

**Scheme and Syllabus for First Degree Programme in
Aquatic Biology and Zoology (Double Main)**

(B.Sc. Aquatic Biology and Zoology)

Under Choice Based Credit and Semester System
(Double Main)



Course Structure & Syllabus



UNIVERSITY OF KERALA

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Syllabus for B.Sc. Aquatic Biology and Zoology (Double Main)

Programme-Specific Outcomes (PSO)

PSO1	Appreciate the complexity of animal life, life processes, their molecular, cellular and physiological processes, their genetics, evolution and behaviour and their interrelationships with the environment.
PSO2	Demonstrate in-depth knowledge and understanding about the fundamental concepts, principles and processes underlying the academic field of Zoology, Aquatic Biology and Aquaculture and its different subfields.
PSO3	Design and conduct experiments to test a hypothesis and understand and interpret scientific data to reach a conclusion
PSO4	Participate in animal welfare, management and conservation programmes in an effective manner.
PSO5	Demonstrate procedural and practical knowledge and skills that creates different types of professionals in the field zoological sciences, aquatic biology, fisheries and aquaculture.
PSO6	Develop expertise and develop confidence for managing aquaculture operations and providing consultancy services to farmers.
PSO7	Acquire hands-on training in the grow-out culture activities in freshwater, brackishwater and marine environments.
PSO8	Enhanced skills and attitudes for becoming a better learner, thinker, professional and skilled person.

First Degree Programme in Aquatic Biology and Zoology
(B.Sc. Aquatic Biology and Zoology)
Under Choice based Credit and Semester System
(Double Main)

Aim and Objectives

The Career Related First Degree Programme is a **Double Main** Course with **Aquatic Biology and Zoology** is designed to develop knowledge, expertise, skills, employment and entrepreneur attitude towards various facets of zoological science and aquatic biology with special emphasis on aquaculture. This will help the students to become efficient and inquisitive in their outlook towards zoological science, besides developing skills in aquaculture as a vocational course. The courses are designed to impart the essential basics in Aquatic Biology, Aquaculture, Zoology and in life sciences through foundation courses. The Programme consists of language courses, foundation courses, core courses and open courses.

The various courses in the programme are aimed to develop proficiency in the theory as well as hands-on experience in practical sessions in both Aquatic Biology/Aquaculture and Zoology. A programme of this kind will surely equip students to be a scholar in various areas of zoology and a professional with scientific knowledge in aquaculture and its allied areas. This programme will cater to the ever-increasing demand of aquaculture professionals as the present world in general and the nation, in particular, is promoting aquaculture, to ensure food security and employment generation. While expanding the scope for the blue economy and blue growth, governments are encouraging aquaculture and allied sectors through various funding schemes and programmes aimed at alleviating poverty and malnourishment, so as to ensure employment generation, improve foreign exchange and economic security of the country. Moreover, students who pursue this programme and pass out successfully, will indeed have an urge to continue higher studies in Zoology, Aquatic Biology or Aquaculture and contribute significantly in its development or to explore possibilities for self-employment in the sector.

Opportunities: Jobs in the fields of animal husbandry, museum, zoos and fisheries departments. Specific consideration for employment in fisheries and allied departments. Opportunity for advanced study and research in the fields of Zoology, Aquatic Biology & Fisheries, Marine Biology, Fisheries, Aquaculture and self-employment and start-ups in all these fields.

Eligibility for Admission

Candidates shall be admitted to the course provided he/ she has passed plus two examinations of the state or central board with biology as one of the subjects.

Scheme, Course Structure, Syllabus and Summary of Courses

First Degree Programme in Aquatic Biology and Zoology (Double Main), consists of a total of 36 courses. They are Language courses, Foundation courses, Main 1 courses of Aquatic Biology, Main 2 courses of Zoology and Open course of Main 1. The project is compulsory for both the core courses and the students may be assigned topics for the projects and should be completed and submitted during the practical assessment at the end of VI semester. There will be one minimum credit for social service/extension activities. **The total number of courses is 36. The total credits of the entire programme is 120.**

Category	Major Subjects	No. of Courses	Credits	Total Credits
1	Languages			
	1.English	4	3	12
	2.Additional Language	2	3	6
2	Foundation Courses	2	2-3	5
3	Main 1: AQUATIC BIOLOGY	14	2-4	48
4	Main 2: ZOOLOGY	13	2-4	47
5	Open Courses (Main 1)	1	2	2
	Total Credits	36		120
	Social Service/Extension Activities			1

Criteria for Course codes

Each course title is represented by a course code consisting of a two-letter subject code followed by four digits. The two-letter subject code is 'ABZ', in which 'AB' depicts Aquaculture and 'Z' depicts Zoology. The first digit indicates the first degree programme, which is always one. The second digit indicated the semester number which is 1-6, the third digit denotes the category of the course which ranges from 1-5 and the last digit indicates the serial number of the course with in a semester.

General Structure of Number of Courses, Credits and Total Credit

The total minimum credits of the programme is 120 and the various courses and its corresponding credits are depicted in the following table, which is followed by the general structure and semester wise allocation of courses, its credits and contact hours.

Cate- gory	No.	Code	Study Components	No. of Courses	Credits		Total credits
					T	P	
1			Languages				
	1	EN1111	English	4	3		12
	2	1111.1	Additional Language	2	3		6
2			Foundation Course	2			5
	1	ABZ 1121	Foundation course in Zoology: Experimental Zoology, Instrumentation, Biostatistics & Bioinformatics		3		
	2	ABZ 1221	Foundation course in Aquatic Biology : Data Presentation & Soft Skills		2		
3			Main 1: AQUATIC BIOLOGY	14			48
	1	ABZ 1131	Aquatic Biology		4		
	2	ABZ 1231	Fundamentals of Aquaculture		4		
	3	ABZ 1232	Practical Aquatic Biology I (Practical of ABZ 1131&1231)			2	
	4	ABZ 1331	Fish Biology		4		
	5	ABZ 1332	Water Chemistry and Water Quality Management		4		
	6	ABZ 1431	Freshwater Aquaculture		4		
	7	ABZ 1432	Ornamental Fish culture		4	2	
	8	ABZ 1443	Practical Aquatic Biology II (Practical of ABZ 1331, 1332, 1431& 1432)		4		
	9	ABZ 1531	Brackish water Aquaculture & Mariculture				
	10	ABZ 1532	Intensive Aquaculture		4		
	11	ABZ 1631	Aquaculture Business Management		3		
	12	ABZ 1632	Live Feed Culture Technology		2		
	13	ABZ 1633	Practical Aquatic Biology III (Practical of ABZ 1531, 1532, 1631& 1632)			3	
	14	ABZ 1634	Project and Farm Internship/Experience			4	
4			Main 2: ZOOLOGY	13			47
	1	ABZ 1141	Animal Diversity I		4		
	2	ABZ 1241	Animal Diversity II		4		

	3	ABZ 1242	Practical Zoology I (Practical of ABZ1121, ABZ1141 &ABZ1241)			2	
	4	ABZ 1341	Ecology, Habitat Destruction &Disaster Management		4		
	5	ABZ 1342	Cell and Molecular Biology		4		
	6	ABZ 1441	Genetics and Biotechnology		4		
	7	ABZ 1442	Immunology and Microbiology		4		
	8	ABZ 1443	Practical Zoology II (Practical of ABZ1342,ABZ1441 &ABZ1442)			2	
	9	ABZ 1541	Physiology and Biochemistry		4		
	10	ABZ 1542	Developmental Biology and Experimental Embryology		4		
	11	ABZ 1641	Ethology, Evolution and Zoogeography		4		
	12	ABZ 1642	Practical Zoology III (Practical of ABZ 1341, 1541, 1542 & 1641)		3		
	13	ABZ 1643	Project in Zoology			4	
5			Open Courses (Zoology)	1	2		2
	1	ABZ 1551	Vermiculture and Apiculture				
	2	ABZ 1552	Human Nutrition				
	3	ABZ 1553	Environmental Impact Assessment				
			Total Courses	36	Total Credit		120
			Social Sciences/Extension Activities				1

Evaluation of Examination

Distribution of marks in theory and practicals between external and Internal assessment is 80: 20. The duration of University examination is 3 hours for all courses. Pass minimum of 40% for external and overall components.

Summary of Semester-wise hour distribution of courses

The total credits of the entire programme is 120, and the distribution of credits, contact hours etc for each course in each semester is summarized below as tables. Total credits for each semester is 20 and contact hours is 25 per week for all the courses.

Semester I

Code	Course Title	Hours/week		Total credits	Total Hours
		T	P		
EN1111	English	5		3	90
1111.1	Additional Language	5		3	90
ABZ1121	Foundation Course in Zoology: Experimental Zoology, Instrumentation, Biostatistics & Bioinformatics	3		3	54
ABZ 1131	Aquatic Biology	4	2	4	108
ABZ 1141	Animal Diversity I	4	2	4	108
	TOTAL	21	4	17	450

Semester II

Code	Course Title	Hours/week		Total credits	Total Hours
		T	P		
EN1211	English	5		3	90
1211.1	Additional Language	5		3	90
ABZ 1221	Foundation Course in Aquatic Biology	2		2	36
ABZ 1231	Fundamentals of Aquaculture	4	3	4	126
ABZ 1232	Aquatic Biology Practical I (Practical of ABZ 1131 & ABZ 1231)			2	
ABZ 1241	Animal Diversity II	4	2	4	108
ABZ 1242	Zoology Practical I (Practical of ABZ 1121, ABZ 1141 & ABZ 1241)			2	
	TOTAL	20	5	20	450

Semester III

Code	Course Title	Hours/ week		Total credits	Total Hours
		T	P		
EN1311	English	5		3	90
ABZ 1331	Fish Biology	3	2	4	90
ABZ1332	Water Chemistry and Water Quality Management	3	2	4	90
ABZ 1341	Ecology, Habitat Destruction & Disaster Management	4	1	4	90
ABZ 1342	Cell and Molecular Biology	3	2	4	90
	TOTAL	18	7	19	450

Semester IV

Code	Course Title	Hours/ week		Total credits	Total Hours
		T	P		
EN1411	English	5		3	90
ABZ 1431	Freshwater Aquaculture	3	2	4	90
ABZ 1432	Ornamental Fish culture	3	2	4	90
ABZ 1433	Aquatic Biology Practical II (of ABZ 1331, ABZ 1332, ABZ 1431,ABZ 1432)			2	
ABZ 1441	Genetics and Biotechnology	3	2	4	90
ABZ 1442	Immunology and Microbiology	3	2	4	90
ABZ 1443	Zoology Practical II (of ABZ1342,ABZ1441 & ABZ1442)			2	
	TOTAL	17	8	23	450

Semester V

Code	Course Title	Hours/week		Total credits	Total Hours
		T	P		
ABZ 1531	Brackish water Aquaculture & Mariculture	4	2	4	108
ABZ 1532	Intensive Aquaculture	4	2	4	108
ABZ 1541	Physiology and Biochemistry	3	2	4	90
ABZ 1542	Developmental Biology and Experimental Embryology	3	2	4	90
ABZ 1551	Vermiculture and Apiculture	3		2	54
ABZ 1552	Human Nutrition	”		”	”
ABZ 1553	Environmental Impact Assessment	”		”	”
	TOTAL	17	8	18	450

Semester VI

Code	Course Title	Hours/week		Total credits	Total Hours
		T	P		
ABZ 1631	Aquaculture Business Management	2	1	3	108
ABZ 1632	Live Feed Culture Technology	2	1	2	
ABZ 1633	Aquatic Biology Practical III (of ABZ 1531, ABZ 1532 , ABZ 1631& ABZ1632)			3	
ABZ 1634	Project in Aquatic Biology		6	4	108
ABZ 1641	Ethology, Evolution and Zoogeography	4	3	4	126
ABZ 1642	Zoology Practical III (of ABZ 1341,ABZ 1541, ABZ 1542, ABZ 1641)			3	
ABZ 1643	Project in Zoology		6	4	108
	TOTAL	8	17	23	450

Accumulated Total Minimum Credits = 120 credits

Minimum credit for Social Sciences/Extension Activities:1

Minimum Duration = 6 semesters

First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester I

Foundation Course in Zoology

ABZ 1121: Experimental Zoology, Instrumentation, Biostatistics and Bioinformatics

No. of Credits - 3

Total hours 54

Course Outcomes

CO1: To introduce the methodology and perspectives of Science in general so as to enable the students to systematically pursue Zoology in relation to other disciplines that come under the different branches of science.

