Fishery Products**

(6 Hrs)

Export of fishery products from India- major countries, important products, role of CIFT and MPEDA in regulating quality and export of fishery products. Export documents and procedures. Prospects and constraints in export including tariff and non- tariff barriers, marine insurance, export incentives, registered exporters.

Legislation on export inspection in India. Quality standards in India and major importing countries like USA, Japan and EU.

Questions from section A (2 Marks) = 22      Questions from Section B (5 Marks) = 8

Questions from Section C (10 Marks) = 4

#### **Module 6: Fisheries Extension**

(6 Hrs)

Extension education – its meaning, importance and scope in fisheries. Various methods of extension – individual, group and mass methods, farm and home visits, seminars, discussions, exhibition and personal contacts.

Questions from section A (2 Marks) = 20      Questions from Section B (5 Marks) = 10

Questions from Section C (10 Marks) = 2

### **Internal Evaluation**

#### **Assignments**

- 1) Relationship of price with demand and supply.
- 2) Success of a business.
- 3) Marketing of a new product.
- 4) Economic analysis of a processing plant

#### **Projects**

- 1) Comparative economic analysis of gill netting and trawling.
- 2) Economic analysis of a carp farm.
- 3) Economics of a peeling shed operation.
- 4) Technology transfer of byproducts technology to a group of fishermen society  
– Fisheries Extension

**Suggested Seminar topics**

- 1) Primary fisheries cooperative society.
- 2) Emerging fisheries tourism.
- 3) Economics of a shrimp hatchery.
- 4) Kerala budget – allocation to fisheries.

**Suggested Reading****Core reading**

- 1) Mithani,D.M. Principles of Economics.
- 2) Stonier,A.W and Hague,D.C. A Textbook of Economic Theory.
- 3) Anderson,L.G.The Economics of Fisheries Management.
- 4) Shang,Y.C. Aquaculture Economics.
- 5) Korakandy,R. Technological Change and the Development of Marine Fishing Industry in India..
- 6) Ibrahim,P. Fisheries Development in India.

**Supplementary Reading**

- 1) Lawson,R.M. Economics of Fisheries Development.
- 2) Panayatou,T. Smallscale Fisheries in Asia.. Socio-economic Analysis and Policy

**Advanced Reading**

- 1) Ralph,T and Jack,W. The Economics of Fisheries, FAO

# B.Sc. Aquaculture Programme

## Core Course Practical

Sl.No.	Code	Name	Hr/Wk	Credit
1	AQC1B02(P) *	Biology of Fishes	2	-
2	AQC2B04(P)	Water and Soil Quality Parameters	2	-
3	AQC3B06(P)	Taxonomy, Fisheries and Fishing Technology	2	-
4	AQC4B08(P)	Aqua Farm Management	2	4
5	AQC5B14(P)	Breeding and Rearing of Aquarium Fishes	5	-
6	AQC5B15(P)	Fish Processing Technology	5	-
7	AQC6B21(P)	Biostatistics and Computer Applications	5	4
8	AQC6B22(P)	Fishery Microbiology and Pathology	5	4
<b>Total</b>			<b>28</b>	<b>12</b>

Exams will be conducted at the end of IV and VI semesters

<b>Course</b>	<b>: Core Practical I</b>
<b>Course Code</b>	<b>: AQC1 B02 (P)</b>
<b>Title</b>	<b>: Biology of Fishes</b>
<b>Hrs/Week</b>	<b>: 2</b>

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**Aim:** To have a working knowledge of the general aspects of fish and shell fish biology

**Course Outcome:**

1. Understand and measure fish and/or prawn morphometric features.
2. Correlate fin forms with swimming behavior.
3. Analyse gut content, and fecundity of fishes/prawns.
4. Study the digestive anatomy of fishes.

**Experiments:**

1. Morphometric measurements of fishes
2. Fin forms of fishes and swimming behaviour
3. Types of scales, placoid, cycloid & ctenoid
4. Examination of structure of gill and assessment of feeding behaviour – *Sardinella/ Channa* sp.
5. Mounting of appendages of Prawn
6. Dissect and display of alimentary canal of fishes/prawns
7. Fecundity estimation in fishes/ prawn and its relationship with length and weight
8. Gut content analysis: - Volumetric methods

**Collection:**

1. Fishes with different caudal fin form
2. Collection of fish with different mouth adaptations
3. Collection of fish with different alimentary canal length.
4. Collection of fish with different types of scales

**Course** : Core Practical II  
**Course Code** : AQC2 B04 (P)  
**Title** : Water and Soil Quality Parameters  
**Hrs/Week** : 2

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**Aim:** To learn effective soil and water quality management practices

**Course Outcome:**

1. Analyze water and soil quality parameters in aquaculture.

**Experiments:**

1. Determination of salinity by refractometer
2. Determination of water pH
3. Determination of alkalinity
4. Determination of hardness of water
5. Determination of dissolved oxygen
6. Determination of organic carbon in pond soil
7. Determination of nitrite / nitrate - demonstration
8. Determination of phosphate in pond water - demonstration
9. Determination of soil pH
10. Calculation of lime requirement
11. Testing of potential acid sulphate soil
12. Determination of Secchi disc transparency of water

**Filed visit:**

1. Visit to aqua farms for water and soil sample collection

**Course** : Core Practical III  
**Course Code** : AQC3 B06 (P)  
**Title** : Taxonomy, Fisheries and Fishing Technology  
**Hrs/Week** : 2

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**Aim:** To provide a holistic view on the species identification and fishery system in vogue in marine fisheries sector

**Course Outcome:**

1. Identify and classify important fishes, molluscs and crustaceans.
2. Identify fishing implements.

**Experiments/ activities:**

1. Identification of fishes up to species level- 20 nos. from different families
2. Identification of prawns of commercial importance
3. Identification of commercially important molluscs
4. Identification of traditional fishing gears
5. Different types of hooks
6. Identification of fishing accessories
7. Identification of synthetic and natural fibres
8. Artificial and live baits
9. Identification of modern gears
10. Fish detection devices - On board visit.

**Collection:**

1. Different commercially important fishes/ crustaceans/ molluscs

**Field visit:**

1. Visit to fishing harbour

**Institutional visit:**

1. Visit to CIFT, NIFPNATT, CIFNET etc.



**Course** : Core Practical IV  
**Course Code** : AQC4 B08 (P)  
**Title** : Aqua Farm Management  
**Hrs/Week** : 2

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**Aim:** To give an understanding on the principles and steps followed in aquaculture farm management and planning

**Course Outcome:**

1. Identify cultivable aquatic organisms.
2. Identify weed fishes, predatory fishes, plankton and live feeds.
3. Identify and demonstrate hatchery, and farm equipment.
4. Formulate and prepare fish feeds.
5. Understand farm and hatchery practices.

**Experiments/Activities**

1. Identification of cultivable aquatic organisms
2. Identification of common weed and predatory fishes
3. Collection and identification of phyto and zooplankters present in an aquaculture pond
4. Identification of different larval stages of shrimp
5. Identification and working of various equipments in farm and hatchery
6. Eradication of aquatic weeds, insects, weeds and predatory fishes from aquaculture pond.
7. Identification of different live feed organisms
8. Enumeration of micro algae using haemocytometer
9. Trials of decapsulation and hatching of artemia
10. Calculation of feed requirement
11. Feed formulation techniques
12. Preparation of artificial feed for aqua cultured organism

**Collection:**

1. Cultivable fin fishes/ crustaceans/ molluscs
2. Weed fishes/ predatory fishes
3. Aquatic insects from aquaculture ponds
4. Collection and identification of cultivable fishes and prawns

**Field visit:**

1. visit to coastal aquaculture farms
2. visit to a shrimp hatchery
3. visit to an ornamental fish farm/ aquarium

**Course** : Core Practical V  
**Course Code** : AQC5 B14 (P)  
**Title** : Breeding and Rearing of Aquarium Fishes  
**Hrs/Week** : 5

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**Aim:** To impart knowledge on ornamental fish production and aquarium keeping.

