

**ANNAMALAI UNIVERSITY  
ANNAMALAINAGAR**

**HAND BOOK**

**DEGREE OF MASTER OF SCIENCE  
COASTAL AQUACULTURE  
(CHOICE BASED CREDIT SYSTEM)**

**2015 - 2016**

**ANNAMALAI UNIVERSITY**  
**ANNAMALAI NAGAR**

**DEGREE OF MASTER OF SCIENCE**

**COASTAL AQUACULTURE**  
**(CHOICE BASED CREDIT SYSTEM)**  
**2015 – 2016**

**FACULTY OF MARINE SCIENCES**

**REGULATIONS**

**MASTER'S PROGRAMME**

A Master's Programme consists of a number of courses. Master's Programme consists of a set of Core Courses and elective Courses.

Core courses are basic courses required for each programme. The number and distribution of credits for core courses will be decided by the faculty.

Elective courses will be suggested by the respective departments, and they may be distributed in III and IV semesters.

A course is divided into five units to enable the students to achieve modular and progressive learning.

**SEMESTERS**

An academic year is divided into two semesters, Odd Semester and Even Semester. The normal semester periods are:

Odd Semester: July to November (90 Working days)

Even Semester: December to April (90 Working days)

**CREDITS**

The term credit is used to describe the quantum of syllabus for various programmes and hours of study. It indicates differential weightage given according to the contents and duration of the courses in the curriculum design.

The minimum credit requirement for a two year Master's Programme shall be 94.

The core courses shall carry 88 credits and the elective courses shall carry 6 credits.

## **ELIGIBILITY**

A Graduate degree in Zoology / Botany / Plant Biology & Plant Biotechnology / Plant Science / Animal Science / Animal Science & Biotechnology / Animal Biotechnology / Advanced Zoology & Biotechnology / Biochemistry / Industrial Fish and Fisheries / Microbiology / Environmental Science / Chemistry or B.F.Sc./B.Sc. Agriculture with a minimum of 50% marks in Part-III

## **COURSES**

Each course may consist of lectures / laboratory work / seminar / project work / practical training / report / viva voce etc.

## **COURSE WEIGHT**

Core and elective courses may carry different weightage. For example, a course carrying one credit for lectures, will have instruction of one period per week during the semester, if three hours of lecture is necessary in each week for that course then 3 credits will be the weightage. Thus normally, in each of the courses, credits will be assigned on the basis of the lectures / laboratory work and other form of learning in a 15 week schedule:

- (i) One credit for each lecture period per week.
- (ii) One credit for every three periods of laboratory or practical work per week.
- (iii) One credit for 3 contact hours of project work in a week.
- (iv) One credit for every two periods of seminar.

## **GRADING SYSTEM**

The term Grading System indicates a 10-point scale of evaluation of the performance of students in terms of marks, grade points, letter grade and class.

## **DURATION**

The duration for completion of a two year Master's Programme is four semesters.

## **STRUCTURE OF THE PROGRAMME**

The Master's Programme will consist of:

- (i) Core courses which are compulsory for all students.
- (ii) Elective courses which students can choose from amongst the courses offered the faculty as well as by Departments of other faculties (Arts, Science, Education and Indian Language).
- (iii) The Elective subjects will be allotted by counseling by a committee of the respective Heads of the Departments under the Chairmanship of the Dean of the Faculty.
- (iv) Dissertation / Project work / Practical training / Field work can be done in an organization (Government, Industry, Firm, Public Enterprise etc.) approved by the concerned department.

## **ATTENDANCE**

Every teaching faculty handling a course shall be responsible for the maintenance of attendance register for candidates who have registered for the course.

The teacher of the course must intimate the Head of the Department at least Seven Calendar days before the last instruction day in the semester about the attendance particulars of all students.

Each student should earn 80% attendance in the courses of the particular semester failing which he or she will not be permitted to sit for the end – semester examination.

However, it shall be open to the authorities to grant exemption to a candidate who has failed to obtain the prescribed 80% attendance for valid reasons on payment of a Condonation fee and such exemptions should not under any circumstance be granted for attendance below 70%.

## **EXAMINATIONS**

The internal assessment for each course carries 25% marks and is based on two sessional tests. The pattern of question paper will be decided by the faculty. The tests are compulsory.

There will be one End Semester Examination (75% marks) of 3 hours duration for each course. The pattern of question paper will be decided by the faculty.

The Internal assessment for each practical course carries 40% of marks while the end semester practical examination carries 60% of marks.

## EVALUATION

The performance of a student in each course is evaluated in terms of Percentage of Marks (PM) with a provision for conversion to Grade Point (GP). The total performance in each semester will be rated by Grade Point Average (GPA) while the continuous performance from the 2<sup>nd</sup> Semester onwards will be marked by Overall Grade Point Average (OGPA).

## MARKS AND GRADING

A student cannot repeat the assessment of Sessional Test I and Sessional Test II. However, if for any compulsive reason, the student could not attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

A student has to secure 50% minimum in the End Semester Examination.

The student who has not secured a minimum of 50% of marks (sessional plus end semester examination) in a course shall be deemed to have failed in that course.

A candidate who has secured a minimum of 50% marks in all the papers prescribed in the programme and earned a minimum of 90 credits will be considered to have passed the Master's Programme.

## GRADING

A ten point rating scale is used for the evaluation of the performance of the student to provide letter grade for each course and overall grade for the Master's Programme.

<b>Marks</b>	<b>Grade</b>	<b>Letter grade</b>	<b>Class</b>
90	10	S	Exemplary
85 – 89	9.0	D	Distinction
80 – 84	8.5	D	Distinction
75 – 79	8.0	D	Distinction
70 – 74	7.5	A	First Class
65 – 69	7.0	A	First Class
60 – 64	6.5	A	First Class
55 – 59	6.0	B	Second Class
50 – 54	5.5	C	Second Class
49 or Less	-	F	Fail

The successful candidates are classified as follows:

I Class – 60% Marks and above in overall percentage of Marks (OPM).

II Class – 50-59% Marks in overall percentage of marks.

Candidates who obtain 75% and above but below 90% of marks (OPM) shall be deemed to have passed the examination in FIRST CLASS (Distinction) provided he / she passes all the papers prescribed for the programme at the first appearance.

For the Internal Assessment Evaluation, the details shall be as follows:

Test - 25 Marks.

### **COURSE – WISE LETTER GRADES**

The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.

A student is considered to have completed a course successfully and earned the credits if he / she secures an overall letter grade other than F. A letter grade F in any course implies a failure in that course. A course successfully completed cannot be repeated for the purpose of improving the Grade point.

The F grade once awarded in the grade card of the student is not deleted even when he / she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the odd / even semester in which the candidate has appeared for clearance of the arrears.

A student who secures F grade in any course which is listed as a core course has to repeat it compulsorily when the examination is held next. If it is an Elective course, the student has the option to repeat it when it is offered next or to choose a new elective if he / she so desires in order to get a successful grade. When new elective is chosen in the place of failed elective, the failed elective will be indicated as dropped in the subsequent grade card.

If a student secures F grade in the Project Work / Field Work / Practical Work / Dissertation, he / she shall improve it and resubmit it if it involves only rewriting incorporating the clarifications of the evaluators or he / she can re-register and carry out the same in the subsequent semesters for evaluation.

**M. Sc., COASTAL AQUACULTURE**  
**(M. Sc., BRANCH VII - B)**  
**CHOICE BASED CREDIT SYSTEM 2015 – 2016**  
**REVISED SCHEME OF EXAMINATIONS**

**I SEMESTER**

CAQC	101	Fundamentals of Marine Biology and Oceanography
CAQC	102	Nutrition and Biochemistry
CAQC	103	Physiology, Cytology and Genetics
CAQC	104	Farm Engineering
CAQC	105	Aquarium Keeping and Management
CAQC	106	Computer Application - I
CAQC	107	Communication Skills
CAQP	108	Practical – I (Covering courses 101 & 104)
CAQP	109	Practical – II (Covering courses 102 & 103)
CAQP	110	Seminar / Journal Club / Assignment

**II SEMESTER**

CAQC	201	Biology and Culture of Crustaceans
CAQC	202	Biology and Culture of Finfishes
CAQC	203	Biology and Culture of molluscs and Seaweeds
CAQC	204	Health management in aquaculture systems
CAQC	205	Post Harvest Technology
CAQP	206	Practical – III (Covering course 201)
CAQP	207	Practical – IV (Covering courses 202 & 203)
CAQP	208	Practical – V (Covering courses 204 & 205)
CAQP	209	Seminar / Journal Club / Assignment

**III SEMESTER**

CAQC	301	Instrumentation and Analytical Methods
CAQC	302	Biotechnology and Applied Marine Biology
CAQC	303	Aquaculture Information, Economics & Extension
CAQC	304	Bioentrepreneurship
CAQC	305	Elective – I
CAQP	306	Practical – VI (Covering courses 301 & 303)
CAQP	307	Practical – VII (Covering course 302)
CAQP	308	Project Proposal Presentation

**IV SEMESTER**

CAQC	401	Elective – II
CAQC	402	Project Work

**M.Sc. COASTAL AQUACULTURE  
CREDITS, INTERNAL ASSESSMENT MARKS AND END  
SEMESTER EXAM MARKS**

Course Code Theory/Practical	Credit Points	Int. Ass.	End Sem. Exam Marks	Total Marks
<b>I SEMESTER</b>				
CAQC 101 Fundamentals of Marine Biology and Oceanography	3	25	75	100
CAQC 102 Nutrition and Biochemistry	3	25	75	100
CAQC 103 Physiology, Cytology and genetics	3	25	75	100
CAQC 104 Farm Engineering	3	25	75	100
CAQC 105 Aquarium Keeping and Management	3	25	75	100
CAQC 106 Computer Application – I		25	75	100
CAQC 107 Communication Skills		25	75	100
CAQP 108 Practical – I (Covering courses 101 & 104)	4	40	60	100
CAQP 109 Practical – II (Covering courses 102 & 103)	4	40	60	100
CAQP 110 Seminar / Journal Club / Assignment	1	40	60	100
Total	<b>24</b>			
<b>II SEMESTER</b>				
CAQC 201 Biology and Culture of Crustaceans	3	25	75	100
CAQC 202 Biology and Culture of Finfishes	3	25	75	100
CAQC 203 Biology and Culture of Molluscs and Seaweeds	3	25	75	100
CAQC 204 Health management in aquaculture systems	3	25	75	100
CAQC 205 Post Harvest Technology	3	25	75	100
CAQP 206 Practical – III (Covering course 201)	3	40	60	100
CAQP 207 Practical – IV (Covering courses 202 & 203)	3	40	60	100
CAQP 208 Practical – V (Covering courses 204 & 205)	4	40	60	100
CAQP 209 Seminar / Journal Club / Assignment	1	40	60	100
Total	<b>26</b>			
<b>III SEMESTER</b>				
CAQC 301 Instrumentation and Analytical Methods	3	25	75	100
CAQC 302 Biotechnology and Applied Marine Biology	3	25	75	100
CAQC 303 Aquaculture Information, Economics & Extension	3	25	75	100
CAQC 304 Bioentrepreneurship	3	25	75	100
CAQC 305 Elective – I	3	25	75	100
CAQP 306 Practical – VI (Covering courses 301 & 303)	3	40	60	100
CAQP 307 Practical – VII (Covering course 302)	3	40	60	100
CAQP 308 Project Proposal Presentation		40	60	100
Total	<b>21</b>			

<b>IV SEMESTER</b>				
CAQC 401 Elective – II	3	25	75	100
CAQC 402 Project Work	20	40	60	100
Total	<b>23</b>			

Students have to choose courses for 6 credits (2 courses) out of the elective courses offered in other departments / faculties of the University. The elective papers are for students of other departments / faculties of the University.