CO2: To learn the fundamental characteristics of science as a human enterprise.

CO3: To understand how science works and to apply scientific methods independently.

Course Content

Module I

Nature and scope of Zoology:

4 Hrs.

Branches of Zoology, Opportunities to a Zoologist, Institutes of Zoological and Scientific importance in India- Location, major achievements and present activities (academic and scientific) [Zoological Survey of India. Central Marine Fisheries Research Institute, Central Institute of Fisheries Technology, Rajiv Gandhi Centre for Biotechnology, Bioinformatics Centre and Library, Indian Institute of Science. Stem Cell Institute, National Institute of Immunology, Centre for Cellular & Molecular Biology, Centre for DNA Fingerprinting and Diagnostics, Central Drug Research-Institute].

Module - II

Instrumentation (Principle Working and Application)

14 Hrs

Microscopes: Types of microscopes- Dissection microscope, Light microscope, Dark field microscope. Fluorescent microscope, Phase contrast microscope, Electron microscope (SEM, TEM); Microtome (Different Types),.Embedding, sectioning and staining techniques of light microscopy.

Photometry: Colorimetry and Spectrophotometry, Autoradiography: Principle, mechanism, and significance; Centrifugation: Principle and applications; Chromatography: Principle and uses.

Module - III

Biostatistics and Experimental Science

13 Hrs

Introduction to Biostatistics: Variable and-attribute; Population vs. Sample; Census vs. Sample survey; Arrangement of data; Frequency distribution.

Graphical presentation of data: Line diagram; Bar diagram; Pie chart; Histogram. Measures of central tendency: Arithmetic mean; Mode; Median.

Measures of dispersion: Variance; Standard deviation; Standard error of mean; Standard score. Testing of hypothesis and goodness of fit: Null hypothesis, Level of significance, Probability, Normal distribution, Error of inference, Student's t-test, Chi-square test.

Module IV

4 Hrs

Overview of Information Technology: features of the modern Personal Computer and Peripherals computer networks and Internet. Introduction to Operating System. DOS/ Windows. Linux. Purchase of technology, license. guarantee. warranty.

Module V

8Hrs

Definition, Nature & Scope of Bioinformatics - Contrast between Bioinformatics and Computational Biology; Key Bio-sequences in Molecular Biology - DNA, RNA and Amino acid sequences. Popular Databases in Bioinformatics – NCBI, DDJB, PDB, OMIM; BLAST & FASTA sequence file formats, Approach of Comparative Biology based on sequence comparison - The basic idea of sequence comparison (algorithms not required) - idea of scoring matrices

Module VI

11 Hrs

The Blast search engine - important features - Idea of Multiple sequence alignment -Proteomics: Basic ideas of Protein Structure prediction- Concept of Homology Modeling- Idea of Molecular Phylogenetics - 'advantages and computational procedure (only description of use of a package such as Phylip). Basic concepts of computer Aided. Drug .Discovery. General description of drug discovery pipeline concept of Personalized medicine; Central Drug Research Institute.

Bioinformatics tools: (i)Molecular Visualization Software - Rasmol (Basic features only) - (ii) ORF finding (iii) gene finding, (iii) BLAST (iv) Hydrophobicity Prediction (v) Single Nucleotide Polymorphism (SNP) prediction using GENSNIP.

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First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester I

Main 1: Aquatic Biology Course 1

ABZ 1131: Aquatic Biology

No. of credits: 4

Total Hours: 108 (T 72+ P 36)

Course Outcome

CO1: Recognize scope and significance of Aquatic Biology and introduce the Limnology, Marine Biology and Oceanography.

CO2: Create awareness about the properties of freshwater and seawater, the elixir of life.

CO3: Understand and study different geomorphic formations of water bodies.

CO4: Give an insight to aquatic flora and fauna

CO5: Critically evaluate the pollution, its sources and eco-restoration of aquatic systems.

Course content

Module I

12 Hrs

Introduction to Marine Biology, Oceanography, Estuarine Biology and Limnology. Water and water cycle. Significance and History of Marine Biology and Limnology. Human cultural relations with water. Ecosystem concepts and services of aquatic bodies. Properties of water – water as a solvent and temperature stabilizer. Physical and chemical properties of water and seawater.

Module II

12 Hrs

Introduction to Marine Environment. Zonation of marine environment - Neritic, oceanic, continental shelves, slopes, rises. Submarine canyons. Oceanic trenches. Island arcs. Mid oceanic ridges. Seamounts. Gyots. Hydrothermal vents. Polar regions. Oceanography: Ocean Currents, Waves and Tides: Types, classification and characteristics. Ocean circulation, Eddies, El-Nino. tsunami, storm surges. Upwelling and mud banks of Kerala.

Module III

7Hrs

Estuarine Biology: Classification and Characteristics of Estuaries. Estuaries, coastal wetlands and its Zonations. Major estuaries and backwaters in India. Mangrove and Saltmarsh ecosystems and biodiversity, its conservation and management. Mangrove ecosystem services.

Module IV

7 Hrs

Geo-Morphic Forms: Distribution and Classification of Inland Waters – Water Table - Aquifer - Watershed – Polar water. Classification and characteristics of different inland water forms – Lentic, Lotic and its zonal classification. Streams, Rivers, Ponds, Lakes, Swamps/Marshes, Springs, Wetlands and Reservoirs.

Module V

14 Hrs

Aquatic Biology: Classification of organisms - Freshwater and Marine forms. Plankton (Phyto and Zooplankton), freshwater plants, seagrasses and weeds, nekton, neuston, periphyton and benthos. Organism classification based on zones – Littoral/riparian, limnetic and profundal. Classification based on nutrition: Autotrophs, heterotrophs and saprotrophs.

Module VI

10 Hrs

Biological productivity and energetic: Productivity – primary and secondary productivity in aquatic ecosystems. Carbon fixation. Decomposition and decomposers. Food chain, food web and niche in aquatic bodies.

Module VII

10Hrs

Man and ocean: Navigation and bio-resources. Fisheries - crafts and gears, major marine and inland fisheries of Kerala. Coral Reefs. Major threats to marine Habitat: Overexploitation, Habitat destruction, Exotic species, ocean acidification, Sea Level Rise and climate change. Coastal Zone Management (CZM) and Integrated Coastal Zone Management (ICZM). Blue economy and Blue carbon.

Marine Pollution and inland water pollution - sand mining, siltation and effluent discharge. eutrophication, eco-restoration and remediation.

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First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester I

Main 2: Zoology Course 1

ABZ 1141: Animal Diversity I

No. of credits: 4

Total Hours: 108 (T 72+ P 36)

Course Outcome

CO1: To learn the basics of systematics and understand the hierarchy of different categories.

CO2: To learn the diagnostic characters of different phyla through brief studies of examples.

CO3: To obtain an overview of economically important invertebrate fauna.

Course Contents

Module I

6 Hrs

Introduction to Zoology: Taxonomy-Definition, history. new trends and importance, mention molecular taxonomy. Components of classification. Taxonomical hierarchy - taxon, category and rank, Linnaean hierarchy, nomenclature, principles of nomenclature. International Code of Zoological Nomenclature (ICZN). rules of nomenclature. requisite - uni, bi and trinomialism. Mention taxonomic aids.

Module II

8Hrs

Kingdom Protista: General characters, structure, zoological importance and systematic position-of *Actinophrys*, *Noctiluca*, *Paramecium* and *Opalina*. Parasitic protozoans- Morphology, life history, pathogenicity and prophylaxis of *Entamoeba histolytica* and *Plasmodium vivax*.

Module III

9 Hrs

Kingdom Animalia: Outlines of classification – Subkingdom Mesozoa, Subkingdom Parazoa, Subkingdom Eumetazoa. Levels of organization- cellular. tissue. organ and organ system Divisions of Eumetazoa-Radiata, Bilateria, Acoelomata, Pseudocoelomata, Eucoelomata, Protostomia, Deuterostomia.

Sub kingdom Mesozoa- General characters, eg. *Rhopalura*.

Subkingdom Parazoa- General characters. Mention the classes of Porifera- Calcispongia, eg. *Sycon*; Hydrospongia, eg. *Euplectella*; Desmospongia, eg. *Spongilla*. General topic: Canal system in sponges.

Module IV

Subkingdom Eumetazoa

4Hrs

Phylum Coelenterata: General characters (self-study). Classes- Hydrozoa eg. *Obelia*, *Physalia*; Scyphozoa, eg. *Aurelia*; Anthozoa, eg. *Madrepora*.

General-topic: Polymorphism in coelenterates, Coral and Coral Reef.

Module V

10 Hrs

Phylum Platyhelminthes: General characters (self-study). Classes- Turbellaria eg: *Planocera*:- Trematoda eg.*Fasciola* ; Cestoda, eg.*Taeniasolium*.

Phylum Nematoda: General characters (self-study). Parasitic nematodes- eg.*Ascaris*, *Ancylostoma*, *Enterobius*, *Wuchereria* [Morphology, life history, pathogenicity and prophylaxis], *Caenorhabditiselegans* (Brief account).

Phylum Annelida: General characters (self-study). Classes -.Polychaeta eg.*Nereis*(mention *heteronereis*), Oligochaeta eg.Earthworm. Hirudinea eg.*Leech*.

Module VI

17 Hrs

Phylum Arthropoda: General. characters(self-study), Type- *Penaeus*. Mention the classes eg. Cockroach, *Limulus*, *Eupagurus*, *Sacculina*, *Apis indica*, *Daphnia*, *Drosophila*. Mosquito-mouth parts. Study of crop pests: Pest of paddy-*Leptocorisa*, *Spodoptera*, *Nilapaarvata*; Pest of coconut- *Oryctes*, *Rhynchophorus*, *Eriophyes*.

Phylum Onychophora: General characters, eg.*Peripatus* (Evolutionary significance). General topic: 1. Diversity of Mosquitoes and diseases transmitted by them.