**Course Outcome:**

1. Identify and classify marine and freshwater aquarium fishes, invertebrates and plants.
2. Identify and demonstrate aquarium accessories.
3. Construct, set and manage aquaria.
4. Understand aquarium fish breeding procedures.

**Experiments:**

1. Identification of common aquarium fishes
2. Indigenous ornamental fishes of Kerala
3. setting up of aquarium ( maintained by students can be evaluated after one month )
4. Aquarium plants
5. Working of air pump and biological filter and other accessories.
6. Breeding of live breeding fish
7. Breeding of egg layers- gold fishes
8. Breeding of bubble nest builder- Gourami
9. Control of snails in ornamental fish culture system
10. Marine aquarium fishes and invertebrates
11. Disease of aquarium fishes ( signs and causative agents and treatments)
12. Water quality management in aquariums
13. Construction of aquarium

**Collection:**

1. Common aquarium fishes
2. Aquarium plants

**Field visit:**

1. Visit to Ornamental fish farms
2. Visit to ornamental fish whole sale and retail outlets

**Course** : Core Practical VI  
**Course Code** : AQC5 B15 (P)  
**Title** : Fish Processing Technology  
**Hrs/Week** : 5

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**Aim:** To get a basic idea on the fish processing techniques and quality control

**Course Outcome:**

1. Study present day technologies involved in fish processing.
2. Analyse quality of fish and fishery products.
3. Prepare important value added products.
4. Identify and/or prepare important fishery byproducts.

**Experiments:**

1. Determination of moisture content in fish and fishery products
2. General description – freezing
3. Processing shrimp
4. Filleting of fish
5. Organoleptic analysis of fish
6. Preparation of fishery by products
7. Preparation/identification of shark fin rays fish maws, chitin, fish wafer
8. Fish pickling
9. Value added fishery products, fish curry, cutlets fish finger.

**Collection:**

1. Collection of fishery by-products

**Filed visit:**

1. Visit to sea food pre-processing plants
2. Visit to fish processing plants

**Institutional Visit:**

1. CIFT,
2. NIFPHATT

**Course** : Core Practical VII  
**Course Code** : AQC6 B21 (P)  
**Title** : Biostatistics and Computer Applications  
**Hrs/Week** : 5

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**Aim:** To impart a basic knowledge on the biostatistics to the students of aquaculture and also to provide basic computer skills for aquaculture study

**Course Outcome:**

1. Apply statistical techniques in fish population analysis, fish growth and fishery data.
2. Use computer aided packages in handling of fisheries and aquaculture data.
3. Identify important computer hardware/storage devices/peripherals.
4. Extract information from fishery databases.

**Experiments:**

1. Study of computer components and external storage devices.
2. Formatting a document using word, use of mail merge
3. Use of internet to collect fisheries data - FAO, NACA, ICLARM etc.
4. Descriptive statistical analysis using excel ; calculation of mean, median, mode, standard deviation, standard error using computer programmes/packages
5. t- test, Chi –square, F- test, one way ANOVA, Data analysis using computer analysis ( excel, free softwares) Analysis of fisheries/ biological data using computer programmes/packages
6. Demonstration of FISHBASE

**Projects:**

1. Length weight analysis of a given fish using computer
2. Analysis of biological data using statistical tools and its representation using appropriate computer tool

**Course** : Core Practical VIII  
**Course Code** : AQC6 B22 (P)  
**Title** : Fishery Microbiology and Pathology  
**Hrs/Week** : 5

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**Aim:** To have a basic understanding of microbial quality of raw and processed fishery products. Identification of fish/shrimp diseases and to suggest remedial measures

**Course Outcome:**

1. Study microbiological microbiology laboratory techniques.
2. Identify bacteria and parasites significant in fisheries/aquaculture.
3. Diagnose fish diseases.
4. Study prophylactic methods.

**Experiments/Activities**

1. Sterilization technique- dry heating, autoclaving
2. Media preparation
3. Isolation and maintenance of bacteria from fishes and water.
4. Gram staining of bacteria
5. Enumeration of bacteria by TPC method
6. Enumeration of total coli forms
7. Identification of various finfish / shellfish disease
8. Parasite in fishes, protozoan, helminths, crustaceans
9. Prophylaxis for the prevention of out break of fish disease

**Collection:**

1. Collection of fishes with disease
2. Collection of diseased larvae from hatchery

**Field visit**

1. Farms and hatchery with disease out break, hatchery

**Institutional visit**

1. CMFRI

# B.Sc. Aquaculture Programme

## Open Courses for other Streams

Sl.No.	Code	Name	Hr/Wk	Credit
1	AQC5 D01	Value Addition and Fishery Byproducts	3	3
2	AQC5 D02	Fish Preservation Techniques	3	3
3	AQC5 D03	Ornamental Fish Culture	3	3

<b>Course</b>	<b>: Open Course for Other Streams I</b>
<b>Course Code</b>	<b>: AQC5 D01</b>
<b>Title</b>	<b>: Value Addition and Fishery byproducts</b>
<b>Hrs/week</b>	<b>3</b>
<b>No. of Credits</b>	<b>3</b>

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**Aim:**

To provide an understanding of value addition and its importance in fish processing to start an enterprise.

**Course Outcome:**

1. Study different fish based value added products .
2. Understand various processes involved in fish and shell fish value addition
3. Explain various byproducts originating from fishes and their importance.

**Course Content**

**Module 1: Value Addition in Sea Foods (9 Hrs)**

Value addition in sea food. Different types of value added products from fish and shell fish. Advantages of value addition. Significance of value addition in the seafood industry.

Questions from section A (2 Marks) = 12      Questions from Section B (5 Marks) = 5  
 Questions from Section C (10 Marks) = 2

**Module 2: Fish Mince Based Products**

Fish mince and Surimi. Production of fish mince – merits and demerits. Analog and fabricated products. Quality assessment of surimi. Equipment and raw material for surimi, Role of cryo protectants in surimi production.

Questions from section A (2 Marks) = 20      Questions from Section B (5 Marks) = 8  
 Questions from Section C (10 Marks) = 4

**Module 3: Coated Fishery Products**

Preparation of coated fishery products – Different types of battering and breading and its applications – Packaging and storing of coated products – Quality evaluation.

Questions from section A (2 Marks) = 30      Questions from Section B (5 Marks) = 10  
 Questions from Section C (10 Marks) = 3

**Module 4: Other Value Added Products**

Preparation of products viz. fish / prawn pickle, fish wafers, prawn chutney powder, fish soup powder, fish protein hydrolysate, fish stacks, fillets, marinated products.

Questions from section A (2 Marks) = 15      Questions from Section B (5 Marks) = 7  
 Questions from Section C (10 Marks) = 3

### **Module 5: By-Products**

Production of chitin, chitosan and glucosamine hydrochloride from shrimp shell waste. Preparation of fish silage. Uses of silage. Isingless, shark fin rays, gelatin from fish waste, Amebrgris, Beche-de-mer, squaline, fish meal and oil.

Questions from section A (2 Marks) = 24      Questions from Section B (5 Marks) = 11

Questions from Section C (10 Marks) = 4

### **Module 6: Spoilage and quality**      (9 Hrs)

Spoilage in thermal processed products – Quality evaluation of thermal processed products – Curing and drying of fish – Spoilage in dry fish products – Masmin, Bombay duck.