Credit	Core	Elective	Total Credit
	<b>88</b>	6	94

#### **SUGGESTED ELECTIVES**

1. Marine Food Technology
2. Marine Pharmacology
3. Plant and Animal Cell Culture Technology
4. Microbial Technology
5. Bioprocess Engineering & Technology
6. Biostatistics
7. Genomics & Proteomics
8. Vaccines
9. Molecular Virology

## **I SEMESTER**

## **I SEMESTER**

### **CAQC101 : FUNDAMENTALS OF MARINE BIOLOGY AND OCEANOGRAPHY**

#### **Objectives:**

A Complex variety of environment for living organisms is provided by the Oceans and Coastal Seas of the world. Marine Biology is an interdisciplinary Science, an introductory marine biology course will help develop a broad conceptual framework for understanding the geographical, physical and chemical aspects related to marine organisms and their environment . Such understanding of the marine environment and organisms living there would be very useful as some of these organisms are candidate species for aquaculture. Selecting suitable candidate species and the success of their culture could be enhanced by acquiring knowledge of the environment they live in. Therefore this paper would form a very important basis for a course in coastal aquaculture.

#### **UNIT I: Ocean – General**

Classification of coastal environment – marine, brackish, estuarine, mangroves, lagoons and coral reefs – their physico – chemical features.

#### **UNIT II: Oceanography**

Basic concepts in physical, chemical and biological oceanography. Sea as a biological environment.

#### **UNIT III: Plankton**

Classification of plankton, methods of collection, preservation, analysis and biomass of phytoplankton and zooplankton. Phytoplankton blooms, primary production – methods of estimation. Carbon Sequensiation by marine algae.

#### **UNIT IV: Benthos**

Benthos – classification, methods of sampling and biomass estimation, adaptations of benthic forms.

#### **UNIT V: Resources - Pollution**

Resources of marine environment – commercially important finfish, shellfish, algal resources – Non- living resources – minerals, salts, petroleum and natural gas, Drug from the seas.

Marine pollution types – sewage, hydrocarbons, pesticides, heavy metals, thermal, oil radioactivity.

#### **REFERENCE BOOKS**

1. Iversen, E.S., 1996. Living Marine Resources. Chapman and Hall, New York, 403 pp.
2. Castro, P. and M.E. Huber, 1997. Marine Biology, Second Edition. Mc-Graw Hill Company, New York, 450 pp.
3. Nybakken, J.W., 1997. Marine Biology – An Ecological Approach. Fourth Edition. Addison Wesley Edu. Pub. Inc, California, USA, 481 pp.
4. ENVIS Centre, ZSI, Calcutta, 1998. Faunal diversity in India, 497 pp.
5. Kenneth Sherman, 1998. Large marine ecosystems of the Indian Ocean, Blackwell science-USA, 394pp.
6. Duxbury, A.C., A.B. Duxbury and K.A. Sverdrup, 2000. An Introduction to the World's Oceans. 6<sup>th</sup> Edition. McGraw Hill Company Inc, New York 528 pp.
7. Michael. H. Glantz, 2001. Currents of change, second edition. Cambridge university press, UK, 252pp.
8. Jeffrey S. Levinton, 2001. "Cd marine biology: function, biodiversity, ecology with CD-ROM" Publishing Oxford University Press, New York, 515pp.
9. Ravi Mishra, 2002. Marine environment. Anmol publications, New Delhi, 299pp.
10. Mitra, A., K. Banerjee and A. Gangopadhyay, 2004. Introduction to marine plankton, Daya Publishing House, New Delhi, 97 pp.
11. Srivastava.,M.M. and Rashni Sanghi, 2007. Chemistry of green environment. Narosa Publications New Delhi, 364 pp.

## CAQC 102 –NUTRITION AND BIOCHEMISTRY

### Objectives:

As the natural fishery resources are dwindling day by day, the aquaculture is the only alternative to compensate the protein paucity of the exploding human population. In any aquaculture practice, the feed and seed are the two important factors that control the whole venture. Further, the cultivable species of fin and shell fishes (larvae, juveniles and adults) prefer live as well as formulated feeds. Besides, the above, the digestion and assimilation of the feed is so important which influences the growing animal in almost all the ways. Hence the paper on ‘Nutrition and Biochemistry’ has been introduced into the curriculum with the objectives of understanding the importance of nutrition in aquaculture, knowing the technical - know – how in the formulation of various artificial feeds, having a knowledge on the various formulated and live feeds used and understanding the metabolism of the feed taken by the animal.

### UNIT 1: Nutrition

In aquaculture - an overview, proteins, amino acids, lipids and fatty acids, carbohydrates and carotenoids - their importance in the nutrition of fin and shellfish, role of vitamins and minerals.

### UNIT 2: Feed

Ingredients – conventional and non – conventional, their nutritive value, feed formulation methods, binders, water stability of feed, use of attractants in feeds, importance of anabolic agents – antioxidants and mould inhibitors, anti – nutritional factors – other additives.

### UNIT 3: Formulated Feed

Different types of formulated feeds – pellets - dry feed, wet feed, floating feed, flakes, microparticulate and microencapsulated diets, storage and quality control. Determination of energy content in feeds, FCR and energy budget.

### UNIT 4: Live feed

Methods of collection of live food organisms, identification, isolation and maintenance of phytoplankton, mass culture of phytoplankton and zooplankton (*Brachionus*, *Copepods* and *Moina*), culture of *Artemia*, production of cyst and their utilization.

### UNIT 5: Biochemistry

Carbohydrate, protein and fat; enzymes – classification, factors influencing enzyme activity, role of enzyme in food processing.

## REFERENCE BOOKS

1. Albert L. Lehninger, David L. Nelson and Michael M. Cox, 1993. Principles of Biochemistry, CBS Pub. & Distributors, New Delhi. 1013 pp.
2. Sena S. De Silva and Trever A. Anderson, 1995. Fish Nutrition in Aquaculture, Chapman & Hall, London, 319 pp.
3. Wedemeyer Gary, A., 1996. Physiology of Fish in Intensive Culture Systems. Champman & Hall, London, 232 pp.
4. Bardach, John E., 1997. Sustainable Aquaculture. John Wiley & Sons Inc., New York, 251 pp.
5. Satyanarayana, U., 1999. Biochemistry, Books and Allied (p) Ltd, New Delhi, 695 pp.
6. Joachim W. Hertramft and Felicitas Piedad – Pascal, 2000. Hand Book on Ingredients for Aquaculture Feeds. Kluwer Academic Publishers, London.
7. Robert R. Stickney, 2000. Encyclopedia of Aquaculture. John Wiley & Sons, Inc., New York, 1063 pp.
8. Jain, J.L., 2001. Fundamentals of Biochemistry. S. Chand and Co. Publishers. New Delhi, 924 pp.
9. Denniston, K.J., J.J. Topping and R.L. Caret, 2004. "General, organic and Biochemistry, 880 pp, McGraw hill publishing, New York, 880pp.
10. Nelson, D.L. and M.M. Cox, 2005. Lehninger Principles of Biochemistry, 1119 pp, W.H.Freeman and Company, 1119pp.

## CAQC 103 – PHYSIOLOGY, CYTOLOGY AND GENETICS

### **Objectives:**

The objective of the paper is to teach the post graduate students of coastal aquaculture about the physiological mechanisms involved during digestion, respiration, excretion and biological behavior etc. in marine animals, structural and functional aspects of cells of marine organisms and to apply the principles of genetics for yielding higher production of marine organisms during culture.

### **UNIT 1: Physiology - General**

Introduction to physiology, physiology of respiration – respiratory organs, mechanism of ventilation, respiratory pigments and gaseous exchange mechanism, physiology of digestion – enzymes and their role in food conversion processes.

### **UNIT 2: Osmoregulation**

Ionic regulation – mechanism of excretion – ammoniotelic, uricotelic and ureotelic in organisms of coastal biotopes, hormones of reproduction in fin and shellfish.

### **UNIT 3: Biorhythms**

Physiological rhythms in marine animals – circadian, tidal and lunar rhythms, reproductive and behavioural rhythms, physiological changes during rhythms.

### **UNIT 4: Cytology**

Types of cells and tissues – cytoplasmic inclusion at ultrastructural level, nucleus and nuclear components, nuclear envelope, cell divisions, chromosome preparation - methodology.

### **UNIT 5: Genetics**

Principles of genetics, interactions and environmental influences, practical application of genetics – hybridization of fishes, recent trends and techniques in hybridization, selective breeding, cross breeding, development of disease resistance and high quality of new strains, transgenic fish production.

Chromosome manipulation, its role in aquaculture, androgenesis, gynogenesis, sex reversal and triploidy, cryopreservation and conservation of germplasm. Transgenic fish.

## REFERENCE BOOKS

1. Kirpichnikov, V.S., 1979. Genetic Bases of Selection in Fish. Springer – Verlag, Berlin, 410 pp.
2. Dass, P. and A.G. Jhingran, 1989. Fish Genetics in India. Today and Tomorrow Printers and Publishers, New Delhi, 266 pp.
3. Nagabhushanam, R., 1989. Text Books of Animal Physiology. Oxford IBH Publishing Co. Pvt. Ltd, New Delhi, 634 pp.
4. Trygve Gjedrem, 1990. Genetics in Aquaculture III (Journal of Aquaculture, Vol. 85). Elsevier Inc, New York, 340 pp.
5. De Robertis, E.D.P. and E.M.F. De Robertis, 1996. Cell and Molecular Biology. Waverly Pvt. Ltd., New Delhi, 734 pp.
6. Old, R.W. and S.B. Primrose, 1998. Principles of Gene Manipulation- an Introduction to Genetic Engineering. Blackwell Science Inc, New York, 474 pp.
7. Karp, Gerald, 2005. Cell and molecular biology: Concepts and Experiments John – Wiley and Sons, New York, 780pp.
8. Pandian, T.J., 2011. Sex determination in Fish, Saenll publishers / CRC Press. New York.

## **CAQC 104 – FARM ENGINEERING**

### **Objectives:**

Shrimp aquaculture is being practiced world wide because of its universal appearance and unique taste. Shrimp fetch demand an international market. Understanding of shrimp culture practices will be highly beneficial for the coastal aquaculture students to get themselves placed in this industry.

### **Unit I**

Principles of fish farm engineering – site selection – technical considerations – topography soil type, water supply, quality and dynamics.

Non-technical considerations – socio-economic, political and legal aspects.