Module VII

18 Hrs

Phylum Mollusca: General characters (self-study), Classes- Monoplacophora. eg.*Neopilina*; Amphineura, eg.*Chiton*; Aplecophora, eg.*Neomenia* Gastropoda eg.*Pila*, Scaphopoda, eg.*Dentalium*; *Pelicypoda* eg.*Perna*, Cephalopoda, eg.*Sepia*, *Octopus*.

Phylum Echinodermata: General characters (self-study). Classes- Asteroidea. eg.*Asterias*: Ophiuroidea, eg.*Ophiothrix*; Echinoidea, eg.*Echinus*; Holothuroidea, eg.Sea cucumber, Crinoidea, eg. Sea lily. General Topic: Water vascular system.

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First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester II

Foundation Course in Aquatic Biology

ABZ 1221: Data Presentation and Soft Skills

No. of Credits - 3

Total hours 36

Course Outcome

CO1: Understanding and application scientific data presentation techniques

CO2: Develop expertise to prepare visual aids for scientific data

CO3: Develop capability to use different software to prepare visual aids

CO4: Acquire different personality development skills

CO5: Effectively apply the living skills

CO6: Understand and develop skills in creativity

Course Content

Module I

10 Hrs

Data, types of data, classification of data. Data collection - Sampling and Census method. Organization –editing, classification and tabulation of data. Presentation of data – Tables and visual aids – Graphs, charts, diagrams and cartographs. Oral and Poster presentations.

Module II

8 Hrs

Introduction to Software: MS Excel, MS PowerPoint, SPSS, R, Statistica.

Module III

8 Hrs

Personality: Skills, attitudes, body language, inter-personal skills, multiple intelligence etc.; values in life. Communication and personality. Skills in English speaking and writing.

Module IV

10 Hrs

Living skills: Green living; healthy living; daily and independent life skills. Smart Thinking Skills: Creativity: Various views on creativity- Habits of critical thinkers, stimulating creativity, obstructions to creativity, creativity and innovation, creativity and craft, visual thinking through mind mapping, creativity exercises.

References

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6. JohanatanSlane 2019. Emotional Intelligence for Leadership: 4 Week Booster Plan to Increase Your Self-Awareness, Assertiveness and Your Ability to Manage People.
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Semester II

Main 1: Aquatic Biology Course 2

ABZ 1231: Fundamentals of Aquaculture

No. of credits:4

Total Hours: 126 (T72 + P54)

Course Outcomes

CO1:Understand the scope /prospects of aquaculture and acquire the status of aquaculture at national and international levels

CO2:Develop a comprehensive knowledge on different types of aquaculture systems with particular emphasis on its operation

CO3:Understanding of candidate species for aquaculture, its taxonomy and winsome qualities

CO4:Develop a comprehensive knowledge of major steps involved in aquaculture and its management

Course Content

Module I

8 Hrs

Aquaculture: Basics, Definition. Prospects and importance of aquaculture for food security, employment generation and entrepreneurship. History of aquaculture. Status: Global and National scenario.

Module II

12 Hrs

Different Aquaculture Systems : Pen culture, cage culture, pond culture, running water culture, zero water exchange system and open sea farming

Module III

14 Hrs

Types of aquaculture operation: Extensive, semi-intensive, intensive and super intensive aquaculture in freshwater, brackish water inland saline and marine water. Merits and demerits

Module IV

14 Hrs

Steps involved in Aquaculture: Criteria for site selection, Pond preparation. Bio-security measures. Soil and water culture. Stocking. Water quality management, feed management, disease management, Growth Assessment. Harvesting.

Module V

14 Hrs

Criteria for selection of candidate species for aquaculture. Major candidate species for aquaculture freshwater, brackish-water and marine systems from finfishes, prawns/ shrimps, crabs, oysters, mussels, bivalves and seaweeds. Identification and systematics

Module VI

10 Hrs

Integrated aquaculture systems: Rice cum fish culture, polyculture, Poultry cum fish, Livestock cum fish farming. Problems and prospects. Principles of organic aquaculture. Sustainable aquaculture practices.

References

1. Agarwal, S.C., 2007. A Handbook of Fish Farming. Narendra Publ. Hse., New Delhi, 133pp.
2. Badapanda, K.C., 2012. *Aquaculture Vol.* . Narendra Publishing House, Delhi, 496pp.
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4. Christenson, K. 2019. Aquaculture- Introduction to Aquaculture for small farmers (3rd Ed). CreateSpace Independent Publishing Platform, USA, 104pp.
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9. Stickney, R.R. 2000. *Encyclopedia of Aquaculture*. John Wiley & Sons, Inc., Canada, 1063pp.
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First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester II

Main 1: Aquatic Biology Course 3

ABZ 1232: Practical Aquatic Biology I (Practical of ABZ 1131 & ABZ 1231)

No. of credits:3

Total Hours: 90

Course Outcomes

CO1: Demonstrate knowledge and understanding

CO2: To develop expertise on the identification of aquatic flora and fauna

CO3: Develop a comprehensive knowledge on different types of aquaculture systems with particular emphasis on its operation

CO3: Hands on experience on the different steps involved in aquaculture and its management

Course Content

Practicals of ABZ 1131

36 Hrs

1. Preparation of a herbarium of aquatic plants (any 7 freshwater and 3 marine)
2. Identification of phytoplankton (any 5 freshwater and 5 marine)
3. Identification of zooplankton (any 5 freshwater and 5 marine)
4. Identification of benthos (any 5 freshwater and 5 marine)
5. Identification of shellfishes (any 5 freshwater and 5 marine)
6. Identification of fin fishes (any 5 freshwater and 5 marine)
7. Analysis of physical properties of water
8. Analysis of chemical parameters of water (pH, Alkalinity, Hardness, DO & CO₂)
9. Report of field visit to a Lake/River/Marsh/Rocky shore/sandy shore

Practicals of ABZ 1231

54 Hrs

1. Aquaculture production statistics- world and India.
2. Identification of candidate fin fish species for aquaculture : Indian Major Carps (IMC), Chinese carps, Cat fishes, Mulletts, Milkfish, Cichlids, Exotic fishes, Important cultured marine fishes
3. Identification of candidate decapod crustacean species for aquaculture : Shrimps, prawns, lobsters, crabs
4. Identification of candidate molluscan species for aquaculture : mussels, edible and pearl oysters and common clams
5. Field visit to aquafarms, hatcheries and Fisheries Institutes
6. Components of Aquaculture farms- Dykes, sluice, motor pumps, Aerators, other equipments, check tray
7. Pond preparation : Soil culture and water culture
8. Practices on pre-stocking and post stocking management.
9. Growth studies in aquaculture system.

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Semester II

Main 2: Zoology Course 2

ABZ 1241: Animal Diversity II

No. of credits: 4

Total Hours: 108 (T 72+ P 36)

Course Outcome

CO1: To learn the general characteristics and classification of different classes of vertebrates.

CO2: To understand the vertebrate evolutionary tree.

CO3: To understand general aspects of applied interest in relation to vertebrates

Course Contents

Module I

6 Hrs

Phylum Chordata: Chordate characters and their classification into three Sub phyla (self-study).

Subphylum: Urochordata- General characters, Class Larvaceaeg: *Oikopleura* : Class Ascidiacea eg.*Ascidia* (Mention -Ascidian tadpole larva, Retrogressive metamorphosis) and Class Thaliacea-eg.*Salpa*. Subphylum: Cephalochordata- General characters, eg. Amphioxus (Mention feeding behaviour).

Module II

10 Hrs

Subphylum Vertebrata: General characters, Division 1 Agnatha -General characters, Class Cyclostomata- eg.*Petromyzon*, Class Ostracodermi; Division 2 Gnathostomata -General characters, Classification into Super class Pisces and Tetrapoda. Super class Pisces- General characters and classification, Class Placodermi, Class Chondrichthyes-Sub class Elasmobranchii- eg: *Shark*, Sub class Holocephali eg.*Chimaera*; Class Osteichthyes- Sub class Choanichthyes- Orderl-Crossopterygii; *Latimeria*, Order. 2 Dipnoi. eg.Protopterus, Subclass Actinopterygii Super order Chondrostei- eg. Acipenser. Super order Holostei – eg: *Lepidosteus*, Super order Teleostei -eg: *Anabas*, *Clarias*, *Saccobranchus*, *Ophiocephalus*, *Echeneis*.

General topic: Accessory respiratory organs in fishes, Dipnoians.

1. Alien fishes escaped from aquarium tanks and transported to water bodies during flood – impact on indigenous diversity.
2. Edible fishes – Tuna, Sardine, Mackerel, Pearl spot, Ribbon fish

Module III

14 Hrs

Super class Tetrapoda: Salient features; **Class Amphibia** - General characters (self-study).

Type study – Frog:

Classification- Oder Urodelaeg.*Amblytoma*, Order Anura eg. Rhacophorus, *Bufo*, *Nasikabatachus*, Order Apoda eg.*Ichthyophis*.

General topic: Parentalcare in Amphibia.

Module IV

12Hrs

Class Reptilia - General characters (self-study). Classification - Subclass Anapsida

Order Chelonia eg. -*Chelone*; Subclass Parapsida- eg. Ichthyosaurus: Subclass Diapsida- Order - Rhynchocephaliaeg.*Sphenodon*, Order Squamata- Suborder Lacertiliaeg.*Chamaeleon*, *Draco*, *Hemidactylus*, Suborder Ophidia eg. (Poisonous -snakes) *Naja*, *Vipera*, *Bungarous*, *Enhydrina*; (Non-poisonous snakes) *Ptyas*, *Lycodon*, *Dryophis*, *Typhlops* and *Eryxjohni* Suborder Crocodilia - eg.*Crocodylus*, *Javialis*, *Alligator*; Subclass Synapsida- eg.*Cynognathus*.

General topic: Identification of poisonous and nonpoisonous snakes: Venom, mode of action and its uses.

Module V

12Hrs

Class Aves – General characters (self-study). Classification – Subclass *Archeornithes*- eg: *Archeopreryx*; Subclass Neornithes – Super order Paleognathae-eg. *Struthio* and *Emu*: Super order Neognathae eg. Pigeon (External features, Feathers)

General Topic: Migration in birds. Flightless birds, Flight adaptations in birds.

Module VI

13 Hrs

Class Mammalia - General characters (self-study) classification of Class Mammalia - Subclass: Prototheria eg.*Tachyglossus*. Subclass Metatheria eg.*Macropus*. Subclass Eutheria – Order Insectivora-eg. *Paraecinus*, Order Dermoptera- eg.*Galeopithecus*. Order Chiroptera- eg.*Pteropus*. Order Primates- eg.*Loris*, Order Carnivora-eg.*Panthera leo*, Order Cetacea- eg.*Delphinus*, Order Perissodactyla- eg.*Equus*, Order Artiodactyla- eg.*Camelus*, Order Proboscidea - eg.*Elephas*. Order Sirenia - eg.*Dugong*, Order Hyracoidea- eg.*Procavia*, Order Rodentia - eg.*Rattus*, Order Lagomorpha- eg.*Oryctolagus*, Order Edentata-eg. *Dasybusnovemcinctus* (Armadillo). Order Pholidota -eg.*Manis*, Order Tubilidentata- eg.*Orycteropus*.

General topic: Dentition in mammals. Egg laying mammals, Adaptations of aquatic mammals.