Questions from section A (2 Marks) = 15      Questions from Section B (5 Marks) = 7

Questions from Section C (10 Marks) =3

## **Internal Evaluation**

### **Assignments**

1. Preparation of surimi and its quality evaluation
2. Retort pouch packaging of fishery products
3. Uses of chitin and chitosan
4. Battered and breaded products
5. Report of fish processing activities around the locality

### **Project**

1. Curing and drying of jew fish / Nemipterus – Evaluation of yield at different stages, sensory and chemical quality parameters
2. Preparation of fish cutlets and pickles– cost analysis
3. Preparation of chitosan –yield. Demonstration of its ..(Flocculation/Settling)

### **Seminar topics**

1. Application of thermal processing in seafood
2. Fish meal production and quality
3. Surimi production and uses
4. Products from Bombay duck

## **Suggested reading**

### **Core reading**

1. Fish Processing Technology – T.K.Govindan
2. Fish Processing Technology – Ed. K. Gopakumar
3. Post Harvest Technology – K.K. Balachandran
4. Seafood Processing – V. Venugopal

### **Supplementary Reading**

1. Fish Processing Technology – Ed. G.M. Hall – Chapman & Hall, Madras
2. Tropical Fishery Products – K. Gopakumar

### **Advanced Reading**

1. Kreuzer,R. Fishery Products.
  2. Borgstrom,G .Fish as Food
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**Course** : Open Course for Other Streams II  
**Course Code** : AQC5 D02

**Title** : Fish Preservation Techniques  
**Hrs/week** 3  
**No. of Credits** 3

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**Aim:**

To undertake a job in sea-food processing industry by students of other stream

**Course Outcome :**

1. Understand post harvest handling
2. Study various methods involved in post harvest technology
3. Acquire knowledge about the storage and marketing of fishery products

**Course Content:**

**Module 1: Fish handling** (9 Hrs.)

Common fishes, shrimps and molluscs landed and processed in Kerala. Handling of fish on board, in the landing center and processing centre. Design and layout of preprocessing and processing centers.

Questions from section A (2 Marks) = 14      Questions from Section B (5 Marks) = 7

Questions from Section C (10 Marks) = 3

**Module 2: Chilling and Freezing** (9 Hrs.)

Icing of fish, different types of ice, quality of ice. Fundamental principles involved in chilling and freezing of fish and fishery products. Various freezing methods. RSW/CSW systems. Changes during freezing and frozen storage.

Questions from section A (2 Marks) = 22      Questions from Section B (5 Marks) = 9

Questions from Section C (10 Marks) = 4

**Module 3: Drying, Smoking, Canning and Freeze-Drying** (9 Hrs.)

Principles of drying and salting of fish, factors affecting drying. Traditional drying / curing methods. Packing and storage of dried products. Principles of freeze drying. Principles involved in canning of fish. Different stages of canning of fish/prawn. Retortable pouch processing. Spoilage of canned products. Cut open test and commercial sterility and quality examination of canned products.

Questions from section A (2 Marks) = 30      Questions from Section B (5 Marks) = 12

Questions from Section C (10 Marks) = 4

**Module 4: Quality Control in Sea Food Processing** (9 Hrs.)

Concept of quality in fish and fishery products. Organoleptic analysis of fish and fishery products. Microbiological analysis of fish and fishery products. TPC and MPN of coliforms in sea food. *Salmonella*, *Vibrio*, *Staphylococcus* and *E. coli* in sea food. Quality standards for sea food.

Questions from section A (2 Marks) = 35      Questions from Section B (5 Marks) = 12

Questions from Section C (10 Marks) = 5

**Module 5: Fishery By-products**

(9 Hrs.)

Fish meal and fish oil. Different methods of production of fish oils and their uses. Different grades of fish meal. Nutritional significance of fish oil. Chitin and chitosan. Fish silage-production and uses. Shark fin rays, gelatin, squalene, beche-de-mer, carrageenan, agar. Questions from section A (2 Marks) =28 Questions from Section B (5 Marks) = 14 Questions from Section C (10 Marks) = 4

**Module 6: Packing, Cold Storage and Export of Fishery Products**

(9 Hrs.)

Functions of packing. Different types of packing materials and its quality evaluation. Packing requirements for frozen and cured products. Statutory requirements for packing. Labelling requirements. Different type of cold storages. Requirements in retail outlet. Insulated and refrigerated vehicles. Export of marine products. Role of MPEDA and EIA in export promotion and quality control. Questions from section A (2 Marks) = 42 Questions from Section B (5 Marks) =13 Questions from Section C (10 Marks) = 5

**Internal Evaluation****Assignments :**

1. Problem facing in the canning industry.
2. smoking is not considered as a best method of preservation.
3. Shark fish rays production and its application .
4. Drying of fish..

**Projects**

1. Canning of fresh water fish
2. Various products from sea weed
3. Preparation of shrimp flavour for fresh water prawn
4. Preparation of gelatin from freshwater fishes.

**Seminar topics**

1. Present status of fish processing in India
2. Popularisation of canned products
3. Problem in the preparation of Accelerated freeze drying

**Suggested reading****Core reading**

1. Fish Processing Technology K.Gopakumar, ICAR, New Delhi
2. Fish Processing Technology T.K. Govindan, Oxford & IBH Publication
3. Fish Canning – Principles & Practices K.K. Balachandran

**Supplementary Reading :**

1. Fisheries – Processing Ed. A.M.Martin, Chapman & Hall, Madras
2. Fish Processing Technology Ed.G.M.Hall – Chopra & Hall. Madras.

**Advanced Reading**

1. Wheatson,F.W. and Lawson,T.B. Processing Aquatic Food Products

**Course** : Open Course for Other Streams III  
**Course Code** : AQC5 D03  
**Title** : Ornamental Fish Culture  
**Hrs/week** 3  
**No. of Credits** 3

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**Aim:** To impart basic understanding for operating an ornamental fish farm for the students of other streams.

**Course Outcome :**

1. Explain potential ornamental fishes and their breeding habits
2. Understand the various management practices for breeding and rearing of ornamental fishes
3. Study aquarium setting and aquarium accessories involved.
4. List and explain the significance of nutrition.
5. List and explain aquarium fish diseases.

**Course Content :**

**Module 1: Introduction** (9 Hrs)

Introduction to Aquarium and ornamental fishes. World aquarium trade and present status. Accessories- Aerators, filters, lights, heaters. Water quality requirements. Different kinds of feeds. Culture of fish food organisms; preparation of dry feeds; feeding methods. Indigenous ornamental fishes of Kerala.

Questions from section A (2 Marks) = 14      Questions from Section B (5 Marks) = 14

Questions from Section C (10 Marks) = 6

**Module 2: Freshwater Ornamental Fishes** (9 Hrs)

Different varieties of Ornamental fishes- Live bearers, Gold fish and koi, Gourami, Barbs and Tetras, angel fish and cichlids. Broodstock development, breeding, larval rearing and grow out. Larval feeds and feeding. Induced breeding.

Questions from section A (2 Marks) = 22      Questions from Section B (5 Marks) = 10

Questions from Section C (10 Marks) = 4

**Module 3: Commercial Production of Freshwater Ornamental Fishes** (9 Hrs)

Requirements and design for the commercial production units of ornamental fishes. Commercial production of goldfish, live bearers, gouramies, barbs and tetras, angel fish. Mass production of aquarium plants. Natural ponds for the mass production of ornamental fishes. Marketing of aquarium fishes, retail outlets, export of ornamental fishes.

Questions from section A (2 Marks) = 34      Questions from Section B (5 Marks) = 11

Questions from Section C (10 Marks) = 3

**Module 4: Marine Ornamental Fishes** (9 Hrs)

Marine ornamental fishes – varieties and their habitat. Major marine ornamental fish resources of India. Method of collection and transportation of live fish. Use of anesthetics. Quarantine measures. Breeding of marine ornamental fishes. Other ornamental organisms – anemones, worms, lobsters, shrimps, octopus, starfish.