### **Unit II**

General principles and procedures of elementary engineering survey, planning of survey in coastal region, computation of area.

### **Unit III**

Requirements of a brackishwater farm. Pond – its types, size, shape, design; Dyke – types, size and shape; Inlet and Outlet structures – types and design; supply and drainage canals – design and construction, operation and maintenance of farms.

### **Unit IV**

Water supply to fish farm – controlling devices of flow, pump types – aerating equipments and filtration systems.

### **Unit V**

Open sea – farming – site selection, Constraints and prospects of open sea farming – Culture in Cages, Pens, rafts rack and raceways: design, construction, repairing and maintenance. This paper is focussed mainly on the site selection farm designing, construction and different types of farming practices.

## REFERENCE BOOKS

1. Pillay, T.V.R., 1972. Coastal Aquaculture in the Indo – Pacific Region. Fishing News (Book) Ltd., London, 497 pp.
2. Bardach, J.E., J.H. Ryther and W.O. McLarney, 1972. Aquaculture: Farming and Husbandry of Freshwater and Marine Organisms. Wiley Interscience, New York, 868 pp.
3. Korringa, P., 1976. Farming Marine Fishes and Shrimps. Elsevier Publishing Company, Amsterdam, 208 pp.
4. Chen, T.P., 1976. Aquaculture Practices in Taiwan. Fishing News (Books) Ltd., London, 160 pp.
5. Shigeno, K., 1978. Problems in Prawn Culture. Amerind Publishing Co. Pvt. Ltd., New Delhi, 103 pp.
6. Gerwick, JR. B.C., 2007. Construction of Marine and Offshore Structures, CRC press, NewYork, 813 pp.
7. Grover, T.K., 2007. Basic Marine Engineering, Anmol, New Delhi, 275 pp.
8. Pandey, B.N., S. Deshpande and P.N. Pandey, 2007. Aquaculture, APH, New Delhi, 236 pp.
9. Bhuejl, R.C., 2008. Statistics for Aquaculture, Wiley – Blackwell, New York, 222pp.
10. Holmer, M., 2008. Aquaculture in the ecosystem, Springer, Newyork, 326 pp.
11. Ramakrishnan, T.V., 2008. Offshore Engineering, Gene – Tech Books, New Delhi, 347 pp.

## **CAQC 105 – AQUARIUM KEEPING AND MANAGEMENT**

### **Objectives:**

Aquarium keeping is worldwide hobby and the production of ornamental fishes is a multi-billion dollar business. This paper deals with all aspects covering right from the aquarium components to the management of the aquarium. At the end of the course the post graduate students shall be well versed in not only the setting up of aquarium but also the successful maintenance.

### **Unit I - Introduction**

Freshwater and marine aquaria – global status of aquarium fish keeping – advantages and benefits of fish keeping – criteria of choosing aquarium fishes – common aquarium fishes – collection techniques.

### **Unit II - Indoor aquarium**

Tank designs – fabrication of tanks – choosing the right tank – buying and locating a tank.

### **Unit III Aeration and filtration**

Air pumps – air operated filters – biofilters – Heating devices – aquarium thermostats – water quality maintenance – lighting methods.

### **Unit IV - Setting up an aquarium**

Tropical marine set up – aquascaping – base covering – adding decorative materials – plants.

### **Unit V – Health Management**

Basic diets – diseases and health management – treatment to sick fishes – guidelines for exhibiting fishes – photographing aquarium fishes.

## TEXT BOOKS

1. Alan Mark Fletcher, 1968. Unusual Aquarium Fishes. J.B.Lippincott Company, 143 pp.
2. Stephen Spotte, 1973. Marine Aquarium Keeping the Science Animals and Art. A. Wiley – Inter Science Publication, New York 171 pp.
3. Er Hunnam, 1981. The Living Aquariums. NORDBOK, 240 pp.
4. Dick Mills, 1987. The Practical Encyclopedia of the Marine Aquarium. Salamander Books Limited, 208 pp.
5. John Dawes, 1995. Live bearing Fishes (A guide to their Aquarium care, Biology and Classification) Cassell Pvt., London, 240 pp.
6. Lieske, E, Myers, R. 1996. Coral Reef Fishes, Princeton University Press, Princeton, New Jersey, 400 pp.
7. Nick Dakin, 1996. The Interpet questions & Answers Manual of the Marine Aquarium. Interpet publishing, 206 pp.
8. Walter H. Adey and Karen Loveland, 1998. Dynamic Aquaria Building Living Ecosystems. Academic Press, New Delhi, 498 pp.
9. Sebastian J. Kuravamveli, 2002. The Aquarium Handbook. Amity Aquatech Pvt. Ltd., Cochin – 28.
10. Sundararaj, V. and J.M. Sathish, 2005. Tropical Marine Aquarium. Yegam Publications, Chennai, 144 pp.

## **CAQC 106 –COMPUTER APPLICATION - I**

### **Objectives:**

This course will offers exposure to the hardware, terminology and functions of the personal computer. Hands on experience using popular software will allow exploration and basic introduction to windows and word processing. It also offers internet, web designing and multimedia operations.

### **UNIT – 1**

Introduction to Computers – Application of Computers – Concepts of Data and Information – A Typical Computer System – Memory Concepts – History of Computers – Types of Computers.

Input –Output Devices – Data Storage Devices – Software – The Definition – The Role of Software – Housekeeping.

### **UNIT – II**

The Computer Internals – Typical PC Configuration – Booting – Virus, Anti-virus, Vaccine – Versions of Software.

Operating System – Definition – Classification – Basics of MSDOS – Introduction to Windows Operating System – Features of Windows OS – Desktop and Desktop Icons – Starting Programs – Browsing and Managing Windows Explorer – Setting – Taskbars and Creating Shortcuts.

### **UNIT – III**

Introduction to Internet – Client Server Basics, e-mail, Telnet and Archie – FTP – Gopher, Jughead and Veronica – WAIS and World Wide Web.

Fundamentals of HTML, TCP/IP and E-commerce.

### **UNIT – IV**

Issues involved in Web Site Management – Addressing – Designing Web Sites and Front Page.

### **UNIT – V**

Multimedia – Concept, Requirements, Applications and Future – Hardware and Software Requirement for Multimedia Development and Deliver Platforms – Multimedia Methodologies, Fundamentals and Use of Hypertext, Hypermedia, Sound, Images, Animation, Video.

Using Multi Media: Multimedia Interface, Planning and Development of Multimedia projects.

### **Text Books**

1. Ron Mansfield, Osbrone, Windows 95 for Busy People, McGraw Hill
2. Ron White, How computers work, BPB
3. Christian Crumlish – The ABCs of the Internet
4. Alexis Leon & Mathews Leon – “Internet in a nut shell” Leon Press, Chennai & Vikas Publishing House, New Delhi.
5. Tay Vaughan – Multimedia Making it work, Osborne tata McGraw Hill, 1996.

### **Reference Books**

1. Computer Fundamentals and Windows with Internet Technology, by Krishnan, Scitech Publications (India) Pvt. Ltd., Chennai.
2. Windows and MS-OFFICE 2000 with database Concepts, by Krishnan, Scitech Publications (India) Pvt. Ltd., Chennai.
3. Stephen Nelson – Field Guide to the Internet.
4. James Meade, David Growder, Rhonda Growder – Microsoft DHTML.
5. RosenBrog – A Guide to Multimedia.
6. Ned Sneel – The Internet Strater kit in 24 hours Techmedia, 1998.
7. Michael Goodwin – Making Multimedia Works, Coomdex, 1995.

## CAQC 107 - COMMUNICATION SKILLS

### Unit - I

#### Process of communication

Concept of effective communication- Setting clear goals for communication; Determining outcomes and results; Initiating communication; Avoiding breakdowns. Creating value in conversation; Barriers to effective communication; Non verbal communication- Interpreting non verbal cues; Importance of body language, Power of effective listening; recognizing cultural differences.

### Unit - II

#### Presentation skills

Formal presentation skills; Preparing and presenting using Over Head Projector, Power Point; Defending Interrogation; Scientific poster preparation and presentation; Participating in group discussions.

### Unit - III

#### Technical Writing Skills

Types of reports; Layout of a formal report; Scientific writing. Problems in the preparation of a scientific document; Plagiarism; Scientific Publication Writing: Elements of a Scientific paper including Abstract, Introduction, Materials and Methods, Results, Discussion, References; Drafting titles and framing abstracts.

### Unit - IV

#### Computing Skills for Scientific Research

Web browsing search engines Hidden Web and its importance in Scientific research; Internet as a medium of interaction of scientists; Effective e-mail strategy using the right tone and conciseness

#### Texts/References

- 1, Wren & Martin, 2000. A Simple course of English Grammer and Composition. S. Chand Publishers, 376 pp.
2. Ruby Lavel, 2001. Writing and Grammer – Communication in Aesian Prentice Hall Inc, 950 pp .
3. Mohan Krishna and N.P. Singh, Speaking English Effectively, Mac Millan, New Delhi, 939pp.
4. Lonidray, D. 2011. Scientific writing – Thinking in words, CSIRO publishing. New Delhi

## **CAQP 108 – PRACTICAL I (Covering courses 101 & 104)**

### **PRACTICALS : CAQC 101 - Fundamentals of Marine Biology & Oceanography**

1. Phytoplankton – Methods of collection, identification of common forms, estimation of standing crop and primary production, Methods of estimation.
2. Zooplankton – collection, estimation, identification of major groups and biomass analysis.
3. Benthos – collection, qualitative and biomass analyses
4. Analyses of water qualities  
Salinity  
Dissolved Oxygen  
Nutrients  
pH  
BOD and COD  
H<sup>2</sup>S and  
Ammonia
5. Identification of commercially important fin and shell fishes, algae especially medicinally important algae, mangroves, animals etc (Snakes, Corals, Sponges etc).

### **PRACTICALS : CAQC 104: Farm Engineering**

1. Survey of sites and topography studies
2. Study of soil characteristics in selected sites – Physical properties of soil – Texture – Permeability – Resistance – Chemical properties of soil – pH – Organic carbon – N.P.K. – Hydrogen sulphide
3. Survey of Water potentials and water quality characteristics
4. Measurement of velocity and discharge of tidal channel
5. Field visit to study the components of a brackishwater farm system
6. Drawing of layout of the farm visited
7. Observations / operation of pumps, aerators, feeding trays, etc.

## **CAQP 109 – PRACTICAL II (Covering courses 102 & 103)**

### **PRACTICALS - CAQC 102 – Nutrition and Biochemistry**

1. Formulation and preparation of artificial feeds for finfish and shrimps
2. Determination of food intake and digestibility coefficient
3. Culture of live – feed organisms (Phytoplankton and zooplankton)
4. Estimation of the following in the feed ingredients and feeds:  
Carbohydrates by Colorimetric method  
Proteins by Colorimetric method  
Use of Spectrometer
5. Chromatographic separation of free aminoacids and carbohydrates by ascending, descending and circular paper chromatographic techniques
6. Chromatographic separation of lipids by T.L.C.
7. Estimation of moisture and lipid content
8. Electrophoretic separation of protein

### **PRACTICALS - CAQC 103 – Physiology, Cytology and Genetics**

1. Estimation on oxygen consumption and rate of respiration in a fish or a crab
2. Effect of hydrogen – ion concentration on amylase activity of the crystalline style
3. Effect of temperature and salinity on respiration of a fish or a crab
4. Effect of temperature – the rate of particle transport in a bivalve
5. The rate of particle filtration in bivalves
6. Hormone study – display of endocrine organs in a crustacea
7. Blood cell counts and haemoglobin estimation
8. Types of cells – study from slides
9. Mitosis – Meiosis – giant chromosomes
10. Preparation of chromosome in fishes
11. Induction of ploidy etc.