Module VII

5 Hrs

Comparative account of Brain and Arterial system of Pisces, amphibian, reptiles, aves and human. .

References

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Semester II

Main 2: Zoology Course 3

ABZ 1242: Zoology Practical I

(Practical of Z0A 1121, ABZ 1141& ABZ 1241)

No. of credits: 4

Total Hours : 72 Hrs

Course Outcomes

CO1:Students learn anatomy through simple dissections and mountings on permitted species.

CO2:Students get familiarized with various organ systems by examining approved animals.

CO3:Emphasize the adage that 'seeing is believing' by observing typical examples and economically important specimens.

CO4:Students learn the working principle of different scientific instruments and basics of biostatistics and bioinformatics.

CO5:Students become familiar with ecologically and economically important species.

Practical of ABZ 1121

8 Hrs

Methodology and Perspectives of Zoology

Study of the following instruments

1. Compound microscope
2. Centrifuge
3. Colorimeter
4. Microtome
5. pH Meter

Biostatistics and Molecular Biology:

1. Graphical representation of data (histograms, Frequency polygon, Pie diagram)

2. Calculation of Mean, median, mode and standard deviation of given data by discrete series Direct method.
3. Molecular Biology: Spotters (Watson & Crick model of DNA, clover leaf model of tRNA and DNA replication)

Practical of ABZ 1141: Animal Diversity I

36 Hrs

Minor Practicals - any four.

1. Nereis - parapodium
2. Earthworm – body setae
3. Scales of butterfly wing
4. Cockroach - mouth parts
5. Honey bee - mouth parts / mosquito - mouth parts
6. Prawn - appendages
7. Radula of Sepia

Major Practical - any two

1. Earthworm - nervous system
2. Cockroach - nervous system
3. Prawn nervous system

Taxonomy

Identification and classification of the following specimens

1. Protista - *Actinophrys, Noctiluca, Pramecium, Opalina*
2. Phylum Porifera - *Euplectella, Spongilla*.
3. Phylum Cnidaria - *Hydra, Obelia, Physalia, Aurelia, Adamsia*
4. Phylum Nematoda - Ascaris male and female (sexual dimorphism)
5. Phylum Platyhelminthes - *Bipalium, Fasciola, Teania solium*
6. Phylum Annelida - Earthworm, *Nereis*, Leech, *Aphrodite, Arenicola*
7. Phylum Onychophora - *Peripatus*
8. Phylum Arthropoda - *Limulus, Eupagurus, Sacculina, Apis indica, Lepisma, Scolopendra, Palamnaeus*
9. Phylum Mollusca - *Chiton, Pila, Xancus, Dentalium, Mytilus, Sepia, Octopus*
10. Phylum Echinodermata - Starfish, Brittle star, Sea urchin, Sea cucumber, Sea lily-
11. Larval forms: Nauplius, Tornaria, Trochophere, Pluteus

Practical of ABZ 1241: Animal Diversity II

28Hrs

Minor practical

1. placoid scales of *Scoloidon*
2. cycloid and ctenoid scales of *Anabas*

Osteology and Dentition

- a. Dentition (1) Carnivore (2) Herbivore
- b. Pectoral girdle and Synsacram of bird

- c. Limb bones, girdles and vertebrae of Frog.
- d. carapace and plastron of turtle.

Taxonomy

Prochordates -*Amphioxus (entire)*

Pisces – Cartilaginous fishes, 2

Fishes with accessory respiratory organs, 2; Edible fishes - 2 ; Culture fishes-2

Amphibia –*Bufo, Rhacophorus, Amblystoma, Axolotl, Ichthyophis*

Reptilia - 2 poisonous and 2 non -poisonous snakes, *Draco, Chamaeleon*

Aves - Different feathers, Pigeon.

Mammals –Pteropus

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Semester III

Main 1: Aquatic Biology Course 4

ABZ 1331: Fish Biology

No. of credits:4

Total Hours: 90 (T54 + P36)

Course Outcomes

CO1:Acquire an overview of taxonomy of major fishery resources and cultured aquatic organisms

CO2:Understand the anatomy and physiology of cultured fin and shellfishes

CO3:Understand the reproductive biology of cultured organisms for critical evaluation and application

CO4:Develop necessary understanding in fish biology for performing technical responsibilities as an entrepreneur/ consultant / administrator/ extension worker in hatchery and aquaculture sector

Course Content

Module I

10 Hrs

Taxonomic criteria for generic and specific identification. Morphological, morphometric and meristic characteristics of finfish and shellfish. Major taxa of inland and marine fishes up to family level.

Capture fishery resources of India :Commercially important marine fishes of India—pelagic, demersal fish, shellfish and seaweed resources. Fisheries of estuarine, riverine systems, major reservoirs and natural lakes of India. Fishing crafts and gears employed in the marine and inland sectors of India

Module II

6 Hrs

Food and feeding of fish and shellfish: Digestive system, in various taxa- comparative accounts. Digestion, absorption and assimilation. Food and feeding analyses. Growth patterns in fish. Factors affecting growth, growth hormones.

Case studies : one or two finfish species, Shrimp: *Penaeus spp.*, crab: *Scylla spp.*, Mollusca-any clam /oyster species.

Module III

5 Hrs

Respiration of fish and shellfish: Gaseous exchange. Respiratory pigments and metabolism. Energetics and swimming. Circulatory System of fish and shellfish: Blood and circulation-comparative account in fish and shellfish. Skeletal system in fish and shellfish

Module IV

5 Hrs

Excretory system in fish and shellfish: comparative account. Comparative study of nephron in different fishes. Pathways of excretion and hormones. Osmoregulation.

Endocrine system in fish and shellfish: Neurosecretions of shellfish responsible for moulting and reproduction. Biological clocks. Fish behaviour and hormonal regulation. Colour change and its regulation. Nervous system and sensory organs

Module V

8 Hrs

Reproductive system: Sexual dimorphism, Reproductive cycle, Modes of reproduction. Endocrine and neuroendocrine control of reproduction in cultured finfishes and shellfishes. Hormones in reproduction. Pheromones. Testes- Spermatogenesis, spermiation and hydration. Ovaries - Oogenesis, vitellogenesis and ovulation. Maturity stages in male and females. Fecundity, Gonado-Somatic Index (GSI), Ova diameter frequency. Age and growth determination by direct and indirect methods.

Module VI

6 Hrs

Fertilization and development in fin fishes: Spawning migration, courtship and mating, Development of eggs and embryogenesis. Hatching. Larval stages, larval Nutrition. Parental care. Case studies

Module VII

8 Hrs

Reproductive biology of cultured shrimps, freshwater prawns, mud crabs, oysters, mussels and clams. Breeding/spawning migration, courtship and mating. Sex ratio Fertilisation, embryogenesis, parental care, spawning, larval stages and development, Ecdysis (moulting) and metamorphosis. Case studies: shrimps, freshwater prawns, crabs, oyster and clams

Module VIII

6 Hrs

Induced Breeding of commercially important fin and shellfishes. Induced breeding techniques. Role of natural and synthetic hormones. Artificial insemination in crustaceans and molluscs. Cryopreservation technique: Principles and Advantages. Cryopreservation of eggs and gametes.

References

1. Biswas, S.P. 1993. Manual of Methods in Fish Biology. South Asian Publ. Pvt. Ltd., New Delhi, 157 pp.
2. Biswas, K.P. 2011. *Marine Prawns & Shrimps*. Daya Publishing House, Delhi, 329pp.
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Semester III

Main 1: Aquatic Biology Course 5

ABZ 1332 : Water Chemistry and Water Quality Management

No. of credits: 4

Total Hours: 90 (T 54+ P 36)

Course Outcomes

CO1: Understand the importance of soil and water chemistry in aquaculture.

CO2: Hands on experience on equipments and techniques involved in the analyses of different parameters of water and soil

CO3: Acquire practical knowledge on water quality monitoring and its management

Course Content

Module I

10 Hrs

Importance of soil and water chemistry in aquaculture. Optimum levels. Fundamentals of Analytical chemistry: Principles, Applications and Types. Classical methods of analytical chemistry: Volumetry and Gravimetry. Solutions: Standard solutions, titration, indicators, dilute solutions etc.

Module II

8 Hrs

Chemical properties of pure water, fresh water and sea water. Composition of waters: surface water, ground water and sea water. Factors affecting natural waters. Acid, base, salts: Hydrogen ions, modern concept of pH and buffer. Dissolved gasses

Module III

12 Hrs

Water Analysis: collection and preservation of water samples. Measurement of temperature, transparency, turbidity, determination of pH, electrical conductivity, salinity, chlorinity, total solids (Total Dissolved Solids, Total Suspended Solids), dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, Calcium, Magnesium, Inorganic Nitrogen (Ammonium and Nitrate) and Phosphorus.

Module IV

12 Hrs

Soil: physical and chemical properties- Depth, colour, texture, pore size, bulk density, water holding capacity, Soil colloids, Soil fertility, soil conductivity, soil redox potential. Types of soil.

Module V

12 Hrs

Soil and water quality management. Optimum conditions of water and soil for aquaculture. Adjusting alkalinity, pH, Dissolved oxygen, metals (Iron), ammonia, nitrite and nitrate toxicity. Soil and water amendments: lime manures, fertilizers, micronutrients, zeolites, alum, gypsum.

References

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Semester III

Main 2 : Zoology Course 4

ABZ 1341: Ecology, Habitat Destruction & Disaster Management

No. of credits:4

Total Hours: 90 (T72 + P18)

Course Outcomes

CO1:Demonstration of basic knowledge on ecosystem, food chain, food web and energy flow.

CO2:Acquire general awareness on pollution and their impacts.

CO3:Imparts basic knowledge on ecosystems and their functioning.

CO4:Learn about various types of anthropogenic pressures on ecosystem, related degradation and management measures.

CO5:Awareness of toxicants, their impacts on human health and environment and remedial measures.

CO6:Create awareness about disasters, prevention and mitigation measures.

Course Content

Ecology

6 Hrs

Module I

Components of ecosystem: Environmental factors - abiotic factors, light, temperature, soil, air; biotic factors- autotrophs, phagotrophs and saprotrophs; ecosystem interaction and relationship between biotic and abiotic factors, the cybernetic nature and the stability of the system. Pond as an ecosystem (self-study)

Module II

8Hrs

Biogeochemical cycles: Basic types of biogeochemical cycles - gaseous cycle-carbon and nitrogen cycles, mention sedimentary cycles (P and S), recycling pathways and recycle index.

Limiting Factors- basic concepts- Leibig's law of minimum, Shelford's law of tolerance, combined concept of limiting factors, Light and temperature as limiting factors.

Module III

10 Hrs

Habitat Ecology: Biosphere classification- lithosphere, hydrosphere and atmosphere physical features, fauna and their adaptations of aquatic, terrestrial and marine habitats (self-study).

Population ecology: Properties of population- density, natality, mortality, age distribution, biotic potential, environmental resistance and carrying capacity, population growth forms, J and S shaped curves, emigration, immigration and migration, population fluctuation. Community ecology: Definition and characters, species diversity; stratification; dominance; ecotone and edge effect; ecological indicators; community periodicity, succession.