Questions from section A (2 Marks) = 22      Questions from Section B (5 Marks) = 14

Questions from Section C (10 Marks) = 6

### **Module 5: Aquarium Management**

(9 Hrs)

Setting up of aquarium. Marine Aquarium setting up and reef aquariums. Maintenance of water quality. Common disease of aquarium fishes, their diagnosis and treatment. Handling, care & transportation of fish. Temperature acclimation, oxygen packing.

Questions from section A (2 Marks) = 24      Questions from Section B (5 Marks) = 13

Questions from Section C (10 Marks) = 6

### **Module 6: Marketing of Aquarium Fishes**

(9 Hrs)

Marketing of aquarium fishes. Whole-sale markets of aquarium fish. Design of retail outlet. Export of ornamental fishes, procedures for export. Training and promotion schemes for the entrepreneurs involved in ornamental fish breeding and marketing by governmental agencies.

Questions from section A (2 Marks) = 28      Questions from Section B (5 Marks) = 14

Questions from Section C (10 Marks) = 4

### **Internal Evaluation**

#### **Assignments**

1. Common Marine Aquarium fishes, their collection.
2. Fish transportation methods.

#### **Projects**

1. Try locally available materials as nutrient source for live feed culture (like urine of cow, cow dung, vermi wash etc.)
2. Collect and identify locally available aquatic organisms that can be used live feed.
3. Construct filters / aerators using locally available materials (bottle, PVC Pipe).
4. Try breeding of ornamental fishes..

#### **Seminar topics**

1. Problems in maintenance of home aquaria.
2. Preparation of different types of feeds for aqua fishes
3. Rules and regulations in the collection and export of ornamental fishes

### **Suggested reading**

#### **Core reading**

1. Biswas. S.P., J.N.Das, U.K.Sarkar and Lakra W.S. 2007 Ornamental fishes of North East India : An Atlas : NBFGR
2. Marine Aquarium keeping : The Sciences, Animals and Art John Wiley & Sons, New York
3. Ramachandran.A, Breeding, Farming and Management of fishes (CUSAT, School of Industrial Fisheries)
4. Madhusoodanakurup etal – Ornamental Fish -Breeding, Farming and Trade. (CUSAT, School of Industrial Fisheries)

#### **Supplementary Reading :**

1. Murthi.V.S. 2002 Marine ornamental Fishes of Lakshadweep CMFRI, Special publication 72

#### **Advanced Reading**

1. Butting.B., Holthus, P.S. Dalding,S. 2003, Marine Aquarium Industry and conservation.
2. Oliver, K 2003. World trade in ornamental species
3. Marine Ornamental species; collection,..... and Conservation
4. Fish Disease and Disorders, CAB international, Oxford.

## **B.Sc. Aquaculture Programme**

### **Core Course - Elective**

<b>Sl.No.</b>	<b>Code</b>	<b>Name</b>	<b>Hr/Wk</b>	<b>credit</b>
1	AQC6 B24(E01)	Fish Biochemistry and Nutrition	2	2
2	AQC6 B24(E02)	Limnology and Oceanography	2	2
3	AQC6 B24(E03)	Endocrinology and Reproductive Biology	2	2

<b>Course</b>	<b>: Core Elective</b>
<b>Course Code</b>	<b>: AQC6 B24 (E01)</b>
<b>Title</b>	<b>: Fish Biochemistry and Nutrition</b>
<b>Hrs/week</b>	<b>2</b>
<b>No. of Credits</b>	<b>2</b>

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**Aims:**To manage feed and feeding in aquaculture farms To learn the feeding physiology, feed composition

**Course Outcome:**

1. Review the structure of fish muscles with special reference to its biochemistry.
2. Understand the nutritional and energy requirements of fishes.
3. List and explain feed ingredients, feeds and feed evaluation.
4. List and appraise the live feeds.
5. Study the methods of feed preparation and management.

**Course Content**

**Module 1: Biochemistry of Fishes**

(9 Hrs )

Proteins - Structure of fish muscle, muscle proteins, non-protein nitrogenous compounds. Flavor active components of fish and shell fishes. Energy requirements of fish and shellfish, factors affecting energy requirement, protein to energy ratio.

Questions from section A (2 Marks) = 15      Questions from Section B (5 Marks) = 8

Questions from Section C (10 Marks) = 2

**Module 2: Nutritional Requirements of Fish**

(9 Hrs )

Protein and amino acid requirement, carbohydrate and lipid requirement, Essential fatty acids. Vitamin and mineral requirements, vitamin C for fish and shell fishes. Feeds and feed additives, pigments, immunostimulants, non-nutritional feed additives - chemoattractants, feeding stimulants, growth promoters, preservatives.

Questions from section A (2 Marks) = 32      Questions from Section B (5 Marks) = 13

Questions from Section C (10 Marks) = 5

**Module 3: Feed ingredients**

(9 Hrs )

Different feed ingredients- animal, plant, microbial origin, SCP, silages, fermented products, anti-nutritional factors in feed ingredients, compounded feeds, pellets crumbles and microencapsulated feed. Feed ingredients- fish meal, fish silage. Digestibility studies.

Questions from section A (2 Marks) = 30      Questions from Section B (5 Marks) = 12

Questions from Section C (10 Marks) = 4

**Module 4: Feed & Feed Manufacturing**

(9 Hrs )

Different forms of feed-fodders, mash, pellets, floating and sinking feeds, Feed formulation - methods, square method. Feed manufacturing processes, Extrusion , Pelletization , Different size and grades of fish / shrimp feeds - starter, grower and finisher feeds. Storage and transportation of feeds. Quality problems- toxins, pests, rancidity, quality standards.

Questions from section A (2 Marks) = 35      Questions from Section B (5 Marks) = 12

Questions from Section C (10 Marks) = 4

### **Module 5: Feed Management & Biological Quality** (9 Hrs )

Practical feeding in grow-outs of fishes & shrimps. Feed ration, feed quantity estimation, feeding frequency, demand feeders, automatic feeders, feed dispensers. Farm made feeds. Data keeping. Feed conversion efficiency, protein conversion ratio, feed conversion ratio, net protein utilization, leaching, water stability. Nutritional diseases.

Questions from section A (2 Marks) = 24      Questions from Section B (5 Marks) = 9

Questions from Section C (10 Marks) = 5

### **Module 6: Live Feeds** (9 Hrs )

Different live feeds and their nutritional value. Manipulation of pond for natural feed production. Candidate species of phytoplankton and zooplankton for fish and shell fish culture - diatoms, micro algae, nano planktons, *Artemia*, *Daphnia* and *Brachionus*. Enrichment of live feeds. Micro-bound feed, micro encapsulated feed. Weaning of fish and prawn larvae.