## II SEMESTER

### CAQC 201 – BIOLOGY AND CULTURE OF CRUSTACEANS

#### Objectives:

Shrimp aquaculture is being practiced worldwide because of its universal appearance and unique taste. Shrimp fetch demand an international market. Understanding of shrimp culture practices will be highly beneficial for the coastal aquaculture students to get themselves placed in this industry. Thus this paper is focused on the biological aspects, farming practices and management of crustaceans including shrimps, crabs and lobsters. In this paper the students are also taught how to estimate the production and work out the economics.

#### UNIT 1

An overview of Crustacean culture – historical background, general review and present status of culture of shrimps, lobsters and crabs and freshwater prawns in India and abroad. Important areas of culture, species of crustaceans cultured in different regions of the world and India, production and its trend.

#### UNIT II

Moulting – different stages of moulting, its influence on growth, interaction with reproduction and endocrine control of moulting.

Collection of brood stock and transportation, breeding under controlled conditions, brood stock development and management techniques of induced breeding. Hatchery production of seed, types of hatcheries, components of a hatchery - Nursery management and Feeding schedule.

#### UNIT III

Field culture – traditional culture practices prevailing in India and in other countries, advantages and disadvantages of these practices. Culture of *Penaeus monodon*, *P.indicus* and *P.vannamei*.

Extensive, semi – intensive and intensive cultures - their management practices.

#### Unit IV

Culture of freshwater prawn *Macrobrachium* spp. and its seed production

Culture of lobsters and crabs in India and elsewhere – prospects and constraints.

## Unit V

Production and economics - Shrimps and *Macrobrachium* culture in extensive and semi – intensive systems.

### REFERENCE BOOKS

1. Pillay, T.V.R., 1972. Coastal Aquaculture in the Indo – Pacific Region. Fishing News (Book) Ltd., London, 497 pp.
2. Bardach, J.E., J.H. Ryther and W.O. McLarney, 1972. Aquaculture: Farming and Husbandry of Freshwater and Marine Organisms. Wiley Interscience, New York, 868 pp.
3. Korringa, P., 1976. Farming Marine Fishes and Shrimps. Elsevier Publishing Company, Amsterdam, 208 pp.
4. Chen, T.P., 1976. Aquaculture Practices in Taiwan. Fishing News (Books) Ltd., London, 160 pp.
5. Shigueno, K., 1978. Problems in Prawn Culture. Amerind Publishin Co. Pvt. Ltd., New Delhi, 103 pp.
6. Josianne., G Stottrup and Lesley A. McEroy, 2003. Live feeds in Marine aquaculture. Black well publishing, 313 pp.
7. David, A. Bengtson, 2003. Status of Marine aquaculture in relation to live prey: past, present and future, Black well publishing , 1-13.
8. Arnaud Muller, Feuga, Jeanne Moal and Raymond Kaas, 2003. The Microalgae of Aquaculture, 206 – 243.
9. Eva.E.Plaganyi, 2007. Models for an Ecosystem approach to fisheries. Organization of the United Nations, 108pp.

## **CAQC 202 – BIOLOGY AND CULTURE OF FINFISHES**

### **Objectives:**

The objective of the paper is to teach the post graduate students of coastal aquaculture about biology and culture of fin fishes. Without understanding the biology of finfishes culturing them is highly impossible scientifically. Therefore, the present paper deals both biology and culture together. This paper is planned to teach in the lines of understanding the candidate species of important cultivable finfishes, gaining knowledge in the food and feeding habits and life history of the candidate species, investigating the natural seed potential and artificial fish seed production through hatcheries, fish farm management and their detailed methods of farming, giving information on market value of fishes and their cost of production and providing scope for employment opportunities in aquaculture activities.

### **UNIT I: Finfish biology**

Biology of cultivable finfishes - Life history – food and feeding – age & growth – reproduction

### **UNIT II: Seed**

Seed production - distribution and abundance, methods for resource assessment and collection of seeds. packing and transportation.

### **UNIT III: Hatchery**

Types of fish hatcheries – Fish hatchery components.

Artificial production of seed, breeding under controlled conditions, techniques induced breeding, egg incubation and larval rearing procedures and systems. Hatchery production of seeds, packing and transport of brooders and seeds.

### **UNIT IV: Fin fish Culture**

Culture practices in ponds of important finfish species, preparation and management of nursery and grow – out ponds, eradication of undesirable organisms, nursery technique, pond fertilization, stocking, feeding and provision for removal of metabolites.

### **UNIT V: Polyculture**

Polyculture – species selection for polyculture, criteria and characteristics of species selected for polyculture, stocking density and ration, feeding and management.

## **Ornamental fish culture**

Ornamental fish culture. Production and economics – optimal size for harvesting, methods of harvesting economics.

### **REFERENCE BOOKS**

1. Bardach, J.E., J.H. Ryther and W.O. McLarney, 1972. Aquaculture: Farming and Husbandry of Freshwater and Marine Organisms. Wiley Interscience, New York, 868 pp.
2. Pilly, T.V.R., 1972. Coastal Aquaculture in the Indo – Pacific Region. Fishing News (Books) ltd., London, 497 pp.
3. Hornell, J., 1984. Marine Fish Farming for India. Shanthi Books, Madras, India, International Books and Periodicals Supply, 83 pp.
4. Shanmugam, K., 1990. Fishery Biology and Aquaculture. Leo Pathippagam, Madras, India, 342 pp.
5. Santhanam, R., N. Ramanathan and G. Jegadeesan, 1990. Coastal Aquaculture in India, CBS Publication, Delhi – 32, 180 pp.
6. Khanna, S.S. and H.R. Singh, 2003. A textbook of fish biology and fisheries. Narendra Publishing House, New Delhi, 524pp.
7. Gurdarshansingh and H. Bhaskar, 2003. An introduction to fishes. Campus Books International, New Delhi, 436pp.
8. Nick Dakin, 2004. The Marine Aquarium. Oxford Publishing, London, 206 pp.
9. Sundararaj, V. and J.M.Satheesh, 2005. Tropical Marine Aquarium, Yegam Publications, Chennai, 140 pp.

## CAQC 203 – BIOLOGY AND CULTURE OF MOLLUSCS AND SEAWEEDS

### Objectives:

In India, the culture of molluscs and Seaweeds is in its growing stage, though these two groups (Molluscs and Seaweeds) include many cultivable important species. Further, for the culture of any group of organism / plant the basic knowledge about its biology becomes imperative. Hence the paper on “Biology and culture of molluscs and Seaweeds” has been included in the curriculum with the objectives of understanding the biology pertaining to food and feeding, reproduction and age and growth of the cultivable important species, knowing and estimating the distribution and seed resources in the natural environment, studying the technology involved in the artificial seed production of the cultivable important species and understanding the various techniques involved in the culture of molluscs (Clams, cockles, mussels and Oysters) and Seaweeds.

### **UNIT1: Biology - molluscs**

Biology of cultivable molluscs – life history, food and feeding, age and growth and reproduction.

### **UNIT 2: Seed from Nature**

Natural seed resources, utilization, ideal condition for seed fall in nature, distribution of seed, time of seed abundance, seed collection techniques for different species, transportation, seed quality and selection.

### **UNIT 3: Hatchery**

Hatchery production of molluscan seed - need for hatcheries for molluscs, brood stock management, induced maturation and spawning, larval rearing & microalgal culture for feeding spat settlement, ideal spat collectors, rearing of juveniles to stockable size, water quality management, transportation.

### **UNIT 4: Culture**

Culture technology – culture operations, rearing, transportation, monitoring of growth, monitoring of environmental parameters, causes of mortality, different culture techniques and various steps involved in detail and problems encountered on the culture of clams, cockles, edible oyster, pearl oyster and mussel, economic importance of molluscs.

### **UNIT 5: Seaweeds**

General introduction to seaweeds – criteria for selection of candidate species in India, biology – life history, growth, reproduction of *Ulva*, *Laminaria* and *Gracilaria*.

## **Culture :**

Seaweed culture – technology for higher yields, products from seaweeds (agar, algin and carageenan) and extraction methods, production and economics of seaweed culture, economic importance of seaweeds.

## **REFERENCE BOOKS**

1. Pillay, T.V.R 1972. Coastal Aquaculture in the Indo – Pacific Region. Fishing News (Books), London, 497 pp.
2. Milne, P.H., 1972. Fish and Shellfish Farming in the Coastal Water. Fishing News (Books), London, 208 pp.
3. Bardach, J.E., J.H. Ryther and W.O. McLarney, 1972. Aquaculture: Farming and Husbandry of Freshwater and Marine Organisms. Wiley Interscience, New York, 868 pp.
4. Dawes, C.J. 1988. Marine Botany. John Willey & Sons, New York, 480 pp.
5. Santhanam, R., Ramanathan and G. Jegadessan, 1990. Coastal Aquaculture in India. CBS Publication, India, 180 pp.
6. John E. Bardach, 1997. Sustainable Aquaculture. John Willey & Sons, Inc., New York, 251 pp.
7. Thomas, P.C., 1998. Current and Emerging Trends in Aquaculture, Daya Pub., Delhi, 422 pp.
8. Robert R. Stickney, 2000. Encyclopedia of Aquaculture. John Wiley & Sons, Inc., New York, 1063 pp.
9. Krisnamurthy.V and M.Balusamy, 2010. Phaeophyceae of India and neighborhood. Madras Christian College publishing, Chennai, 193pp.

## **CAQC 204 – HEALTH MANAGEMENT IN AQUACULTURE SYSTEMS**

### **Objectives:**

Marine microbes play a major role in causing diseases in capture and culture fisheries. For sustainable development of the aquaculture, a thorough understanding of microbial pathogens and their control are necessary.

### **UNIT 1: Microbiology**

General introduction to marine microbiology and pathology – their importance in aquaculture system – Health management in aquaculture system.

### **UNIT 2: Methods: Isolation and Culture**

Methods of studying the coastal microorganisms – methods of collection of water, sediment, finfish and shellfish samples, isolation and culture of bacteria, enumeration, total and viable counts, identification of bacteria based on their morphological, physiological and biochemical characteristics.

Microbial nutrition, influence of environmental factors on microbial growth and activity, structure and biology of bacteria and viruses.

Role of microorganisms in the cycling of minerals – sulphur cycle, nitrogen cycle and phosphorus cycle, probiotics.

### **UNIT 3: Diseases – Finfishes**

Disease development factors involved, abiotic and biotic.