Module IV

7Hrs

Anthropogenic impact on ecosystem: Ionizing radiation and radioisotopes, ionizing radiation and human health, radiation accidents and other exposures, disposal of radioactive wastes, pesticides like DDT, endosulfan, furadan, insect repellants, e-wastes. Monitoring of pollutants - physical, chemical and biological.

Module V

5 Hrs

Wild life conservation and management: Significance, causes of extinction, concepts of threatened species, red data book, IUCN, WWF, CITES, Green Environment and Green peace; protected areas, biosphere reserves, national parks and sanctuaries in India, forests in India, desertification, deforestation, carbon trading; importance of mangroves in coastal ecosystems-conservation and management.

Module VI

12 Hrs

Environmental biotechnology: Biotechnological methods of pollution detection, biotechnological methods in pollution management, bioremediation, biotechnology and biodegradation, genetically engineered microbes in bio-treatment of waste, eco-friendly bioproducts for environmental health, bio-piracy, bio-pesticides and bio-fertilizers, organic farming and its merits. Green chemistry - designing a Green synthesis, basic principles of Green chemistry.

Module VII

6 Hrs

Environment Movements

Environment and health - Environment and development: Environmental Movements (Chipko, Narmada BachaoAndolan). environmental movements in Kerala (MadhavGadgil/KasturiRangan Reports. Ramsar sites Wetland Reclamations and localized anti-reclamation movements) Kerala state Biodiversity Board, Biodiversity Register.

Habitat Destruction and Disaster Management

Module VIII

8 Hrs

Disruption in Ecosystem

Natural-flood, Draught, Earth quake, Cyclone, Tsunamis, Volcanic eruption. Anthropogenic influence on erosion, climate change and pollution. Mining activities. Monoclonal plantations,

genetically modified plants and their impact in ecosystem. Impact of Developmental projects such as construction of dams, Hydroelectric projects Thermal power station.

Module IX

10 Hrs

Disaster Management – Meaning and Definition: Definitions of Disaster, Hazard, Risks, Vulnerability, and Resilience and their relationship: Classification of disasters- Human induced and Natural; Cause of Disasters; Impact of disasters. Factors affecting Vulnerability – Economic, Political, Environmental and Social Counselling.

References

Ecology

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Habitat Destruction and Disaster Management

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19. Sharma, H.S.: Rathambhore Sanctuary - Dilemma of Eco-development, Concept.

First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester III

Main 2: Zoology Course 5

ABZ 1342: Cell and Molecular Biology

No. of credits:4

Total. Hours: 90 (T54 + P36)

Course Outcomes

CO1:Acquire sufficient knowledge on the fundamental structure, function and biochemistry of the cell.

CO3:Understand the principles of molecular biology and gene manipulation.

CO3:Learn ultra-structure of prokaryotic and eukaryotic cells and understand the fundamental differences between.

CO4: Learn the structure, replication and modification of the genetic material of eukaryotes.

CO5: Understands the mechanism of gene expression and gene regulation and get an awareness of bacterial recombination.

CO6: Acquire scientific knowledge on cancer and ageing.

Course Content

Cell Biology

34 Hrs

Module I

14Hrs

History, development and scope of cell biology, discovery of cells; cell theory and its modern version (self-study). Cell and its components:basic types of cells- prokaryotic and eukaryotic, nature and comparison. Ultra-structural organization and functions:

Plasma membrane- ultra structure- fluid mosaic model , functions of plasma membrane, trans-membrane transport. Cell communication- cell signaling and signal transduction, basic elements involved.

Mitochondria- structure, functions, mention oxidative phosphorylation and electron transport chain. Endoplasmic reticulun - morphology, types, functions and formation. Golgi bodies- morphology, types, functions (role in secretion) and formation. Lysosomes morphology, mention major groups of enzymes, classification, polymorphism and functions. Microbodies - morphology, major enzymes, peroxisomes and glyoxisomes functions. Ribosomes - different types, subunits, functions. Proteosomes - structure, ubiquitin - tagged protein degradation. Centrioles and basal bodies- structure and functions. Cytoskeleton- microtubules, microfilaments and intermediate filaments- examples and functions.

Interphase nucleus - gross structure and functions; nuclear envelope- pores and pore complexes; nuclear lamina, formation of nucleoplasm- nature and importance. Nucleolus - structure, nucleolar cycle, nucleolar organizer and functions. Chromatin - euchromatin and heterochromatin,

nucleosomes, unit fibre, solenoid fibre, and higher order of organization, condensation and coiling. Chromosome - structure of a typical metaphase chromosome; giant chromosomes- polytene chromosomes, lamp brush chromosomes; endomitosis.

Module II

8Hrs

Cell Division: cell cycle- G₁, S, G₂, and M phases (mention G₀, and D₀ stages and their significances); amitosis (brief account only). Mitosis Meiosis: description of all stages, synaptonemal complex, significance

Module III

6 Hrs

Biology of cancer: characteristics of cancer cells, dedifferentiation of cancer cells, theories of cancer, carcinogenesis, oncogenes and tumor suppressor genes , carcinoma, sarcoma, lymphoma. Treatment and targeted drug delivery.

Module IV

6 Hrs

Ageing process and problems of elderly: cellular and other changes, apoptosis, causes of aging, mention free radicals and superoxide dismutase (SOD), theories of aging. Hypertension and stroke, Balancing problems and fall in elderly, Urinary incontinence, Senile dementia, Osteoporosis, Senile cataract, Benign prostate hypertrophy (males), Reduced sleep and sleep disturbances, Interstitial long disease and decreased lung capacity, Wax deposition and hearing problems, constipation, Hyperacidity and gastric ulcer.

Module V 6 Hrs

Molecular Biology

Introduction: History, development and scope.

Nature of genetic material: search for the genetic material, Griffith's experiment, transformation, contributions of Avery, MacLeod and McCarty, Conrat & Stern's experiment with TMV, Hershey & Chase's experiment, and transduction. Composition and structure of nucleic acids - Watson - Crick model of DNA, clover leaf model of tRNA, different types of DNA and RNA; DNA replication in prokaryotes and eukaryotes -Semi-conservative method, Meselson & Stahl experiment, replication machinery and mechanism; modification and repair of DNA.

Module VI

6 Hrs

Gene Expression: contributions of Garrod, one gene - one enzyme hypothesis, one gene one polypeptide hypothesis, central dogma of Molecular Biology, central dogma reverse, co-linearity of genes and gene products.

Genetic code - deciphering / cracking the GC, characteristics of GC, codon assignment and wobble hypothesis.

Mention contributions of Nirenberg and his associates, Khorana and his associates. Transcription of RNAs - RNA polymerases, transcription factors, mechanism of transcription, post-transcriptional modifications of mRNA, rRNA and tRNA, reverse transcription, translation - machinery and mechanism; post translational modification of proteins; role of chaperones in protein normal folding and protection

Module VII

4 Hrs

Gene regulation: in prokaryotes (inducible and repressive systems); operon concept - Lac operon and Trp operon

Module VIII

4 Hrs

Bacterial Recombination: transformation, conjugation and transduction (general and specialized transduction)

References

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Semester IV

Main 1: Aquatic Biology Course 6

ABZ 1431: Freshwater Aquaculture

No. of credits:4

Total Hours: 90 (T 54+ P 36)

Course Outcomes

CO1: Knowledge in biology of freshwater culturable species so as to choose them for aquaculture according to the quality of natural resources available at the farm.

CO2: Familiarize with the standard practices followed in the establishment of a scientifically managed freshwater farm

CO3: Develop deep understanding on the seed production and grow-out techniques involved in the culture of major species farmed in the country

CO4: Appreciate the need for integrating aquaculture with animal husbandry and agriculture activities to maximize utilization of resources and recycling of materials

Course Contents

Module I

7 Hrs

Biology of major cultured species: Indian major carps (catla, rohu and mrigal), Chinese carps (silver carp and grass carp), common carp, Tilapia (GIFT), cat fishes, air breathing fishes, freshwater prawn

Module II

8 Hrs

Freshwater aquaculture resources: Ponds, tanks, lakes, reservoirs etc. – properties of the ecosystem, type of suitable aquaculture practices, nature of ownership, levels of farm management.

Module III

6 Hrs

Preparation for fish farming: Site selection, pond construction, clearance of aquatic weeds, management of weed fishes and predatory fishes, aquatic insects, selection of species for culture.

Module IV

12 Hrs

Seed production of major cultured fishes and shell fishes: Carps, Tilapia, Cat fishes, Air breathing fishes and freshwater prawns- hatchery requirements, brood stock management, spawning and larval rearing, nursery rearing, larval nutrition, health management, cost of seed production, packing and transportation.

Module V

12 Hrs

Grow out culture: Major carps and Exotic carps (composite fish culture, poly culture, mixed farming), Tilapia, Cat fishes, Air breathing fishes and freshwater prawns – pond preparation, acclimatization and stocking, feed management, health management

Module VI

9 Hrs

Integrated aquaculture: culture of fish along with paddy, cattle, goat, duck, chicken, pig and agriculture/horticulture crops. Sewage fed aquaculture: characteristics of sewage, utilization of agro/industrial waste in aquaculture, case study of West Bengal.

Practicals

36 hours

1. Identification of cultivable carps
2. Identification of cultivable air breathing fishes, freshwater prawn
3. Identification of weed and predatory fishes
4. Identification of aquatic insects
5. Identification of aquatic weeds
6. Calculation and application for weed eradication strategies
7. Calculation of pond fertilization
8. Calculation of stocking density of different group of fishes and feed management
9. Water quality monitoring and management
10. Disease diagnosis and treatment
11. Visit to freshwater farms and hatcheries

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Semester IV

Main 1: Aquatic Biology Course 7

ABZ 1432: Ornamental Fish Culture

No. of credits: 4

Total Hours: 90 (T 54+ P 36)

Course Outcomes:

CO 1: Acquire fundamental information on ornamental fish industry

CO 2: Familiarity on diversity of ornamental fish and other species for maintaining in aquarium

CO 3: Understand comprehensive awareness on accessories used in aquarium industry

CO 4: Proficiency in culture and breeding of fresh and marine ornamental varieties at commercial level

CO 5: Hands on experience in setting up and maintain fresh and marine aquariums as hobby and at commercial level

Course Content

Module I

6 Hrs

Diversity of ornamental fish- fresh and marine. Major hotspots of ornamental fish- global and Indian perspective. Ornamental fish trade- global and Indian perspective. Preferred species in trade. Indigenous ornamental fish species. Ornamental invertebrates.

Module II

14 Hrs

Introduction to aquarium keeping and hobby, global and national scenario. Principles of setting up and maintenance of aquaria: Construction of fresh and marine aquarium. Aquarium accessories- aerators, filters, skimmers, chillers, lighting, decorates, etc. Ornamental plants. Latest trends in aquarium designs. Types of aquaria- Biotope aquarium, Vivarium, insectarium, terrarium, paludarium, oceanarium, dolphinarium. Reef aquarium. Nano aquariums.

Module III

8 Hrs

Sex determination in ornamental fish. Breeding and seed production of common ornamental fishes: Construction of breeding tanks. Commercial farming technologies for indigenous ornamental fishes- culture, propagation and trade.