Questions from section A (2 Marks) = 28      Questions from Section B (5 Marks) = 12

Questions from Section C (10 Marks) = 6

### **Internal Evaluation**

#### **Assignments**

1. Description of proteins in fishes.
2. Nutritional requirements of Carps.
3. Nutritional requirements of penaeid prawns.
4. Techniques of feed formulation and manufacturing.
5. Live feeds & culture techniques.
6. Importance of Farm made feeds

#### **Projects**

1. Preparation of aquarium feeds using locally available materials and its evaluation.
2. Growth rates of shrimp/ fish juveniles fed with different feeds
3. Survey on different types of feeds used in local aqua farms
4. Study of larval feeds used in shrimp hatcheries
5. Natural feed estimation, identification, laboratory culture

#### **Seminar topics**

1. Roles of minerals and vitamins in aquafeeds.
2. Different types of aquaculture feeds
3. Artificial larval feeds
4. Biological quality of feed

### **Suggested reading**

#### **Core reading**

1. Brown E.E      Fish Farming Handbook
2. Milne P.H.      Fish and shell fish farming in coastal waters
3. CMFRI manual on research methods for fish and shellfish nutrition
4. Borgstorm, G. Fish as Food
5. Heen, E and Kreuzer, R. Fish in Nutrition
6. Shepherd, J and Brommage, W. Intensive Fish Farming Techniques
7. Hefher, B. and Pruginin, Y. Commercial Fish Farming

#### **Supplementary Reading**

1. Halver J.E.      Fish Nutrition
2. Hefher      Nutrition of pond fishes

#### **Advanced Reading**

- 1) Muir, J.F. and Donald, R. Recent Advances in Aquaculture

<b>Course</b>	<b>: Core Elective</b>
<b>Course Code</b>	<b>: AQC 6B24 (E02)</b>
<b>Title</b>	<b>: Limnology and Oceanography</b>
<b>Hrs/week</b>	<b>2</b>
<b>No. of Credits</b>	<b>2</b>

### **Aim**

To introduce the students to basic concepts of limnology and oceanography

### **Course Outcomes:**

1. Perceive the freshwater and marine environment as the habitat of fish,
2. Familiarize with the processes taking place in the ocean
3. Study the major instruments for measuring various oceanic parameters
4. List and evaluate marine and inland resources and the need for their conservation.

### **Course Content**

#### **Module 1: Introduction to Limnology** (9 Hrs)

Limnology - introduction, classification and dynamics of inland waters. Biological communities of inland waters-common groups of phyto and zooplanktons and benthos. Macrovegetation- limnological significance. Ecology of ponds, lakes, rivers, reservoirs and estuaries.

Questions from section A (2 Marks) = 12      Questions from Section B (5 Marks) = 7  
 Questions from Section C (10 Marks) = 2

#### **Module 2: Oceanography** (9 Hrs)

Oceanography. Major ecological zones of oceans. Physical properties of sea water- latitudinal and vertical distribution of temperature, salinity and density, seasonal thermocline. Light penetration- colour of the sea, concept of extinction coefficient, sound propagation, SOFAR channel and shadow zone.

Questions from section A (2 Marks) = 14      Questions from Section B (5 Marks) = 8  
 Questions from Section C (10 Marks) = 3

#### **Module 3: Ocean Currents** (9 Hrs)

Concept of water masses in Arabian sea and Bay of Bengal. Pressure gradient force- Coriolis force. Ekman current- Ekman spiral. Coastal upwelling and sinking- importance to fisheries. Concept of thermohaline circulation- equatorial current system, great gyres and westward intensification, Peru Current and El-Nino. Catastrophic effects of El-Nino. Wind waves- characteristics, generation, wind speed, fetch and duration. Sea and swell- long shore currents and rip currents. Tides- influence of sun and moon, spring and neap tides.

Questions from section A (2 Marks) = 25      Questions from Section B (5 Marks) = 10  
 Questions from Section C (10 Marks) = 5

#### **Module 4: Marine Environment** (9 Hrs)

Characteristics and importance of beaches, intertidal area, continental shelf, slope and rise. Deep ocean topographic features – ridges, trenches, sea mounts, guyots, plateaus, submarine canyons. Tsunamis - characteristics and causes. Non-living resources from marine environment - ocean as a source of non- conventional energy. Mineral wealth, petroleum and gas from the shelf, polymetallic nodules and their distribution. Marine oozes.

Questions from section A (2 Marks) = 20      Questions from Section B (5 Marks) = 7  
 Questions from Section C (10 Marks) = 4



### **Module 5: Chemical Oceanography and Instruments** (9 Hrs)

Oceanographic equipments- metre wheel, messenger, winches etc. Water samplers- Nansen, Van-don and Niskin bottles. Temperature measurements- reversing thermometers, MBT, XBT, CTD. Composition of sea water- major and minor elements, salinity, chlorinity, concept of constancy of composition. Dissolved gases- oxygen, carbon dioxide and hydrogen sulphide.

Questions from section A (2 Marks) = 28      Questions from Section B (5 Marks) = 8

Questions from Section C (10 Marks) = 5

### **Module 6. Biological Oceanography** (9 Hrs)

Biological divisions of the sea. Intertidal zone. Fauna of rocky, sandy, and muddy shores. Mangroves and salt marshes. Population of the oceans - phytoplankton, zooplankton, benthos and nekton. Marine food chains and food webs. Oceanography in relation to fisheries. Application of GIS in fisheries. Coastal zone management. Application of remote sensing in coastal zone management. Coastal zone regulation.

Questions from section A (2 Marks) = 30      Questions from Section B (5 Marks) = 10

Questions from Section C (10 Marks) = 5

### **Internal Evaluation**

#### **Assignments**

1. Marine pollution and its impact on fisheries.
2. Application of remote sensing in oceanography.
3. Modern oceanographic equipments.
4. Estuaries and their significance.

#### **Projects**

1. Plankton identification and slide preparation.
2. Elementary study of beach profile.
3. Collection and identification of inter-tidal fauna.
4. Faunal survey of sandy, rocky and muddy shore
5. Salinity and dissolved oxygen study in a mangrove ecosystem.
6. A survey of mangrove flora and fauna.

#### **Seminar topics**

1. Productivity- concepts and methods of measuring it and its significance.
2. Research institutes associated with oceanography.
3. Oceanic circulation and monsoon.
4. Application of remote sensing in fisheries.
5. Ocean and human life.
6. Activities of institutes associated with oceanographic study and research

### **Suggested reading**

#### **Core reading**

1. P.S. Welsh Limnology-
2. Sverdrup H.V. et al The Oceans - Their Physics, Chemistry and General Biology .
3. Piuert An introduction to oceanography
4. K. Sidharthan Oceanography
5. Nair N.B. and Thampi D.M A text book of Marine Biology .

#### **Supplementary Reading**

1. Sarma, R.S. and Vittal, M.- Oceanography for Oceanographers.
2. Wetzel, R.G. – Limnology.

#### **Advanced Reading**

1. Kinne, O.- Marine Ecology.
  2. Pickard, G.L. – Descriptive Physical Oceanography.
  3. Klaff, J. – Limnology:- Inland Water Ecosystems.
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<b>Course</b>	<b>: Core Elective</b>
<b>Course Code</b>	<b>: AQC6 B24 (E03)</b>
<b>Title</b>	<b>: Endocrinology &amp; Reproductive Biology</b>
<b>Hrs/week</b>	<b>2</b>
<b>No. of Credits</b>	<b>2</b>

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**Aim:**

To impart theoretical knowledge necessary for the breeding and rearing of aquatic organisms.

**Course Outcome:**

1. Study the reproductive biology of fishes and shellfishes.
2. Understand the endocrine regulation taking place in fishes and shellfishes during reproduction.
3. Illustrate the anatomy of endocrine glands in relation to their function.

**Course Content**

**Module 1: Major Endocrine Glands** (9 Hrs)

Major glands – pituitary – thyroid, adrenal, pancreatic islets.

Questions from section A (2 Marks) = 12      Questions from Section B (5 Marks) = 4  
 Questions from Section C (10 Marks) = 1

**Module 2: Hormones** (9Hrs)

Hormones and their functions. Hormones – types – endocrine hormones in fish and shell fish.

Questions from section A (2 Marks) = 20      Questions from Section B (5 Marks) = 10  
 Questions from Section C (10 Marks) = 2

**Module 3: Endocrine Control of Reproduction** (9 Hrs)

Endocrine control of reproduction in fishes – role of pituitary and gonads in the control of sex and reproduction in fishes. Use of pituitary glands, pituitary extracts and its analogs in induced breeding.