Detailed study on diseases of finfish (food fishes) – viral, bacterial, fungal, parasitic (protozoan & metazoan), environmental and nutritional diseases.

Diseases of ornamental fishes.

### **UNIT 4: Diseases – Shell fishes**

Detailed study on shellfish diseases (shrimp, lobster, molluscs) – viral, bacterial, fungal, parasitic (protozoan & metazoan), environmental and nutritional diseases.

Larval health monitoring with special reference to shrimps and fishes.

Modern techniques employed in diagnosis of diseases in cultivable organisms with special reference to shrimps, WSSV sample collection and preparation for different techniques (microbiology, immune studies)

## **UNIT 5: Diseases – Prevention**

Prevention of diseases – Good management procedure (GMP) - environmental and physical methods, chemical methods, biological methods.

Salinity practices and prophylactic measures – in hatcheries and grow out ponds, disinfection procedures, water quality standards and their levels associated with fish health and disease, common chemicals and antibiotics in use, toxic substances damaging fish health.

Immune mechanisms and immunization of cultivable organisms.

### **REFERENCE BOOKS**

1. Conroy, D.A. and R.L.Herman, 1997. Text Book of fish diseases, Narendra Publishing House, New Delhi, 301 pp.
2. Woo, P.T.K. and D.W. Bruno, 1998. Fish Diseases and Disorders – Vol. 3. Viral, Bacterial and Fungal Infections. CABI Publishing, New Delhi 874 pp.
3. Presscott, L.M., Harley, J.P. and D.A. Klein, 1999. Microbiology, McGraw Hill Inc, New York pp. 962.
4. Wedemeyer, G.A., Meyer, F.P. and L. Smith, 1999. Environmental Stress and fish diseases, NPH Publishing House, New Delhi 192 pp.
5. Austin B. and D.A. Austin, 1999. Bacterial Fish Pathogens – Diseases of farmed and wildfish. Springer Praxis Publishing, New York, 457 pp.
6. Stickney, P.R., 2000. Encyclopedia of Aquaculture. John Wiley & Sons, Inc, New York, 1063 pp.
7. Nowak, M.A. and R.M. May, 2000. Virus dynamics: mathematical principles of immunology and virology .Oxford University Press, London, 273pp.
8. Cann, A.J., 2000. DNA virus replication. Oxford University Press, London, 232pp.
9. Dimmock, N.J., A.J. Easton and K.N. Jeppard, 2001. "Introduction to Modern Virology Blackwell Science, New York, 449pp.
10. Wagner, E.K. and M.J. Hewlett, 2004. Basic Virology 440pp
11. John Humphrey, J. Richard Arthur, Rohana P. Subasinhe and Michael J.Philips, 2005. Aquatic animal quarantine and health certification in Asia. FAO, Daya publishing House, 145pp.
12. Aquatic animal quarantine and health certification in Asia. FAO, Daya publishing House, 145pp.

## CAQC 205– POST HARVEST TECHNOLOGY

### **Objectives:**

Last few decades had witnessed widespread development in the technologies for capture as well as culture of aquatic organisms world over. There is tremendous advancement in the post-harvest technology in the field of fisheries. As fish is one of the most perishable commodities, there is a need for proper preservation and processing. Pre-processed handling, processing, packaging and transportation are the essential steps involved in preservation and processing. Being a commodity of high economic value earning substantial quantum of foreign exchange, the fish and fishery products receive utmost care and importance and the scope for the further development in this sector are quite promising. The human resources development in this sector is also promising as it is a major provider of employment next only to agriculture and the much – needed inexpensive wholesome protein food to the masses. With these facts in mind the syllabus has been framed to impart knowledge on the entire gamut of preservation and processing.

### **UNIT 1: Importance of preservation and processing**

Cultured organisms, criteria for assessing the freshness of cultured organisms – handling of fresh materials, phenomena of rigor mortis, quality assurance, HACCP –Concepts – Plans – Hazard Analysis – Identification – Assessment.

### **UNIT 2: Fish spoilage**

Types of fish spoilage, causative factors – autolytic spoilage, microbial spoilage, oxidative changes.

### **UNIT 3: Drying and Curing**

Dehydration – conventional and modern methods of drying (Solar driers), relative merits and demerits.

Salt curing, pickling and smoking – merits and demerits.

### **UNIT 4: Freezing and canning**

Cold storage – various types of freezers, individually quick freezing (IQF), cold storage design and equipments, freeze – drying, canning – history of canning containers, canning procedures.

## **UNIT 5: Fishery By-products**

Fishery by – products of commerce – processing of miscellaneous products, fish meal, oil, fish protein concentrate, fish wafers, ensilage, chitosan etc., development of diversified products.

Antibiotic residue analysis – Muddy smell - marketing – export – domestic – economics.  
Marketing role of MPEDA.

### **REFERENCE BOOKS**

1. Kreuzer, R., 1965. The Technology of Fish Utilisation. Fishing News (Books) Ltd., London, 280 pp.
2. Kreuzer, R., 1965. Freezing and Irradiation of Fish. Fishing news (Books) Ltd., London, 528 pp.
3. Burges, G.H.O., C.L. Cutting, J.A. Lovern and J.J. Waterman, 1965. Fish Handling and Processing Her Majesty's Stationery Office, Edinburg, 390 pp.
4. Pillay, T.V.R., 1972. Coastal Aquaculture in the Indo – Pacific Region. Fishing News (Books), London.
5. Kreuzer, R., 1974. Fishery Products. FAO Fishing News (Books), England, 462 pp.
6. Govindan, T.K., 1985. Fish Processing Technology. Oxford and IBH publishing Company Private Ltd, 252 pp.
7. Gopakumar, K. 1997. Tropical Fishery Products. Oxford & IBH Publications, 190 pp.
8. Chandran, K.K., 2000. Post Harvest Technology of Fish and Fish Products. Daya Publishing House, New Delhi, 440 pp.
9. Balachandran, K.K., 2001. Post harvest Technology of fish and fish products. Daya Publishing House, New Delhi, 440 pp.
10. Malhotra, S.P. V.R.P. Sinha, 2007. Indian fisheries and Aquaculture in a globalizing economy. Narendra Publishing House, New Delhi, 385 pp.
11. Dietrich Knorr, 2005. Food Biotechnology, Marcel Dekker Publishing, New York.
12. Vickie, A. Vaclavir, Elizabeth W. Christian, 2009. Essentials of food Science – Second edition Springer – Food Science text series, New York.

## CAQP 206 – PRACTICAL - III (Covering course 201)

### PRACTICALS : CAQC 201 : Biology and Culture of Crustaceans

1. Collection and identification of prawns, shrimps, lobster and crab seeds from nature by using different nets.
2. Technique of induced breeding and rearing of eggs through larval and postlarval stages to stocking size, counting methods of eggs and nauplii in a hatchery.
3. Study of hatchery facilities like tanks, pumps, aerators, filters etc. in prawn hatcheries.
4. Determination of stocking density, techniques of field culture operation and monitoring of the stocked prawn through demonstration and field visits.
5. Recording and maintenance of data in a prawn and shrimp farms.
6. Field visit to observe harvesting operation, recording of data of production estimation.
7. Visit to sea food processing unit.
8. Visit to CIBA to see sea bass culture technology and feed mill etc.
9. Identification of males and females in commercially important fishes.
10. Hyphophysation technique.

## CAQP 207 – PRACTICAL IV (Covering course 202 & 203)

### PRACTICALS CAQC 202 - Biology and Culture of Finfishes

1. Identification of fish and shrimp larvae from plankton collection
2. Collection and identification of seeds from wild using different gears and seed resource survey.
3. Identification of important cultivable species and common ornamental fishes.
4. Techniques of induced breeding – dissection, preservation and demonstration of pituitary gland in alcohol and glycerol, rearing of eggs and larvae.
5. Observation on the management practices of nursery and stocking ponds, stocing density.
6. Field visit to finfish culture systems and submission of report
7. Harvest, data recording, growth and production estimation.
8. Methods of transport of seeds and brooders.

### . PRACTICALS : CAQC 203 : Biology and Culture of Molluscs and Seaweeds

1. Collection of molluscan seed – materials, preparation and laying of spat collectors, observation of spat fall.
2. Farm visit to witness seeding, growth, measurement, thinning, harvesting and *in situ* measurements of production.
3. Induction of spawning by physical, chemical and biological techniques.
4. Identification of locally available seaweeds.
5. Demonstration of algin and agar extraction.
6. Field visit to observe the culture of seaweeds and the technique of harvest.

7. Submission of field report.
8. Identification of males and females in commercially important hypopharynx technique

### **CAQP 208 – PRACTICAL V (Covering course 204 & 205)**

#### **PRACTICALS : CAQC 204 - Health Management in Aquaculture Systems**

1. Preparation of Media
2. Microbial population enumeration in water and sediment of ponds and fin and shellfish samples.  
Pond water samples  
Pond sediment samples
3. Isolation of pathogens from diseased specimens
4. Separation of mixed cultures, different types of streaking – phase streaking, continuous streaking, ‘T’ streaking and radial streaking.
5. Estimation of Coliforms – MPN method.
6. Identification of bacteria, staining – negative, simple and gram, motility test – Hanging drop method (or) using Semisolid medium,  
Biochemical tests – oxidase, catalase, triple sugar iron agar, decarboxylase, arginine, lysine, ornithine, indole, oxidation fermentation test, nitrate reduction test, methyl red test, voges test, proskauer test, citrate test, starch hydrolysis, gelatin hydrolysis, casein hydrolysis.
7. Antibiotic assay
8. Isolation of fungi from old stocked feeds
9. Identification of fungi
10. Larval Health monitoring – shrimp  
Microbial load – bacteria, fungi, protozoa.  
Physiological / physical manifestations  
Occlusion bodies
11. Demonstration of disease symptoms through histopathological slides
12. Demonstration of dot plot and PCR

## **PRACTICALS : CAQC 205 - Post Harvest Technology**

1. Field visit to different processing plant and submission of report
2. Quality Analysis in Fishes
3. Proximate composition in fresh and ice stored Fishes
  - Moisture
  - Protein
  - Ash
  - Acid insoluble ash
  - Fat
  - Peroxide value
    - Free fatty acid
    - Thiobarbitoric acid value
4. Sensory analysis in Fishes and Prawns
5. Prawns – Formulation of different products for export
  - PD
  - PUD
  - HL
  - Fillets
6. Analysis of Indole in Prawns
7. Ice storage studies – observations – nature of the eyes, gills, texture, peritonium, fibrousness, smoothness, toughness succulence.
8. pH – Fresh & Stored Fishes and Prawns.
9. Shell fish poisoning in processed fish.
10. Microbial Analysis
  - Total bacterial count
  - Coliforms
  - Staphylococcus
  - Streptococci
11. Preparation of certain by – products and miscellaneous products.
12. Preparation of Coated Products.

### III SEMESTER

#### CAQC 301 – INSTRUMENTATION AND ANALYTICAL METHODS

##### **Objectives:**

The main objectives of this paper are to expose students to state of the art instrumentation, to introduce them to the methods of various instruments used in aquaculture and to prepare them to use these techniques in their own research. The course is a combination of lectures and demonstrations on the principles of the instruments such different minor equipments necessary for aquaculture, microscopes, spectrophotometers and chromatographs. The laboratory work is scheduled separately for each student. The students also gain the knowledge and skill in the preparation of whole mounts. Instruments in each category are provided to work with and conduct field and laboratory trails.