Module IV

8 Hrs

Packing, transportation and marketing of ornamental species. Anesthetics used in the trade. Problems in ornamental fish export. Feeding and nutrition of ornamental fishes. Larval feeding. Live feed culture- Artemia, Infusoria, Brachionus culture.

Module V

9 Hrs

Water quality parameters and management. Preparation of artificial sea water. Disinfection/Treatment of water.

Module VI

9 Hrs

Common diseases and parasites of freshwater and marine ornamental fish treatment. Health management of aquarium fishes. Prophylaxis and quarantine.

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Semester IV

Main 1: Aquatic Biology Course 8

ABZ 1433: Aquatic Biology Practical II

(Practical of ABZ 1331, ABZ 1332, ABZ 1431 & ABZ 1432)

No. of credits: 2 Total Hours: 144

Course Outcomes

- CO1:** Knowledge in identification of culturable aquatic organisms, its basic biology and physiology with special emphasis on reproductive biology
- CO2:** Hands on experience on equipments and techniques involved in the analyses of different parameters of water and soil
- CO3:** Familiarize with the standard practices followed in the establishment of a scientifically managed freshwater farm
- CO3:** Develop expertise on the commercial seed production and grow-out techniques involved in the culture of major freshwater species farmed in the country
- CO 4:** Proficiency in culture and breeding of fresh and marine ornamental varieties at commercial level
- CO 5:** Hands on experience in setting up and maintain fresh and marine aquariums as hobby and at commercial level

Course Content

Practical of ABZ 1331

36 Hrs

1. Visit to fish landing centers to study commercially important fishes and catch composition.
2. Collection and identification of commercially important inland and marine fishes.
3. Morphometric and meristic studies of candidate species of fin and shellfish species
4. Dissection and display of various body systems of fish and shellfish
5. Reproductive systems in fish and shell fish - maturity stages, fecundity and ova-diameter studies and GSI
6. Visit to fish breeding centres and hatcheries

Practical of ABZ 1332

36 Hrs

1. Demonstration of laboratory glass wares and equipments used in water and soil analysis.
2. *In situ* water Analysis using equipments: Temperature, salinity, pH, DO using equipments
3. Water analysis: measurement of Temperature, Salinity, pH, Oxygen Concentration, Transparency.
4. Determination of Nitrite, Nitrate, Ammonia, TOC, alkalinity, Phosphate, Silicate, Chlorophyll

5. Soil analysis: Analysis of soil texture, soil pH, conductivity, soil available nitrogen, available phosphorus, and organic carbon.
6. Water quality monitoring devices and kits-operation
7. Adjustment of water quality parameters to optimum levels

Practical of ABZ 1431

36Hrs

1. Identification of cultivable carps
2. Identification of cultivable air breathing fishes, freshwater prawn
3. Identification of weed and predatory fishes
4. Identification of aquatic insects
5. Identification of aquatic weeds
6. Calculation and application for weed eradication strategies
7. Calculation of pond fertilization
8. Calculation of stocking density of different group of fishes and feed management
9. Water quality monitoring and management
10. Disease diagnosis and treatment
11. Visit to freshwater farms and hatcheries

Practical of ABZ 1432

36Hrs

1. Identification of commercially important live bearers
2. Identification of commercially important egg layers
3. Identification of commercially important marine ornamental species
4. Identification of common aquatic plants
5. Fabrication and setting up of aquarium
6. Preparation of ornamental fish feed
7. Preparation of live feed
8. Breeding setup for live bearers
9. Breeding setup for egg layers
10. Diseases, prophylaxis and quarantine
11. Visit to ornamental fish farms

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Semester IV

Main 2: Zoology Course 6

ABZ 1441: Genetics and Biotechnology

No. of credits: 4

Total Hours: 90 (T54 + P36)

Course Outcomes

CO1: Structure of gene is to be learned.

CO2: Students get educated on the underlying genetic mechanism operating in human and state of the art of bio-techniques

CO3: Students develop a proper understanding on the relation between heredity and variation.

CO4: Learn the mechanism of crossing over and inheritance patterns in human.

CO5: Students become aware of different genetic syndromes and the possible ways to reduce its occurrence.

CO6: Students understand the principles and techniques involved in DNA technology and get an overview of modern techniques like PCR, Hybridoma technology, gene therapy and human cloning

Course Content

Genetics

30 Hrs

Module I

6Hrs

Introduction: Mendel and his experiments, relevance of Mendel's principles in modern genetics (self-study); genetic terminology-gene, allele, genotype, phenotype, genome; wild type and mutant type, test cross, back cross and reciprocal cross.

Interaction of genes: Allelic, incomplete dominance, lethal and co-dominance, non-allelic, complementary gene action; Co-epistasis, dominant (feather coat) and recessive (coat colour), polygenic action (skin colour), pleiotropism(one example). Multiple alleles- ABO Blood group system, Rh group and its inheritance.

Module II

7Hrs

Linkage, crossing over and recombination: Linked genes, linkage groups, chromosome theory of linkage, factors affecting linkage, crossing over and recombination, mechanism, kinds and factors affecting crossing over and its significance. Chromosome mapping (brief account only);

Sex Linkage: Characteristics of sex-linked inheritance, sex linked inheritance of human (colour blindness and haemophilia), incompletely sex-linked genes, holandric genes, sex limited genes and sex influenced genes.

Module III

6Hrs

Sex Determination: Environmental factors on sex determination, mention genic balance theory, chromosome theory of sex determination, chromosomal mechanism of sex determination, (XX-XY, XX-XO, ZZ-ZW), sex determination in human, role of Y chromosome, Barr bodies, dosage compensation and Lyon hypothesis. Chromosome mosaicism; Mention inter sex, gynandromorph and hermaphrodite.

Module IV

4Hrs

Mutation: Types of mutations - somatic, germinal, spontaneous, induced, autosomal and allosomal, euploidy and aneuploidy. Gene mutation, molecular basis of mutation, induced mutation- chemical, ionizing and non-ionizing radiations

Module V **3Hrs**

Cytoplasmic inheritance: Mitochondrial DNA, *kappa* particles in paramecium, maternal effects in *Drosophila*.

Module VI **4Hrs**

Human Genetics: Karyotyping, normal chromosome complement, pedigree analysis, chromosomal anomalies in man, autosomal (eg. Down syndrome, Edwards syndrome), allosomal (eg. Klinefelter's syndrome, Turner's syndrome) Biochemical genetics: Human biochemical genetics, biochemical pathway of phenyl alanine - tyrosine metabolism in normal human. Disorders. Phenylketonuria, Alkaptonuria, Tyrosinosis and Albinism.

Module VII **4Hrs**

Biotechnology Introduction-Scope of biotechnology, emerging branches of biotechnology. Genetic engineering and recombinant DNA technology, techniques in gene cloning, restriction endonucleases, ligases, major steps in cutting and joining of DNA, tools used in recombinant DNA technology, vectors, plasmids, probes, linkers, host cells, transformation and detection of recombinant molecules.

Module VIII **5Hrs**

Genomic library, construction of genomic library and cDNA library, Polymerase Chain Reaction-basic steps and applications of PCR, DNA sequencing (Sanger method, Automated sequencing), patenting DNA sequences.

Module IX **4Hrs**

Blotting Techniques: Southern, Northern and Western blotting, DNA fingerprinting.

Module X **4Hrs**

Human Genome Project, hybridoma technology and monoclonal antibodies; gene transfer techniques (chemical treatment, electroporation, lipofection, microinjection, retro viral vector method, embryonic stem cell method and shot gun method); transgenic microbes, plants and animals.

Module XI **3Hrs**

Gene therapy: somatic gene therapy and germ line gene therapy; gene doping and its implications; DNA vaccines; Human cloning -therapeutic and reproductive cloning.

Module XII **4Hrs**

Practical applications of biotechnology-in medicine, agriculture, industry, pollution control, forensics and judiciary. Potential hazards of biotechnology. Bio-ethics - problems and solutions. Biotechnology in future.

References

Genetics

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Biotechnology

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First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester IV

Main 2: Zoology Course 7

ABZ 1442: Immunology and Microbiology

No. of credits:4

Total Hours: 90 (T54 + P36)

Course Outcome

CO1: Understand the scope, importance, principles and mechanisms of clinical immunology.

CO2: Acquire knowledge on immunodeficiency diseases and malfunctioning and disorders of the immune system

CO3: Transplantation and mechanism of Graft retention and rejection are learned.

CO4: Develop a broad understanding of the positive as well as negative aspects of microbes and the economic importance (applied aspects) of microbes in industry is studied.

Course Content

Module I

2Hrs

Introduction, history, development and scope.

Module II

3Hrs

Immunity: definition, classification of immunity. Innate (non-specific) - species, racial and individual IM with examples, acquired (specific) - active IM (natural and artificial) with examples, passive IM (natural and artificial) examples.

Module III

7Hrs

Immune system: organs and tissues of the immune system. Primary (central) - thymus, bone marrow, bursa of Fabricius, secondary (peripheral)- spleen, lymph nodes, MALT etc. Cells lymphocytes - T cells and B cells - formation, development and maturation; plasma cells and null cells - natural killer

cells, lymphokine - activated killer cells; phagocytes / macrophages; antigen presenting cells - macrophages, B-lymphocytes, dendrite cells, Langerhans cells; follicular dendrite cells, neutrophils, eosinophils, basophils, mast cells. Mitogens - mention only

Module IV

10Hrs

Antigens (immunogens) (Ag): definition, complete antigens, haptens, antigenic determinants or epitopes; antibodies (Immoglobulins)- definition, general structure of Ig, Ig determinants, physico-chemical properties of Ig, classes of Ig- G, M, A, D, E; mention abnormal Igs; antigen - antibody reactions- mechanism (mention zone phenomenon), precipitation reactions, agglutination reactions, complement fixation, neutralization, opsonisation (brief accounts only) Complement system: definition, general features, major histocompatibility complex (MHC) (brief account only). Immune response- definition, types of immune responses- humoral immune response (antigen mediated immunity - AMI) and cellular immune response (cell mediated immunity - CMI) in detail, induction of CMI, mention cytokines, define immunological memory, immunological tolerance and immune suppression

Module V

10Hrs

Hyper sensitivity / allergy: definitions, classification- types I, II and III (Brief accounts only); immune-deficiency diseases (ID)- definition, primary IDs, disorders of immune mechanism (humoral, cellular and combined IDs), disorders of complements, disorders of phagocytosis, mention one example each, secondary IDs - mention example, an account of Acquired Immune Deficiency Syndrome (AIDS); Auto immunity-definition, mechanism, mention AI diseases; transplantation immunity-definition, classification of transplants, graft versus host reactions; graft rejection, mechanism of graft rejection, factors affecting graft survival; Immunisation and vaccination-definitions, vaccines; types of immunization- active immunization- killed and live attenuated vaccines, microbial extracts, vaccine conjugates, toxoids, recombined vaccines, DNA vaccines; passive immunization- pooled nonnal human Igs, specific Igs (hyper antisera); combined immunization