Questions from section A (2 Marks) = 30      Questions from Section B (5 Marks) = 18  
 Questions from Section C (10 Marks) = 5

**Module 4: Anatomy of Sex Organs** (9 Hrs)

Structure of gonads. Sexuality – development of sex organs in fish – Sex differentiation – sexual dimorphism and hermaphroditism in fish. Sex reversal in fish.

Questions from section A (2 Marks) = 22      Questions from Section B (5 Marks) = 9  
 Questions from Section C (10 Marks) = 3

**Module 5: Reproduction**

Reproductive behaviour patterns in fishes, breeding cycles, breeding migration, development of accessory structures and breeding coloration during reproduction. Oviparous, viviparous and ovoviviparous fishes and their adaptive significance. Parental care in fishes. Fecundity analysis in fish.

Questions from section A (2 Marks) = 30      Questions from Section B (5 Marks) = 15  
 Questions from Section C (10 Marks) = 5

## **Module 6: Control of Reproduction**

(9 Hrs)

Control of sex and reproduction in crustaceans. X-organ, Y-organ, sinus gland, androgenic gland. Role of pheromones in reproduction. Eye-stalk ablation and induced breeding in crustaceans. Neuro secretory cells in molluscs. Induced breeding in molluscs.

Questions from section A (2 Marks) = 18      Questions from Section B (5 Marks) = 7

Questions from Section C (10 Marks) = 4

### **Internal Evaluation**

#### **Assignments**

1. Endocrine regulation of reproduction in crustaceans
2. Parental care in egg laying fishes
3. Breeding coloration in fishes
4. Role of pheromones in reproduction

#### **Projects**

1. Colour change in fish under different situations (Experiments)
2. Collection and identification of and reporting of variously colored fishes
3. Collection & Preservation and extraction of pituitary from different fishes
4. Collection and preservation of reproductive tissues from crustaceans and fishes
5. Estimation of fecundity in fishes/crustaceans

#### **Seminar topics**

1. Significance of pituitary in fish reproduction & hatchery technology
2. Environmental factors influencing reproduction
3. Endocrine systems in fishes and crustacean – a comparison.
4. Induced breeding in shell fishes.

### **Suggested reading**

#### **Core reading**

1. Matty A.J. – Fish Endocrinology
2. Evans D.E – The Physiology of Fishes
3. Lagler K.F. – Ichthyology
4. Smith – Fish Physiology
5. Pandey, A.K. and Sandhu G.S. – Encyclopedia of Fish and Fisheries of India
6. Norman, J.R. – A History of fishes
7. Purchon, R.D. The Biology of Mollusca.
8. Dorothy E Bliss. The Biology of Crustacea
9. Nelson, J.S. Fishes of the World

#### **Supplementary Reading**

1. Matty A.J. – Fish Physiology

#### **Advanced Reading**

1. Hoar, W.S., Randall, D.J. and Donaldson, E.M. – Fish Physiology, Vol.I, II , IX A & B
2. Nicholsky – Ecology of Fishes.

**MODEL QUESTION PAPERS FOR CORE COURSES  
AND OPEN COURSE (Same Stream)**

**FIRST SEMESTER B.Sc. DEGREE EXAMINATION**  
**AQUACULTURE – CORE COURSE**  
**AQC1 B01: BIOLOGY OF FISHES**

**TIME:2 HRS**

**MAXIMUM MARKS: 60**

Part A

(Answer the following questions – ceiling 20)

1. Give two examples for catadromous fish.
2. Give two examples for weedfish.
3. Explain fecundity.
4. What is ovovivipary?
5. What is binomial nomenclature?
6. What is Weberian Apparatus?
7. Explain tagging of fishes.
8. What is GSI?
9. Explain bioluminescence in fishes.
10. What is the use of lateral line system?
11. Give two examples for viviparous?
12. Explain anadromous migration.

Part B

(Answer the following questions – ceiling 30)

13. Structure of lateral line sense organs in fishes.
14. Circadian rhythm in fishes.
15. Caudal fin types and their significance in fishes.
16. Types of scales in fishes.
17. Migration in eels.
18. Sexuality in fishes.
19. Pituitary gland and their secretions.

Part C

(Write essays on **any one** of the following)

20. Explain migration in fishes.
21. Describe the methods for gut content analysis in fishes.

(10x1 = 10marks)

**SECOND SEMESTER B.Sc. DEGREE EXAMINATION**  
**AQUACULTURE – CORE COURSE**  
**AQC2B03: FRESHWATER AQUACULTURE**

**TIME:2HRS**

**MAXIMUM MARKS: 60**

Part A

(Answer the following questions – ceiling 20)

1. What method is used to reduce acidity in ponds?
2. Give scientific name of Grass carp and Common carp.
3. What are Bheries?
4. Explain the use of sluiceway.
5. What is Ovaprim?
6. Explain Primary Productivity.
7. What is a Red tide?
8. Significance of turbidity.
9. What is meant by limiting nutrients.
10. Significance of phytoplankton
11. What is IMTA?
12. Name two important freshwater molluscs.

Part B

(Answer the following questions – ceiling 30)

13. Explain pen culture with its advantages and disadvantages.
14. Explain CRZ and CZM.
15. Explain major objectives of Aquaculture.
16. Explain algal blooms and their control mechanisms.
17. What are the major biotic components of a pond?
18. Explain the fertilization of a nursery pond.
19. Explain different parts of water supply systems in an aquaculture pond.

Part C

(Write essays on **any one** of the following)

20. Write an essay on Integrated Aquaculture.
21. Give a detailed account management of soil and water quality parameters.

(10x1 = 10marks)

**THIRD SEMESTER B.Sc. DEGREE EXAMINATION**  
**AQUACULTURE – CORE COURSE**  
**AQC3 B05: FISHERIES AND POPULATION DYNAMICS**

**TIME:2HRS**

**MAXIMUM MARKS: 60**

**Part A**

(Answer the following questions – ceiling 20)

1. Two examples for deep waterfishes
2. Common names of *Katsuwonus pelamis* and *Euthynnus affinis*
3. Pearlsport fishery.
4. What is Catamaran?
5. Briefly describe a fishingtrap.
6. Name major coldwater fisheries in India.
7. Advantages of motorization.
8. Major pomfret resources in India.
9. Benefits of trawling ban.
10. Explain mud bank fishery.
11. Explain closed season.
12. What do you mean by maximum sustainable yield?

**Part B**

(Answer the following questions – ceiling 30)

13. Coromandel Coast and Konkan Coast.
14. Marine sanctuaries.
15. Fishery of Lakshadweep.
16. Mesh size regulation.
17. List the major demersal fisheries of India.
18. Major Indian institutes imparting fisheries extension.
19. State the important molluscan fisheries in India.

**Part C**

(Write essays on **any one** of the following)

20. Describe the trends in marine pelagic fisheries of India.
21. Detail the shrimp resources of India and their fisheries.

(10x1 = 10marks)



**FOURTH SEMESTER B.Sc. DEGREE EXAMINATION**  
**AQUACULTURE – CORE COURSE**  
**AQC4 B07: BRACKISHWATER AQUACULTURE AND MARICULTURE**

**TIME:2HRS**

**MAXIMUM MARKS: 60**

**Part A**

(Answer the following questions – ceiling 20)

1. What are the advantages of semi-intensive shrimpfarming?
2. What is Zoea?
3. Briefly explain cage culture.
4. What is lab-lab?
6. Describe Euphoticzone.
5. What is Megalopa?
7. What is Pokkali farming?
8. Explain Searanching.
9. What are abiotic and biotic factors?
10. Differentiate between extensive and intensive shrimp farming.
11. Name two species of crabs used for culture.
12. What is sea farming?