##### **UNIT 1: Field Equipments**

Minor equipments – Working principles and uses of water and sediment samplers – secchi disc, lux meter, turbidity meter, pH meter, oxygen analyzer, refractometer, salinometer, echosounder,.

##### **UNIT 2: Microscopes and Centrifuge**

Microscopy – light microscope, phase contrast, electron microscope, and photomicrography.

Centrifugation – Centrifugal force and principles of sedimentation, sedimentation coefficient, types of centrifuges, types of centrifugation, molecular weight determination.

##### **UNIT 3: Spectroscopy**

Absorption and emission principles – Principles and application of colorimeters, UV visible spectrophotometers, spectrofluorometer, Flame photometer, atomic absorption spectrophotometer, Inductively coupled plasma spectrometer (ICP).

##### **UNIT 4: Electrophoresis and Chromatography**

Electrophoresis: General principles – factors affecting mobility of charged molecules – principles and uses of electrophoresis, agarose gel electrophoresis, pulsed field gel electrophoresis, isoelectric focusing, polyacrylamide gel electrophoresis.

Chromatography: Paper, thin layer, gas chromatography high performance liquid chromatography, ion-exchange chromatography – principles and uses of each type.

## **UNIT 5 – Microtechnique**

Microtechnique – sliding and rotary microtomes, freezing microtome, specimen fixation, dehydration, embedding and sectioning, staining of sections, whole mount preparation.

### **REFEERNCE BOOKS**

1. Richard W. Von Norman, 1963. Experimental Biology. Prentice – Hall, New York.
2. Gunter Zweig and Joseph Sherma, 1972. Handbook of Chromatography Vols. I & II. Cleveland, Ohio 44128. (317 pp)
3. Gabe Manfred, 1976. Histological Techniques. Springer – Verlag, New York.
4. Galan W. Ewing, 1985. Instrumental Methods of Chemical Analysis.. McGraw – Hill Book Company, 538 pp.
5. Skoog, D.A. and J.J. Leary 1992. Principles of Instrument Analysis. Fourth Edition. Saunders College Publishers, Philadelphia, 700 pp.
6. Hawley, T.S. and R.G. Hawley, 2004. Flow cytometry protocols, Humana Press, 434 pp.
7. Gilian Mc Mohan, 2007. Analytical Instrumentation. A Guide to Laboratory, portable and miniaturized Instruments. John Wiley & Sons Ltd, England, 283 pp. ISBN 978 – 0470 – 027950.
8. Susanta Latiri, 2008. Trace analysis. Narendra Publishing House, New Delhi, 186 pp.
9. Rasan Katoch, 2011. Analytical Techniques in Biochemistry and molecular Biology, Springer Science & Business media, LLC, USA, c 431 pp, ISBN– 978-1– 4419– 9784-5
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## **CAQC 302 – BIOTECHNOLOGY AND APPLIED MARINE BIOLOGY**

### **Objectives:**

The improvement of the production, quality and other important traits of cultivable organisms is possible through the improvement of the system of culture and management practices followed in one hand and in the other hand the quality improvement is possible by employing certain biotechnological tools and improving the genetic makeup. Further the many of the organisms are the storehouses of some biologically important substances. In this context the present paper has been designed to teach the student about the various techniques, methodologies involved in the health management etc.

### **UNIT 1: Genetics**

Application of genetics, coastal aquaculture - genetic engineering and biotechnology in marine organisms.

### **UNIT 2: Pharmacology**

Application of biological concepts / systems in the seafood industries – seafood biochemistry - human health – marine pharmacology, bioactive compounds from marine flora and fauna and environment – mangrove coastal forestry.

### **UNIT 3: Immunology**

Disease diagnosis – concepts, ELISA, dot immunobinding, western blotting, latex agglutination test, monoclonal antibodies – DNA based diagnosis of diseases, fish vaccines.

### **UNIT 4: Biotechnology**

Rural and industrial biotechnologies – cell and tissue culture, microbial biofertilizers, microbial enzymes, fermentation, effluent treatments, biocorrosion, biofouling.

### **UNIT 5: Uses**

Production of biological systems for commercial utility;

Mass scale culture of microbes, seaweed – agar agar – other products – utilization. Peoples participatory approach - marine resource - management.

## REFERENCE BOOKS

1. Albert Sasson, 1984. *Biotechnologies: Challenges and Promises*. Oxford & IBH Publishing Co., New York, 315 pp.
2. David H. Attaway and R. Oskar, 1993. *Marine Biotechnology. Vol. I. Pharmaceutical & Bioactive Natural Products*. Plenum Press, New York & London, 500 pp.
3. Dubey, R.C., 1993. *A Text Book of Biotechnology*. S. Chand & Com. Ltd., New Delhi, 702 pp.
4. Singh, B.D., 1998. *Biotechnology*. Kalyani Publishers, Ludiana, N.D., Noida U.P., 694 pp.
5. Glick, B.R. and J.J. Pasternak, 1998. *Molecular Biotechnology: Principles and applications of recombinant DNA*, ASM Press, New York, 683 pp.
6. Milton Fingerman, R. Nagabushanam and Mary – Frances Thompson, 1999. *Recent Advances in Marine Biotechnology*, Vol. 1,2,3.
7. Pat Vaughan, 2000. *Methods in Molecular Biology: DNA Repair protocols: Prokaryotic Systems*, 209pp.
8. Rodney, J.Y. Ho, Milogibaldi, 2003. *Biotechnology and Biopharmaceuticals*, Wiley Liss publication, New Jersey, 556 pp.
9. Bhatia, S.C. 2005. *Text book of Biotechnology*, Atlantic Publishers, New Delhi, 492 pp.
10. Bir Bahadur, 2005. *Essentials of Biology and Biotechnology*. Pharma Book Syndicate, 594 pp.
11. Ghose, T.K and P. Ghose, 2008. *Biotechnology in India. Part – I* Springer Publishing, India, 292 pp.

## **CAQC 303 – AQUACULTURE INFORMATION, ECONOMICS AND EXTENSION**

### **Objectives:**

This paper is very useful to the candidates for self employment. It deals with important aspects like, how to avail land?. How to register a farm, hatchery? etc., starting from soil culture till harvest the steps involved are discussed. Further, extension education, marketing, techniques were given in this paper.

### **UNIT 1: Registration**

Land leasing policies of maritime states, setting – up of a aquaculture farm in practice how to go about, purchase of land, registration, registration in MPEDA / BFDA for getting subsidy and technical guidance, getting electric connection and other practical considerations.

### **UNIT 2: Funds**

Role of financial institutions – availing bank loan – formalities to be followed.

Role of insurance companies – formalities to be followed for getting insurance cover and preparation of claim for loss.

### **UNIT 3: Data**

Data base collection and Data processing : Data collection in different aquaculture practices - Traditional, extensive, semiintensive and intensive culture.- Relative economic model for the different practices.

### **UNIT 4: Information**

Aquaculture information – Internet, information collection of aquaculture practices – Dissemination processes – WTO, IPR issues in aquaculture farming.

### **UNIT 5: Extension**

Fishery extension – principles of extension, theory of motivation, extension methods and evaluation. Extension education.

Status of extension activities, transfer of technology, behavioural pattern of fishermen to structural changes, adoption of villages for integrated rural development, socio – economics, marketing, internal and external markets and trade, demand and supply.

## REFERENCE BOOKS

1. Bardach, F.E., J.H. Ryther and W.O. Mc Larney, 1972. Aquaculture: Farming and Husbandry of Freshwater and Marine Organisms. Wiley Interscience, New York.
2. Brown, E., 1976. World Fish Farming: Cultivation and Economics.
3. James Hornell., 1984. Marine Fish farming for India, International Books & Periodicals Supply service, 81 pp.
4. MPEDA, 1995. Sea fishes, Special publications, 63 pp.
5. MPEDA, 1995, Shrimp Hatchery, 65 pp.
6. Barry A. Costa, Pierce, 2002. Ecological Aquaculture, The evolution of the blue revolution, Black Well Science, 382 pp.
7. Pillay.T.V.R. and M.V. Kutty, 2005. Aquaculture principles and practices, Fishing News (Books), London. 624pp.
8. Tucker, C.S and Hargreaves, J.A, 2008. Environmental best management practices for aquaculture, Wiley Blackwell, New York.
9. Handbook on aqua farming shrimp, lobster, mud crab-MPEDA-Kochi, 72pp.

## CAQC 304 - Bioentrepreneurship

### Objectives:

This paper deals with all the aspects of accounting to marketing. The content of this paper trains and prepares the post graduate students in the above aspects to take up any position in the field of aquaculture and aquaculture related product's marketing.

### Unit I: Accounting and Finance

Taking decision on starting a venture; Assessment of feasibility of a given venture/new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/Plan for seeking loans from financial institution and Banks; Funds from bank for capital expenditure and for working; Statutory and legal requirements for starting a company/venture; Budget planning and cash flow management; Basics in accounting practices: concepts of balance sheet, P&L account, and double entry bookkeeping; Estimation of income, expenditure, profit, income tax etc.

### Unit II: Marketing & Negotiations/Strategy

Assessment of market demand for potential product(s) of interest; Market conditions, segments; Prediction of market changes; Identifying needs of customers including gaps in the market, packaging the product; Market linkages, branding issues; Developing distribution channels; Pricing/Policies/Competition; Promotion/ Advertising; Services Marketing

With financiers, bankers etc.; With government/law enforcement authorities; With companies/Institutions for technology transfer; Dispute resolution skills; External environment/changes; Crisis/ Avoiding/Managing; Broader vision–Global thinking

### Unit III: Information Technology

How to use IT for business administration; Use of IT in improving business performance; Available software for better financial management; E-business setup, management.

### Unit IV: Human Resource Development (HRD)

Leadership skills; Managerial skills; Organization structure, pros & cons of different structures; Team building, teamwork; Appraisal; Rewards in small scale set up.

### Unit V: Fundamentals of Entrepreneurship & Role of knowledge centre and R&D

Support mechanism for entrepreneurship in India

Knowledge centres like universities and research institutions; Role of technology and upgradation; Assessment of scale of development of Technology; Managing Technology Transfer; Regulations for transfer of foreign technologies; Technology transfer agencies.

## **Practical Case Study**

1. Candidates should be made to start a ‘mock paper company’, systematically following all the procedures.
  - The market analysis developed by them will be used to choose the product or services.
  - A product or service is created in paper and positioned in the market. As a product or services available only in paper to be sold in the market through the existing links. At this juncture, the pricing of the product or the service needs to be finalized, linking the distribution system until the product or services reaches the end consumer.
  - Candidates who have developed such product or service could present the same as a project work to the Panel of Experts, including representatives from industry sector. If the presented product or service is found to have real potential, the candidates would be exposed to the next level of actual implementation of the project.
2. Go to any venture capital website (like sequoiacap.com) and prepare a proposal for funding from venture capital.