Microbiology

22Hrs

Module VI

8Hrs

Introduction: history, development and scope Importance of microbes in various ways beneficial, harmful, ecological and others. Classification of microbes/ particles: broad classification- viruses-different groups, examples; mention viroids and prions, *Mycoplasmas*, *Rickettsiae* and *Chlamydiae*; Bacteria: 1. Archaea - significance of extreme life forms(Methanoarchaea , extreme halophiles and thermophiles); Eubacteria (=Bacteria) Major groups of Eubacteria: Bergey's system of classification; modern methods classification of Eubacteria (outline only with familiar examples)- Non-photosynthetic proteobacteria:- (Fennentative Rods and Vibrios) ex. *Vibrio*, *Pasteurella* (oxidative rods and cocci) eg.*Pseudomonas*, *Azotobacter*, *Rhizobium*; Chemo-lithotrophic bacteria:- eg. nitrifying, sulphur and iron bacteria; Firmicutes (eg.*Staphylococcus*) and Actinobacteria (Coryneform bacteria); Phototrophic bacteria (Cyanobacteria); Algae-(details not expected) Protista- different groups-examples: *Plasmodium*, *Giardia*; Fungi- Mention different groups - example *Candida*. Structure of a bacteriophage and a typical bacterium

Module VII

4Hrs

Applied microbiology: various fields: emphasis on environmental, agricultural, medical, biotechnological, industrial and strategic fields

Module VIII

10Hrs

Symbiotic and Pathogenic Microbes: microbes with other microbes, microbes with plants, microbes with animals; microbe - human host interactions, normal human microbiota of various organs- mention any 3 examples, pathogenic microbes - mention any 3 examples, microbial toxins - mention any 2 examples. Microbial diseases in man (of skin, respiratory system etc.)- viral- chicken pox,

measles, cold, herpes, hepatitis, poliomyelitis; bacterial - diphtheria, pneumonia, leprosy, ornithosis; fungal - aspergillosis, candidiasis and others - malaria

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First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester IV

Main 2: Zoology Course 8

ABZ 1433: Zoology Practical II

(Practical of ABZ 1342, ABZ 1441 & ABZ 1442)

Cell and Molecular Biology, Genetics and Biotechnology, Immunology and Microbiology

No. of credits:4

Total Hours:108 Hours

Course Outcomes

CO1:To familiarize the basics in cell biology and to prepare and observe chromosomal arrangements during cell division

CO2:To study chromosomal aberrations in man

CO3:To gain broad knowledge on conventional biotechnological- procedures

CO4:To perform routine blood analysis.

CO5:To expertise the student to carry out routine hematological and microbiological techniques

Course Content

Practical of ABZ1342

36 Hrs

Cell Biology [Any six]

1. Staining of prokaryotic cells: (a) *Lactobacillus* from curd (I) Nitrogen fixing bacteria (*Rhizobium*) from root nodules of legumes
2. Staining of eukaryotic cells: buccal epithelial cells (observe Barr body)
3. Study of cell organelles
4. Mitosis: stages in onion (*Allium cepa*) root meristem (squash preparation)
5. Calculation of mitotic index and metaphase index in root meristem of *Allium cepa*
6. Meiosis: stages in testis of grass hopper (demonstration. only).
7. Giant chromosomes in Diptera: (*Drosophila/Chironomus* larvae) salivary gland cells (Demonstration only)
8. Localisation of mitochondria in Yeast cells using Janus green

Practical of ABZ1441

36 Hrs

Genetics [Any five]

1. Study of monohybrid cross using coloured beads.
2. Study of normal chromosome complement and karyotype of human.
3. Study of genetic syndromes and abnormal karyotypes of human (Klinefelter's syndrome. Turner's syndrome. Down syndrome and Edward syndrome)
4. Recording the dermatoglyphic patterns (Human finger prints) significance, comment.
5. Study of Barr body and its significance (in stained buccal epithelial cells)
6. Construction of Pedigree chart.

7. Identification of male and female *Drosophila*.

Biotechnology and Bioinformatics (Any two)

1. Polymerase chain reaction (PCR)
2. Southern Blotting and Northern Blotting
3. Gene cloning

(Schematic arrangement in orderly sequence, the steps involved in the above three methods and make comments) C D display or visit to any Research Institute.

4. Sequence comparison using software (BLAST/FASTA)

Practical of ABZ1442

36 Hrs

Immunology and Microbiology (Any Two)

- 1) Effect of anticoagulant in human blood.
- 2) Total leucocyte count (Demonstration)
- 3) Human blood groups and Rh Factors.
- 4) Identification of bacterial types (Permanent slides)

(Coccus, Vibrio, Bacillus Spirilla) any two.

First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester V

Main 1 : Aquatic Biology Course 9

ABZ 1531: Brackish water Aquaculture & Mariculture

No. of credits:4

Total Hours: 108 (T72 + P36)

Course Outcomes

CO1: Knowledge in biology of culturable marine and brackishwater species so as to choose them for aquaculture according to the quality of natural resources available at the farm.

CO2: Familiarize with the standard practices followed in the establishment of a scientifically managed aquafarm

CO3: Develop deep understanding on the seed production and grow-out techniques involved in the culture of major marine and brackishwater species farmed in the country

CO4: Appreciate the need for integrating aquaculture with animal husbandry and agriculture activities to maximize utilization of resources and recycling of materials

Course Contents

Module I

8 Hrs

Biology of major cultured species: Shrimps (*Penaeus monodon*, *Fenneropenaeus indicus* and *Litopenaeusvannamei*); Milk fish, Mulletts, Seabass, Groupers, Pompano, Cobia, Pearlsplit, crabs, lobsters, molluscs, sea cucumbers and seaweeds

Module II

8 Hrs

Methods of culture-traditional, extensive, semi intensive and intensive systems.

Module III

12Hrs

Pond culture- site selection, design and construction, bunds, sluice gates, water supply, pond preparation, water quality maintenance and aeration, Feed Management, Disease Diagnosis and treatment. Cages- types, designs, materials used, constraints. Pens- designs and uses. Methods of molluscan culture – ropes, rafts, etc.

Module IV

10 Hrs

Seed production and grow out culture of shrimps: Hatchery production of shrimp seeds – site selection, design, construction, water source and management of quality, live feed management, testing for diseases, packing and transportation, marketing. Grow out culture - acclimatization and stocking, feeding and nutrition, water quality management in the ponds, health management, harvesting and marketing. Intensive culture systems; economics of hatchery and farm operations; rules and regulations

Module V

12Hrs

Seed production and culture of fin fishes. Wild seed collection - mullets, milkfish, pearlspot, etc; Hatchery production of seeds – seabass, milkfish, pearlspot, pompano, cobia, groupers, etc. Grow out culture – Culture in ponds, cages and pens. Intensive culture techniques.

Module VI

10Hrs

Seed production and culture of Crabs, Lobsters and Molluscs. Wild seed collection techniques for crabs, lobsters and molluscs. Hatchery seed production technology for crabs, lobsters and molluscs. Grow out culture techniques for crabs (grow out and fattening), lobsters (fattening and grow out), molluscan culture techniques (mussels, oysters and clams). Pearl production.

Module VII

12Hrs

Mariculture—Species used in Mariculture, culture operation procedures. Seed production and grow out culture of sea weed. Seaweed culture – biology of common cultured species, production potential, culture methods, water quality requirements, harvesting and utilization. Biofloc culture; recirculatory aquaculture systems; Integrated multi-trophic aquaculture; concepts of biosecurity.

References

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Semester V

Main 1: Aquatic Biology Course 10

ABZ 1532: Intensive Aquaculture

No. of credits:3

Total Hours: 108 (T72 + P36)

Course Outcomes

CO 1: Fundamental information on intensive farming techniques

CO 2: Familiarity on the properties of soil chemistry

CO 3: Comprehensive awareness on feed management for intensive aquaculture

CO 4: Proficiency in designing of instrumentation for intensive systems

CO 5: Detailed knowledge on online water quality monitoring system

CO 6: Basic information on effluent treatment protocols

Course Content

Module I

14Hrs

Design of Intensive Aquaculture Systems: water flow rate and component ratio in intensive systems. Recirculating Aquaculture Systems (RAS). Water inlet –outlet ratio for RAS, size of biofilter in RAS. Intensive Aquaculture Systems- Cage, Aquaponics, Biofloc, RAS, Pond.

Module II

14Hrs

Stocking density. Feed Management in Intensive Aquaculture: Effective feeding practices-timing, ratio, quality. Partial feeds, feeding chart. Disease management. Growth Assessment

Module III

12 Hrs

Ways to improve effective production- system component inclusion/improvement, strategic plans- multiple species/size stocking, monosex/sex reversal, ploidy induction, higher stocking density, crop rotation. Record keeping.

Module IV

10Hrs

Waste management in Intensive Aquaculture Systems: Treatment of solid/liquid waste. Site characteristics for discharge regulations. Effluent treatment scheme of Aquaculture Authority of India.

Module V

11 Hrs

Harvesting. Value addition of products- processed products, by-products, Ready to eat/cook products. Marketing strategies- online marketing, group of fish farmers, sale of fresh & live fish.

Module VI

11Hrs

Automation in Intensive Aquaculture Systems- Automatic Feeder- demand feeder. Online water quality monitoring and maintenance. Uninterrupted power supply/generator- solar, battery.

Practicals

36 hours

1. Designing and fabrication of RAS
2. Designing and fabrication of Aquaponics
3. Monitor the performance of RAS
4. Monitor the performance of Aquaponics
5. Monitor the performance of Biofloc technology
6. Value addition of fish- processing- pickles, ready to cook/eat
7. Setting up of a demand/automatic feeder
8. Visit to commercial level RAS unit
9. Visit to commercial level Biofloc system
10. Visit to commercial level aquaponics

References

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First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester V

Main 2: Zoology Course 9

ABZ 1541: Physiology and Biochemistry

No. of credits: 4

Total Hours: 90 (T54 + P36)

Course Outcome

CO1: Develop a clear understanding of the correlation and coordination between the structure and function of different organs and organ systems of the body.

CO2: Study on the physiology help students understand the physiology of different organ systems of the body.

CO3: Learn the correlation between diseases and the abnormal structure or improper functions of organs.

CO4: Understand the possible causes of abnormal physiology and the resultant diseases.

CO5: Understand the structure and functions of bio-molecules and their role in metabolism.

Course Content

Physiology

30 Hrs

Module I

4Hrs

Nutritional Physiology: Structure of digestive system (self-study). General introduction, types of nutrition, mechanical and chemical changes of food in the alimentary canal, balanced diet, nutritional disorders - PEM, vitamin deficiency, deficiency of iron, iodine and calcium, lifestyle diseases, role of fibres, nervous and hormonal control of digestion

Module II

4Hrs

Circulatory Physiology: Structure of Heart. (self-study). Blood- Composition and functions of blood plasma and formed elements, blood groups, mechanism of blood clotting, intrinsic and extrinsic pathways, disorders of blood clotting, anticoagulants, heartbeat, conducting system and pace maker, pulse and blood pressure, clinical significance, control of cardiac activity, common cardio vascular diseases - arteriosclerosis, atherosclerosis, Myocardial infarction, electrocardiogram, angiogram, angioplasty. Lymph and lymphatic system (brief account)

Module III

4Hrs

Respiratory Physiology: Structure of lungs (self-study). Gas exchange, respiratory pigments-structure of haemoglobin, transport of O₂- Oxyhaemoglobin curve, Bohr effect, transport of CO₂ - carbonic acid, carbamino haemoglobin, bicarbonate and chloride shift, regulation of respiration - neural and chemical; respiratory disturbances - apnoea, dyspnoea, hypoxia, hypo and hyper capnia, asphyxia, carbon monoxide poisoning, bronchitis, asthma. Physiological effects of smoking.