(10x2 = 20marks)

**Part B**

(Answer the following questions – ceiling 30)

13. Crab fattening.
14. Culture of green mussel.
15. Water quality management in semi-intensive shrimp farming.
16. Eutrophication.
17. Social issues related to aquaculture.
18. Cage culture of lobsters.
19. Polyculture.

(6x5 = 30marks)

**Part C**

(Write essays on **any one** of the following)

20. Write an essay on pearl culture and induced pearl production.
21. Site selection for brackish wateraquaculture.

(10x1 = 10marks)

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**FIFTH SEMESTER B.Sc. DEGREE EXAMINATION**  
**AQUACULTURE – CORE COURSE**  
**AQC5 B09: HATCHERY TECHNOLOGY OF AQUATIC ORGANISMS**

**TIME:2.5 HRS**

**MAXIMUM MARKS: 80**

**Part A**

(Answer the following questions – ceiling 25)

1. What is the importance of maintaining the salinity range for larval rearing?
2. Name two synthetic inducing agents.
3. For what purpose Pituitary extract is used in hatchery?
4. What is Ovatide?
5. What is Mysis?
6. Name two air-breathing fishes?
7. What is eyestalk ablation?
8. Explain the use of Electrocutation apparatus.
9. What is Bundh breeding?
10. Differentiate between Sundanese and Tjimindi technology.
11. What is decapsulation?
12. What are the selection criteria for broodstock?
13. Name a few fish food organisms.
14. What is green water system?
15. Name two trouts in India.

**Part B**

(Answer the following in not more than two paragraphs – ceiling 35)

16. Sundanese method of common carp seed production.
17. CIFE hatcheries.
18. Water quality management in carpn urseries.
19. Chinese hatchery.
20. Mass culture of *Chaetoceros*.
21. Brood stock management of shrimps.
22. Facilities required in a pearl oyster hatchery.
23. Preparation and significance of artificial sea water.

**Part C**

(Write essays on **any two** of the following)

24. Write an essay on seed production of Scampi.
25. Discuss hypophysation in fishes.
26. Explain the methods for transportation of fish seed.

(10x2 = 20marks)

**FIFTH SEMESTER B.Sc. DEGREE EXAMINATION**  
**AQUACULTURE – CORE COURSE**  
**AQC5 B10: FISH PROCESSING TECHNOLOGY AND QUALITY CONTROL**

**TIME: 2.5 HRS**

**MAXIMUM MARKS:80**

**Part A**

(Answer the following questions – ceiling 25)

1. What is exhausting?
2. What is a flipper?
3. What is Pink and Dun?
4. What are the traditional fish preservation method adopted in S.E coast of India?
5. Advantages of retort pouches.
6. Define glazing.
7. What is a flipper?
8. Differentiate between pit curing and wet curing.
9. What is thaw drip?
10. Role of EIA.
11. Describe commercial sterility.
12. What is cut open test?
13. Differentiate between RSW and CSW.
14. Advantages of MAP.
15. What are biotoxins?

**Part B**

(Answer the following in not more than two paragraphs – ceiling 35)

16. Good Manufacturing Practices.
17. IPQC and MIPQC.
18. Accelerated Freeze Drying.
19. Coldchain.
20. Autolysis.
21. Refrigerated Sea water Storage.
22. Retort Pouch Processing.

**Part C**

(Write essays on **any two** of the following)

23. Describe the shrimp canning process with suitable layout diagrams.
24. Describe various pre-shipment quality control programmes in seafood.
25. Explain various traditional indigenous methods of fish salting and curing

(10x2 = 20marks)

**FIFTH SEMESTER B.Sc. DEGREE EXAMINATION**  
**AQUACULTURE – CORE COURSE**  
**AQC5 B11: FISHING METHODS**

**TIME:2HRS**

**MAXIMUM MARKS: 60**

Part A

(Answer in 2-3 lines – ceiling 20)

1. Lobstertrap.
2. Vertical longline.
3. Remotesensing.
4. Marineplywood.
5. Polyamide.
6. Coracle.
7. Circle hooks.
8. Square mesh netting.
9. Live baits.
10. Name two passive fishingmethods.
11. Ghost fishing
12. HDPE

Part B

(Answer the following questions – ceiling 30)

13. Responsiblefishing.
14. Bycatch reductiondevices.
15. Classification of ottertrawls.
16. Tuna longline.
17. Recreationalfishing.
18. Issues in ring seine fishery ofKerala.
19. Fishing gears in aquaculturesystems.

Part C

(Write essays on **any one** of the following)

20. Draw the deck layout of a stern trawler and explain the functioning of deckequipments andfittings.
21. Draw the design of a surface drift gill net for seer fish and explain theoperation  
(10x1 = 10marks)

**FIFTH SEMESTER B.Sc. DEGREE EXAMINATION**  
**AQUACULTURE – CORE COURSE**  
**AQC5 B12: BREEDING AND REARING OF AQUARIUM FISHES**

**TIME: 2 HRS**

**MAXIMUM MARKS: 60**

Part A

(Answer the following questions – ceiling 20)

1. Scientific name of Gold fish and Arrow head
2. What are copulatory organs?
3. What is rust disease?
4. How is salinity determined?
5. Common name of *Puntius denisoni* and *Carrasius auratus*
6. What is MS 222?
7. Name two aquatic plants.
8. Give few examples of ornamental marine worms.
9. Advantages of trickle filter.
10. Examples for mouth brooder.
11. What is acclimatization.
12. What is a breeding trap.

Part B

(Answer the following questions – ceiling 30)

13. Types of filters in aquarium.
14. Market trends in ornamental fish.
15. Indigenous ornamental fishes of Kerala.
16. Categories of egg layers.
17. Sexing of goldfish.
18. Importance of invertebrates in marine aquarium.
19. Role of live plants in aquaria.

Part C

(Write essays on **any one** of the following)

20. Describe the breeding of angelfish.
21. Give a detailed account of setting and maintenance of a freshwater aquarium.

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**FIFTH SEMESTER B.Sc. DEGREE EXAMINATION**  
**AQUACULTURE – CORE COURSE**  
**AQC5 B13: AQUACULTURE ENGINEERING AND BIostatISTICS**

**Time: 2 Hrs**

**Max Marks : 60**

**Part A**

(Answer the following questions – ceiling 20)

1. What is ANOVA?
2. Advantages of pie chart.
3. Method for acidity management in pond bottom.
4. What is a Biofilter?
5. What is the advantage of a under gravel filter?
6. What is Poisson distribution?
7. Advantages of pie chart.
8. Define standard deviation.
9. What is the use of monk?
10. Use of an air stone.
11. What is acid sulphate soil?
12. Name two types of aerators.

**Part B**

(Answer the following questions – ceiling 30)

13. Explain different steps in pond soilsampling.
14. Paddle wheel aerator.
15. Methods in calculation of the area of land by trapezoidal and Simpson's rule.
16. Describe the standard procedures for stocking prawn seeds.
17. Describe the importance of aeration in aquaculture ponds.
18. Explain biofilters.
19. Chi square test.
20. Tabulation of data.

**Part C**

(Write essays on **any one** of the following)

21. Explain the steps involved in designing a shrimp hatchery.
22. Describe the methods of data collection and explain various sampling methods.

(10x1 = 10marks)

**FIFTH SEMESTER B.Sc. DEGREE EXAMINATION**  
**AQUACULTURE – OPEN COURSE**  
**AQC5 D01: VALUE ADDITION AND FISHERY BYPRODUCTS**

**TIME:2 HRS**

**MAXIMUM MARKS:60**

**Part A**

(Answer the following questions – ceiling 20)

1. What is fish protein concentrate?
2. How is fish silage made?
3. What is fishmeal?
4. What is the nutritional importance of fish oil?
5. Explain enzyme hydrolysis of fish
6. What is chitin?
7. What is glucosamine hydrochloride?
8. What is shrimp extract?
9. What is fish maws?
10. What is isinglass?
11. What is beche-demer?
12. What is fish glue?