## **REFERENCE BOOKS**

1. Hine, D. and J. Kapeleris, 2006. Innovation & Entrepreneurship in Biotechnology, An International Perspective- Concepts, Theories and Cases, Edward Elgar Publishing Limited, UK 259pp.
2. Patzelt, H. and T. Brenner (Eds.), 2008. Handbook of bioentrepreneurship International Handbook Series on Entrepreneurship, Springer Science + Business media LLC, 294pp.

## CAQC 305 Elective – I

### CAQP 306 – PRACTICAL VI (Covering courses 301 & 303)

#### **PRACTICALS: CAQC 301 - Instrumentation and Analytical Methods**

1. Measurement of salinity of seawater by refractometer
2. Determination of salinity of seawater by conductivity
3. Determination of salinity of seawater by salinometer
4. Determination of turbidity using turbidity meter,
5. Water sampling Devices:
  - a) Mayer's Water Sampler
  - b) Knudsen Water sampler
  - c) Nansen Water sampler
  - d) Universal Water sampler
  - e) Horizontal Water sampler
  - f) Bacteriological Water sampler
6. Sediment sampling Devices
  - a) Ekman's Dredge
  - b) Petersen grab
  - c) Mud snapper
  - d) Vertical Gravity Corer
  - e) Ooze Sucker
7. Light measuring devices
8. Secchi Disc
9. Lux Meter
10. Depth measuring devices
11. Study of light, phase contrast & electron microscopes
12. Photomicrography
13. Measurements using microscopes- ocular & stage micrometer
14. Preparation of whole mount
15. Paper Chromatography
16. Thin layer Chromatography
17. Electrophoresis

#### **PRACTICALS : CAQC 303 - Aquaculture Information, Economics and Extension**

1. Visit of fishermen co-operative society.
2. Visit to aquaculture farms.

3. Income statement analysis.
4. Preparation of farm plans and budgets.
5. Preparation leaflets, folders, pamphlets, circular letter, poster, charts etc for fisheries extension activities.
6. Preparing and practicing a script for radio talk and public speaking.
7. Training to get license, Subsidy and from the Government.
8. Identification of fishes for Integrated farming.
9. Estimation of Ammonia, Hydrogen sulphide and organic matter
10. Identification of Zeolite and lime used in aquaculture.
11. Submission of field report.

### **CAQP 307 – PRACTICAL VII (Covering course 302)**

#### **PRACTICALS : CAQC 302 - Biotechnology and Applied Marine Biology**

1. Visit to biotechnology industries / Laboratories
2. ELISA test
3. Amplification of DNA
4. Gel electrophoresis
5. Cell and tissue culture
6. Chromosome studies

## **IV SEMESTER**

**CAQC 401 - Elective – II**

**CAQC 402 - Project Work**

### **SUGGESTED ELECTIVES**

#### **CAQE 01 - MARINE FOOD TECHNOLOGY**

##### **Unit I**

Preservation and processing – chilling methods, phenomena of rigor mortis, spoilage changes – causative factors. Drying – conventional methods. Salt curing, pickling and smoking. Freezing and cold storage, Canning procedures. Role of preservatives in processing.

##### **Unit II**

Packing – handling fresh fish, frozen packs, IQF, layered and shatter packs. Fishery by – products, cannery waste, feeds, silage, fish gelatin, fish glue, chitin and chitosan, pearl essence, fertilizer.

##### **Unit III**

Seafood microbiology – factors influencing microbial growth and activity. Seafood borne pathogens – bacteria, fungi, viruses. Spoilage factors in seafood. Toxins influencing food spoilage. Microbes as food – SCP, microbial neutraceuticals.

##### **Unit IV**

Quality management – concepts, planning, system, quality control, quality assurance, quality improvement. Certification standards – ISO and HACCP. Principles of quality related to food sanitation, contamination, pest control, human resource and occupational hazards.

##### **Unit V**

Novel product development, marketing and sea food export – MPEDA, marketing, government policies, export finance, economic importance. Novel products – nutrition promotion, consumer studies qualitative and quantitative research methods

### **REFERENCE BOOKS**

1. Kreuzer, R., 1974. Fishery Products, FAO Fishing News (Books) Ltd., England, 280 pp.
2. Anon, 1979. Handling, Processing and Marketing of Tropical Fish. Tropical Products Institute, London.
3. Miller, M.D., 1990. Ciguatera Seafood Toxins, CRC Press New York.

4. Carison, V.R. and R.H. Graves, 1996. Aseptic Processing and Packing of Food : A Food Industry Perspective, CRC Press, New York.
5. Gopakumar, K., 1997. Tropical Fishery Products. Oxford & IBH Publications, New Delhi, 190 pp.
6. Oliveira, F.A.R. and J.C. Oliveira, 1999. Processing Foods : Quality Optimization and Process Assessment, CRC Press, New York.
7. Chandran, K.K., 2000. Post Harvest Technology of Fish and Fishery Products, Daya Publishing House, New Delhi, 440 pp.
8. Wilson, C.L., S. Droby, 2000. Microbial food contamination, CRC Press, New York.
9. Balachandran, K.K., 2001. Post Harvest Technology of fish and fish products, Daya Publishing House, New Delhi 440 pp.
10. Novak, J.S., G.M. Sapres and V.K. Juneja, 2002. Microbial safety of minimally processed foods, CRC Press, New York.
11. Weidenborner, M., 2003. Encyclopedia of food mycotoxins, Springer Verlag, USA.

## **CAQE 02 - MARINE PHARMACOLOGY**

### **UNIT I: Introduction to marine pharmacology**

Terms and definitions. Medicinal compounds from marine flora and fauna - marine toxins – antiviral and antimicrobial agents.

### **UNIT II: Separation of bioactive compounds**

Steps involved in Marine Pharmacology: extraction of crude drugs, screening, isolation, purification and structural characterization of bioactive compounds.

### **UNIT III : Drug formulation and designing**

Formulation of drugs and drug designing: Pharmacological evaluation – routes of drug administration – absorption, distribution, metabolism and excretion of drug – clinical trials.

### **UNIT IV : Nutraceuticals**

Development of novel foods and food ingredients - Low calorie sweeteners, Flavour modifiers. Nutritional enrichment - food supplements. Food colouring agents and water binding agents.

### **UNIT V : IPR**

WTO-GATT & TRIPS. Different types of intellectual property rights (IPR) - patents - patent applications and rules governing patent - Selected examples of patent in biotechnology. Licensing and compulsory licensing.

### **REFERENCE BOOKS**

1. Morries H. Baslow, 1969. Marine Pharmacology. The Williams & Wilkins Co., Baltimore, 286 pp.
2. Strichartz, G. 1990, Marine toxins: Origin, Structure and Molecular Pharmacology - American Chemical Society, Washington, D.C., 333 pp.
3. Irfan A.Khan, Atiya Khanm, 1998.Role of Biotech Medicinal and Aromatic plants - Vol I, Ukkaz Publications, Hyderabad, 510 pp.
4. Irfan A.Khan, Atiya Khanm, 1999, Role of Biotech Medicinal and Aromatic plants Vol.II, Ukkaz Publications, Hyderabad, 319 pp.
5. Paul Singleton, 1999, Bacteria in Biology, 5<sup>th</sup> edition John Wiley, USA, 489 pp.

6. Treves - Brown, K.M., 2000. Applied Fish Pharmacology. Kluwer Academic Publishers, the Netherlands, 309 pp.
7. Lee Yuan Kun, 2003, Microbial Biotechnology, Principles and Applications, World Scientific Publishing, 724 pp.
8. Williams Bains, 2004. Biotechnology from A – Z, 3<sup>rd</sup> edition, Oxford publishing, 413 pp.

## CAQE 03. PLANT AND ANIMAL CELL CULTURE TECHNOLOGY

### Unit I

Structure and organization of animal cell - Cell proliferation – Cell differentiation – Cell adhesion – Senescence – Cell transformation

### Unit II

Cell culture media: Components, physicochemical properties – Serum: Components, advantages and disadvantages, serum free media – Use of Antibiotics – Primary cell culture: Initiation of cell culture, mechanical and enzymatic disaggregation – Cell lines: Development, characterization, maintenance – Cell separation

### Unit III

Adherent & non adherent cell lines – Culture methods – Subculture – Cryopreservation – Contamination in animal cell culture – Quantification and cytotoxicity – Embryonic stem cells – cancer stem cells.

### Unit IV

Plant tissue culture – Introduction, cellular totipotency, basic requirements for plant tissue culture laboratory, tissue culture media (constituents and preparations), types of culture – cell, protoplast, callus, suspension culture and its applications.

### Unit V

Explant, surface sterilization, plant growth hormones, micropropagation (direct and indirect method), somatic hybridization, plant transformation technique using *Agrobacterium tumefaciens*, applications of plant tissue culture.

### REFERENCE BOOKS

1. Razdan, M. K., 2003. Introduction to plant tissue culture (2<sup>nd</sup> Edition), Science Publishers, USA. 375 pp.
2. Martin Clynes, 1998. Animal Cell Culture Techniques. Ed. Springer, NY, 618 pp.
3. Rudolf Endreb, 2004. Plant cell biotechnology –Springer publications, NY, 368 pp.
4. Robert N. Trigiano and Dennis J. Gray, 2004. Plant tissue culture concepts and laboratory exercises (2<sup>nd</sup> Edition), CRC, USA, 454 pp.
5. Gerald Karp, 2008. Cell and Molecular Biology, Wiley Press, USA, 843 pp.

## **CAQE 04 - MICROBIAL TECHNOLOGY**

### **Unit I**

Isolation and screening of industrially important microbes; Large scale cultivation of industrial microbes; Strain improvement to improve yield of selected compounds e.g. antibiotics, enzymes or recombinant proteins.

### **Unit II**

Basic principles of bioprocess as applied to selected microbes; Process optimization of selected products.

### **Unit III**

Recombinant protein production in microbes ; Commercial issues pertaining to the production of recombinant products from microbes; Downstream processing approaches; Industrial microbes as cloning hosts (Streptomyces/Yeast)

### **Unit IV**

Environmental application of microbes; Ore leaching; Toxic waste removal; soil remediation.

### **Unit V**

Microbial application in food and healthcare industries; Food processing and food preservation; Antibiotics and enzymes of pharmaceutical use.

### **REFERENCE BOOKS**

1. Peter F. Stanbury, 1999, Principles of Fermentation Technology, Butterworth-Heinemann Publishing, UK, 376 pp.
2. Young M.M ,2004.Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4., Elsevier India Private Ltd, India.
3. Glazer and Nikaido, 2007, Microbial Biotechnology, 2nd Edition, Cambridge University Press, UK, 576 pp.

## CAQE 05 - BIOPROCESS ENGINEERING AND TECHNOLOGY

### Unit I

#### **Basic principle of Biochemical engineering**

Isolation, screening and maintenance of industrially important microbes; Microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); Strain improvement for increased yield and other desirable characteristics.

### Unit II

#### **Concepts of basic mode of fermentation processes**

Bioreactor designs; Types of fermentation and fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media; Fermenter design- mechanically agitated; Pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation and air sterilization; Upstream processing: Media formulation; Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process.