**Part B**

(Answer the following questions – ceiling 30)

13. What are the principal types of FPC?
14. Describe the composition of fish silage and how long does fish silage keep?
15. Explain the preparation of fish oil.
16. Explain the utilisation of Shrimp waste, crab shell and squilla as byproducts.
17. Explain the preparation of fish maws and isinglass
18. What are battered products? Explain some of the products.
19. Explain the method of preparation of chitosan

**Part C**

(Write essays on **any one** of the following)

20. What is value addition? What are the advantages of value addition?
21. What are coated products? Explain the preparation of coated products.

(10x1 = 10marks)

**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION  
AQUACULTURE – CORE COURSE**

**AQC6 B17: FISH GENETICS, BIOTECHNOLOGY & BIOINFORMATICS**

**TIME: 2.5 HRS**

**MAXIMUM MARKS: 80**

**Section A**

(Each question carries 2 Marks. 15 questions. Ceiling 25 Marks)

1. Give two functions of Golgi Complex.
2. 'Suicidal Bags'.
3. Define mutation.
4. Name two protein databases.
5. Define hybrid.
6. State Mendel's law of segregation.
7. Mention different steps in meiosis.
8. Function of cryoprotectant.
9. List the fishery databases.
10. Totipotency
11. Acrocentric chromosome.
12. Euchromatin.
13. Define bioinformatics.
14. Two advantages of PCR.
15. Pedigree selection – advantages.

**Section B**

(Each question carries 5 Marks. 8 questions. Ceiling 35 Marks)

16. Explain androgenesis.
17. Describe cryopreservation.
18. Application of tissue culture in mariculture.
19. Differentiate codominance and independent complete dominance with suitable examples.
20. Sex determination in fishes.
21. Monosex culture.
22. Marine toxins.
23. Recombinant DNA technology.

**Section C**

(Each question carries 10 Marks. Answer 2 questions. Ceiling 20)

24. Explain the structure of animal cell with a suitable diagram and explain membrane bound organelles.
  25. Explain fish hybridization.
  26. Describe chromosome manipulation techniques.
  27. Give an account of application of genetic selection in aquaculture.
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**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION  
AQUACULTURE – CORE COURSE**

**AQC6 B18: FISH PATHOLOGY, HEALTH MANAGEMENT**

**TIME: 2 HRS**

**MAXIMUM MARKS: 60**

**Section A**

(Each question carries 2 Marks. 12 questions. Ceiling 20 Marks)

1. Saprolegniasis.
2. Quarantine.
3. Chemotherapeutants.
4. Whirling disease.
5. Branchiomycosis.
6. Define sustainable aquaculture..
7. Furunculosis.
8. List the vitamin B Complex vitamins.
9. *Microsporidium*.
10. What is saddle back disease?
11. Give two typical symptoms of baculovirus infection.
12. Gas bubble disease

**Section B**

(Each question carries 5 marks. 7 questions. Ceiling 30 marks)

13. Explain different steps in pond soil sampling.
14. Explain steps involved in the production of disease-free seeds in fish hatchery.
15. Give the steps involved in the feed management for healthy shrimps.
16. Methods in calculation of the area of land by trapezoidal and Simpson's rule.
17. Explain the genetically and environmentally derived diseases.
18. Describe the standard procedures for stocking prawn seeds.
19. Describe the importance of aeration in aquaculture ponds.
20. Explain biofilters.

**Section C**

(Each question carries 10 Marks. 2 questions. Ceiling 10 Marks)

21. Describe the various fungal diseases of cultivable carps.
22. Explain the steps involved in designing a shrimp hatchery.

**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION**  
**AQUACULTURE – CORE COURSE**  
**AQC6 B19: FISHERY MICROBIOLOGY**

**TIME: 2 HRS**

**MAXIMUM MARKS: 60**

**Section A**

(Each question carries 2 Marks. 12 questions. Ceiling 20 Marks)

1. Chitosan
2. What is lysogenic life cycle?
3. Define phase contrast microscopy.
4. What is gelatin?
5. Bacterial growth.
6. What is depuration?
7. Define synthetic medium.
8. Reagents used in gram staining.
9. Mention intrinsic factors in fish spoilage.
10. Features of prokaryote.
11. What is a bacteriophage?
12. Four symptoms of salmonellosis.

**Section B**

(Each question carries 5 marks. 7 questions. Ceiling 30 marks)

13. Describe the preparation of fish silage.
14. Mention the role of microbes in sulphur cycle.
15. Setting up of Winogradsky column.
16. Explain different types of bacterial culture media.
17. Briefly explain different types of economically important moulds.
18. Give the role of autotrophic and heterotrophic microorganisms in a culture pond.
19. Describe the importance of aeration in aquaculture ponds.

**Section C**

(Each question carries 10 Marks. 2 questions. Ceiling 10 Marks)

20. Explain Intrinsic and extrinsic factors affecting spoilage.
21. Explain the life cycle of a bacteriophage with a neat diagram.

**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION  
AQUACULTURE – CORE COURSE**

**AQC6 B20: FISHERIES ECONOMICS AND EXTENSION**

**TIME: 2 HRS**

**MAXIMUM MARKS: 60**

**Section A**

(Each question carries 2 Marks. 12 questions. Ceiling 20 Marks)

1. Expand MPEDA.
2. What is NPV?
3. Two services given by NABARD.
4. Expand KMFRA.
5. State Law of demand.
6. Significance of Net Present Value.
7. Elasticity of demand.
8. What is Mixed Economy.
9. Aquaculture farm inputs.
10. Significance of extension.
11. Marginal revenue.
12. ATTIC.

**Section B**

(Each question carries 5 marks. 7 questions. Ceiling 30 marks)

13. Give an account of production function.
14. Fishermen co-operatives.
15. Prices and price determination of fishes.
16. Mixed Economy.
17. Apex societies.
18. Economic importance of recreational fisheries.
19. Extension methods and their importance in rural development.

**Section C**

(Each question carries 10 Marks. 2 questions. Ceiling 10 Marks)

20. Role of NCDC in fishermen welfare.
21. Influence of fishery co-operatives in Indian Fisheries.

**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION**  
**AQUACULTURE – CORE COURSE (ELECTIVE)**  
**AQC6 B24 (E01): FISH BIOCHEMISTRY AND NUTRITION**

**TIME: 2 HRS**

**MAXIMUM MARKS: 60**

**Section A**

(Each question carries 2 Marks. 12 questions. Ceiling 20 Marks)

1. Indicate the largest and most expensive nutrient component in manufactured feeds .
2. An inorganic acid used in fish silage preparation.
3. Give two roles of lipids in fish nutrition.
4. Name two deficiency diseases due to vitamin B.
5. Why fishes are unable to synthesize Vitamin C?
6. Which is the precursor of bile acids?
7. What is scoliosis?
8. What are binders?
9. Define Probiotic.
10. What is a finisher feed?
11. Give two physiological roles of proteins.
12. What is ment by enrichment?

**Section B**

(Each question carries 5 Marks. 7 questions. Ceiling 30 Marks)

13. Preparation of fish meal.
14. Significance of live feeds.
15. Importance of protein in diet.
16. Probiotics in fish nutrition.
17. Methods of feed formulation.
18. Plant protein sources in aquaculture feeds.
19. Different size grades of feeds.

**Section C**

(Each question carries 10 Marks. 2 questions. Ceiling 10 Marks)

20. Describe the role and relevance of vitamins and minerals in fish nutrition.
21. Explain in details non-nutritional feed additives.