### Unit III

#### **Downstream processing**

Bioseparation - filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal.

### Unit IV

#### **Applications of enzymes in food processing**

Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Interesterified fat; Hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

#### **Applications of Microbes in food process operations and production**

Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins from lactic acid bacteria – Production and applications in food preservation.

## Unit V

Enzyme kinetics; Two-substrate kinetics and pre-steady state kinetics; Allosteric enzymes; Enzyme mechanism; Enzyme inhibitors and active site determination

Production, recovery and scaling up of enzymes and their role in food and other industries; Immobilization of enzymes and their industrial applications.

### REFERENCE BOOKS

1. Aiba S, Humphrey AE and Millis NF 1973, Biochemical Engineering, 2nd Edition, University of Tokyo press, Tokyo. 434 pp.
2. Baily, J.E. and Ollis, D.F., 1986, Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York, 984 pp.
3. Jackson AT.,1991. Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs.
4. Stanbury R.F. and Whitaker A.,1997. Principles of Fermentation Technology, Pergamon press, Oxford, 357 pp.
5. Shuler ML and Kargi F., 2002. Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs. 171 pp.
6. Young M.M ,2004. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4., Elsevier India Private Ltd, India.
7. Mansi EMTEL, Bryle CFA 2007. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 308 pp.

## CAQE 06 - BIOSTATISTICS

### Unit I

Applications of statistics in biological sciences and genetics; Descriptive statistics; Mean; Variance; Standard deviation and coefficient of variation(CV); Comparison of two CVs; Skewness; Kurtosis

### Unit II

Probability – axiomatic definition; Addition theorem; Conditional probability; Bayes theorem; Random variable; Mathematical expectation; Theoretical distributions – Binomial, Poisson, Normal, Standard normal and Exponential distributions; Sampling- parameter, statistic and standard error; Census sampling methods; Probability and non-probability sampling; Purposive sampling; Simple random sampling; Stratified sampling.

### Unit III

Testing of hypothesis; Null and alternative hypothesis; Type I and type II errors; Level of significance; Large sample tests; Test of significance of single and two sample means; Testing of single and two proportions - Small sample tests: F-test – testing of single mean; Testing of two sample means using independent t test, paired t test; Chi square test: Test for goodness of fit - association of attributes – testing linkage – segregation ratio.

### Unit IV

Correlation – Pearson’s correlation coefficient and Spearman’s rank correlation; Partial and multiple correlation  
– regression analysis; Sample linear and non linear regression; Multiple regression.

### Unit V

Analysis of variance – definition – assumptions – model; One way analysis of variance with equal and unequal replications; Two way analysis of variance; Non parametric tests – sign test – Mann Whitney ‘U’ test – Kruskal Wallis test.

### REFERENCE BOOKS

1. Chandel, S.R.S,1999. A Hand Book of Agricultural Statistics, Achal Prakashan Mandir, Kanpur, 588 pp.
2. Rangaswamy, R, 2000. A text book of Agricultural Statistics, New Age International (P) Ltd., New Delhi. 500 pp.
3. Gupta S.P, 2005.Statistical Methods, Sultan Chand & Sons, New Delhi,1425 pp.
4. Panse V.G.Panse, Sukhatme P.V, 2000. Statistical methods for Agricultural Workers, ICAR Publications, New Delhi.
5. Jerrold H. Zar, 2003. Bio Statistical Analysis, Tan Prints(I) Pvt. Ltd., New Delhi, 620 pp.
6. Sundar Rao P.S.S, P.H.Richard and J.Richard, 2003. An introduction to Bio-statistics, Prentice Hall of India (P) Ltd., New Delhi, 272 pp.

## CAQE 07- GENOMICS AND PROTEOMICS

### Unit I

#### Introduction

Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

### Unit II

#### Genome sequencing projects

Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

### Unit III

#### Proteomics

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

### Unit IV

#### Pharmacogenetics

High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development

### Unit V

#### Functional genomics and proteomics

Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics

### REFERENCE BOOKS

1. Glick BR & Pasternak JJ,1998. Molecular Biotechnology, 3rd Edition, ASM Press, 683 pp.
2. Voet, D., Voet, J.G. and Pratt, C.W., 2006. Fundamentals of Biochemistry, 2<sup>nd</sup> Edition. Wiley, USA. 931 pp.
3. Brown, T.A., 2006. Genomes, 3<sup>rd</sup> Edition. Garland Science, New York. 736 pp.
4. Primrose, S., and Twyman, R., 2006. Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 390 pp.
5. Campbell, A.M. and Heyer, L.J., 2007. Discovering Genomics, Proteomics and Bioinformatics, 2<sup>nd</sup> Edition. Benjamin Cummings, 447 pp.

## CAQE 08 - VACCINES

### Unit I

Innate Immunity; Activation of the Innate Immunity through TLR mediated signaling; Adaptive Immunity; T and B cells in adaptive immunity; Immune response in infection; Protective immune response in bacterial; Viral and parasitic infections; Correlates of protection

### Unit II

Vaccination and immune response; Appropriate and inappropriate immune response during infection: CD4+ and CD8+ memory T cells; Memory B cells; Generation and Maintenance of memory T and B cells; Dendritic cells in immune response

### Unit III

Adjuvants in Vaccination; Induction of Th1 and Th2 responses by using appropriate adjuvants; Microbial, Liposomal and Microparticles as adjuvant; Chemokines and cytokines; Role of soluble mediators in vaccination; Oral immunization and mucosal Immunity

### Unit IV

Conventional vaccines; Bacterial vaccines; Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine

### Unit V

New Vaccine Technologies; Rationally designed Vaccines; DNA Vaccination; Mucosal vaccination; New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for specific targets; Tuberculosis Vaccine; Malaria Vaccine; HIV vaccine

### Reference books

1. Stefan H.E. Kaufmann (Ed.), 2004. Novel Vaccination Strategies, Wiley-VCH Verlag GmbH & Co. KgaA, 628 pp.
2. Topley and Wilson's, 2005. Microbiology and Microbial Infections Immunology Edited by Stefan H.E. Kaufmann and Michael W. Steward Holder Arnold, ASM Press, 1033 pp.
3. Charles A Janeway. Jr, Paul Travers, Mark Walport and Mark J. Shlomchik, 2005. Immuno Biology, The Immune system in health and Disease, 6<sup>th</sup> Edition, Garland Science, New York, 635 pp.

## CAQE 09 - MOLECULAR VIROLOGY

### Unit I

Economic losses due to important viruses; Types of plant viruses, DNA viruses, RNA viruses, satellite viruses, satellite RNA, satellite DNA, viroids, virusoids; Disease symptoms, local and systemic symptoms, necrosis, hypoplasia, hyperplasia; Vectors for virus transmission; Cell to cell and systemic movement of viruses, plasmodesmata and virus movement.

### Unit II

Genome Organization of DNA viruses; *Caulimovirus* – eg. *Cauliflower mosaic virus*, Replication of CaMV, Badnavirus – *Rice tungro virus* (RTBV); *Geminiviridae* – *Bean golden mosaic virus*,  $\beta$ - DNAs of geminiviruses, rolling circle replication, *Nanovirus* – *Banana bunchy top virus*

### Unit III

Genome Organization of positive-stranded RNA viruses – *Potyviridae*, Potato virusY (PVY), processing of polyprotein, *Comoviridae*, *Citrus tristeza virus*; *Bromoviridae*, *Alfalfa mosaic virus*; *Tubiviridae*, *Tobacco mosaic virus*, Replication of TMV, *Tobacco rattle virus*.

### Unit IV

Genome Organization of negative-stranded RNA viruses; *Rhabdoviridae*, *Sonchus yellow net virus*; *Bunyaviridae*, *Tomato spotted wilt virus*; *Tenuivirus*, *Rice stripe virus*; Double-stranded RNA viruses, *Reoviridae*, *Rice dwarf virus*.

### Unit V

Virus detection and diagnosis; Infectivity assays – Sap transmission, insect vector transmission, agroinfection (using *Agrobacterium*); Ultracentrifugation, electron microscopy, serological methods, immunoelectrophoresis in gels, direct double-antibody sandwich method, Dot ELISA, Immunosorbent electron microscopy (ISEM), Decoration technique, Polymerase chain reaction; DNA and oligonucleotide microarray; Gene silencing, PTGS & TGS, viral suppressors of gene silencing.

## REFERENCE BOOKS

1. Walkey, D.G.A, 1991. (Ed.), Applied Plant Virology, 2<sup>nd</sup> Edition, Chapman & Hall, London, 338 pp.
2. C.L. Mandahar, 1999. (Ed.), Molecular Biology of Plant viruses, Kluwer Academic Publishers, Dordrecht, 281 pp.
3. Roger Hull, 2002 (Ed), Mathews Plant Virology, 4<sup>th</sup> Edition, Academic Press, San Diego, 1001 pp.

## CAQO 401 - MARINE PHARMACOLOGY

### UNIT I: Introduction to marine pharmacology

Terms and definitions. Medicinal compounds from marine flora and fauna - marine toxins – antiviral and antimicrobial agents.

### UNIT II: Separation of bioactive compounds

Steps involved in Marine Pharmacology: extraction of crude drugs, screening, isolation, purification and structural characterization of bioactive compounds.

### UNIT III : Drug formulation and designing

Formulation of drugs and drug designing: Pharmacological evaluation – routes of drug administration – absorption, distribution, metabolism and excretion of drug – clinical trials.

### UNIT IV : Nutraceuticals

Development of novel foods and food ingredients - Low calorie sweeteners, Flavour modifiers. Nutritional enrichment - food supplements. Food colouring agents and water binding agents.

### UNIT V : IPR

WTO-GATT & TRIPS. Different types of intellectual property rights (IPR) - patents - patent applications and rules governing patent - Selected examples of patent in biotechnology. Licensing and compulsory licensing.

#### REFERENCE BOOKS

1. Morries H. Baslow, 1969. Marine Pharmacology. The Williams & Wilkins Co., Baltimore, 286 pp.
2. Strichartz, G. 1990, Marine toxins: Origin, Structure and Molecular Pharmacology - American Chemical Society, Washington, D.C., 333 pp.
3. Irfan A.Khan, Atiya Khanm, 1998.Role of Biotech Medicinal and Aromatic plants - Vol I, Ukkaz Publications, Hyderabad, 510 pp.
4. Irfan A.Khan, Atiya Khanm, 1999, Role of Biotech Medicinal and Aromatic plants Vol.II, Ukkaz Publications, Hyderabad, 319 pp.
5. Paul Singleton, 1999, Bacteria in Biology, 5<sup>th</sup> edition John Wiley, USA, 489 pp.
6. Treves - Brown, K.M., 2000. Applied Fish Pharmacology. Kluwer Academic Publishers, the Netherlands, 309 pp.
7. Lee Yuan Kun, 2003, Microbial Biotechnology, Principles and Applications, World Scientific Publishing, 724 pp.
8. Williams Bains, 2004. Biotechnology from A – Z, 3<sup>rd</sup> edition, Oxford publishing, 413 pp.