Module IV

3Hrs

Renal Physiology: Structure of Kidney. (self-study). Nephron - structure, urine formation, counter-current multiplier system, role of kidney in osmoregulation, composition of urine, abnormal constituents of urine, regulation of kidney functions, renal disorders - nephritis, haematuria, renal calculi, acidosis and alkalosis - Dialysis and kidney transplantation.

Module V

3 Hrs

Muscle Physiology: Brief account of types of muscles, fast and slow twitch muscles, red and white muscles. Ultra-structure of striated muscle fibre, muscle proteins, simple muscle twitch, summation, tetanus, tonus, All or None law, fatigue, oxygen debt, rigor mortis. Physiological and biochemical events in muscle contraction.

Module VI**3 Hrs**

Nerve Physiology: Structure of Brain. (self-study). Neurons - structure, types of neuron. Synapse and types of synapse, nerve impulse propagation, synaptic transmission. Reflex action, refractory period, neuro transmitters, electro encephalogram. Nerve disorders - epilepsy, Alzheimer's disease, Parkinson's disease.

Module VII**3 Hrs**

Sensory Physiology: Structure of eye and ear (self-study). Physiology of vision, visual elements and pigments, photo chemistry of vision. Eye defects - myopia, hyperopia, presbyopia, astigmatism, cataract. Structure of ear and mechanism of hearing, hearing impairments -deafness, labyrinthine disease. Olfactory, gustatory and tactile sense organs

Module VIII**3Hrs**

Reproductive physiology: Male and female reproductive organs (self-study). Reproductive cycles, puberty, adolescence, pregnancy, parturition, lactation and birth control.

Module IX**3Hrs**

Endocrinology: Endocrine glands in man, hormones and disorders, feed-back mechanism, mechanism of hormonal activity.

Biochemistry**24 Hrs****Module X****8Hrs**

Biomolecules: Micromolecules, macromolecules, water, buffer systems and importance; **Carbohydrates**-structure, classification- monosaccharides (trioses, tetroses, pentoses, hexoses, aldoses, ketoses), disaccharides and polysaccharides (homo and hetero polysaccharides); biological functions of carbohydrates.

Lipids- classification- simple lipids, (neutral fats and waxes), conjugated lipids (phospho lipids, sphingo lipids, glyco lipids, lecithins, cephalins, cerebrosides, gangliosides), derived lipids (fatty acids, steroids, prostaglandins), biological functions of lipids.

Proteins - classification of proteins, amino acids- basic structure, structure of protein primary, secondary tertiary and quaternary structures, haemoglobin as atypical protein, biological functions of proteins.

Module XI**12Hrs**

Metabolism: Carbohydrate metabolism- glycogenesis, glycogenolysis, hexose monophosphate shunt, metabolic pathway of glucose- glycolysis, Kreb's cycle, electron transport series, chemi-osmotic theory, energetic; hormonal control of carbohydrate metabolism.

Lipid metabolism- hydrolysis of lipid, beta oxidation, mention alpha and omega oxidation of fatty acids, hormonal control of lipid metabolism, hormonal control of lipid metabolism.

Protein metabolism- deamination, transamination, Ornithire cycle, hormonal control of protein metabolism.

Module XII**4 Hrs**

Enzymes: Chemical nature, mechanism of enzyme action, factors affecting enzyme activity, kinetics of enzyme action, Michaelis - Menten equation, iso enzymes, co-enzyme, co-factors, enzyme activation and inhibition.

References**Physiology**

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Biochemistry

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First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester V

Main 2: Zoology Course 10

ABZ 1542: Developmental Biology and Experimental Embryology

No. of credits:4

Total Hours: 90 (T54 + P36)

Course Outcome

CO1:Students get a brief idea about the history of developmental biology.

CO2:Provide the students a bird's eye view of sophisticated embryological techniques

CO3:Study the various stages involved in the development of organisms.

CO4:Study the initial developmental procedures involved in Amphioxus, Frog and chick

CO5: information on state- of- the art experimental procedures in embryology.

CO6:Understanding of different control mechanisms of development including gene action are studied.

Course Content

Developmental Biology

44Hrs

Module I

7 Hrs

Introduction, Historical perspective (brief account), theories- Preformation, Epigenesis, Recapitulation and Germplasm. Subdivisions of Developmental biology. Spermatogenesis and oogenesis, structure of Graafian follicle, typical egg and sperm. Polarity of egg, egg envelopes; classification of eggs based on different criteria.

Module II

6Hrs

Fertilization: Agglutination, sperm penetration, activation of egg, amphimixis; physiological and biochemical changes during and after fertilization. Parthenogenesis- introduction, natural and artificial parthenogenesis, arrhenotoky and thelytoky, obligatory and facultative, significance of parthenogenesis.

Module III

7 Hrs

Cleavage: types of cleavage - holoblastic and meroblastic; patterns of cleavage - radial, bilateral, spiral, rotational; cell lineage in Planocera (brief account only). Morula formation in microlecithal, mesolecithal, macrolecithal eggs; blastulation - introduction, different types of blastula - stereo blastula, coeloblastula, discoblastula, periblastula, blastocyst. Presumptive organ forming areas and fate maps, eg. amphioxus, frog, construction of fate maps.

Module IV

3Hrs

Gastrulation: introduction, brief account of morphogenetic movements - epiboly and emboly (invagination, involution, infiltration, ingression, delamination, convergence, divergence) concept of germ layers, derivatives of germ layers.

Module V

5 Hrs

Cell differentiation: totipotency, pluripotency and unipotency of embryonic cells. Determination and differentiation in embryonic development. Gene action, Drosophila as a model organism (brief account only), Homeotic genes and Hox genes.

ModuleVI

14Hrs

Development: Amphioxus - cleavage, blastulation, gastrulation, neurogenesis, notogenesis, mesoderm and coelom formation. **Frog** -cleavage, blastulation, gastrulation, organogeny - development of brain, eye, heart; metamorphosis - ecological, morphological and physiological

changes and hormonal control. **Chick** - cleavage, blastulation, gastrulation, study of 24 Hrs chick embryo; development of extra- embryonic membranes in chick. **Human** - implantation, pregnancy, parturition. Placentation in mammals - different types of placenta, functions.

Module VII

3Hrs

Teratology: definition, causes, infections, drugs and chemicals, metabolic imbalance, ionizing radiation, malnutrition, autoimmunization.

Experimental Embryology

10Hrs

Module VIII

10Hrs

Spemann's constriction experiments, organizers and embryonic induction, transplantation experiments involving optic cup, nuclear transplantation experiments in amphibians. *In vitro* fertilization and embryo transfer experiments in farm animals, In vitro fertilization and embryo transfer experiments in human and test tube babies; cloning experiments in animals (mammals); prenatal diagnosis and sex determination methods - amniocentesis chorionic villus sampling, ultra sound scanning. Embryonic and adult stem cell research and stem cell therapy.

References

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First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester V

Open Course 1

ABZ 1551: Vermiculture and Apiculture

No. of credits:2

Total Hours: 54

Course Outcomes

CO 1: To promote self-employment and self-reliance among educated youth

CO 2: To learn the basic procedure and methodology of vermiculture

CO 3: To learn the scope and methodology of apiculture.

Course Contents

Vermiculture

24Hrs

Module I

6 Hrs

Introduction: Definition and scope of vermiculture. Nature and species of earthworms: habit categories - epigeic, endogeic and anecic, indigenous and exotic species (*Eudrillus eugeniae*/*Eisenia foetidae*/*Perionyx excavatus*/ *Lampito mauritii*). Identification of the above four species based on morphological characters.

Module II

10Hrs

Methodology of vermicomposting: step by step methodology -containers for culturing, raw materials required, preparation of bed, environmental pre-requisites, feeding, harvesting and storage of vermicompost. Advantages of composting, precautions to be taken to prevent attack by pests and pathogens:

Module III

8 Hrs

Vermicompost profile and applied aspects: physical, chemical and biological parameters of vermicast, vermin enrichment, economic uses of vermiculture (biofertilizer, waste disposal, vermivash, poultry feed, vermi-remediation etc.

Apiculture

30 Hrs

Module IV

8 Hrs

Introduction and Scope: Definition and significance of the study. Caste system and Social behavior; common species of honeybees used, organization of bee colony, social life and adaptations of honeybees.

Module V

12 Hrs

Bee keeping methods and equipments: indigenous methods, extraction appliances, extraction of honey from the comb and processing. management and maintenance of an apiary, bee pastures

Module VI

10 Hrs

Diseases and economics: diseases (bacterial, fungal, protozoan, acarine, brood diseases, preventive and curative measures. Use of honey, bees wax, bee venom, nutrient profile of honey, marketing strategies.

References

1. Cherian & Ramachandran Bee keeping in-South Indian Govt. Press, Madras.
2. Gupta, K.C. Romance of bee keeping. Khadi Paristhan, Calicut.
3. Mary Appelhof. Worms eat my Garbage.

4. Mishra R.C. Perspectives in Indian Apiculture
5. Sathe, T.V. Vermiculture and Organic farming.

First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester V

Open Course 2

ABZ 1552: Human Nutrition

No. of credits:2

Total Hours: 54

Course Outcome:

CO 1: To make aware the students about the importance of nutrition in maintaining health

CO 2: To cultivate proper feeding habits

CO 3: To learn the proper and scientific value of different food items.

Course Contents

Module 1

15 Hrs

Introduction and scope. Carbohydrates, Proteins and Lipids - Carbohydrates : Functions, classification, food sources. storage in body, biomedical importance. Brief outline of metabolism :glycogenesis & glycogenolysis (in brief), glycolysis, citric acid cycle. Clinical significance.

Proteins - Functions, classification. food sources, composition, essential & non-essential amino acids, protein deficiency. biomedical importance. Metabolism: Transformation, Decarboxylation, Ammonia formation & transport, Urea cycle. Clinical significance

Fats & oils: Function of fats. classification, food sources, composition. saturated and unsaturated fatty acids. biomedical importance, essential fatty acids. Brief out line of metabolism : Beta oxidation of fatty acids. Ketosis. Cholesterol. Clinical significance.

Module 11

15 Hrs

Vitamins and minerals - sources and functions, deficiency status. Minerals - macro & micronutrients - functions, sources. Bioavailability and deficiency of Calcium, Iron, Iodine, Sodium & Potassium (very brief account). Water - as a nutrient, function, sources, requirement, water balance & effect of deficiency.

Module 111

5 Hrs

Calorific values of food - Basal metabolic rate, energy requirements of man, women infants and children.

Module IV

15 Hrs

Nutritional value of foods- cereals, fruits, milk, egg, meat, fish. Balanced diet. Nutrition in pregnancy - Physiological stages of pregnancy, nutritional requirements, food selection, complication of pregnancy.

Nutrition during lactation - Physiology of lactation, nutritional requirements. Nutrition during infancy -growth & development. nutritional requirements, breast feeding, infant formula. introduction of supplementary foods. 'Nutrition during early childhood (Toddler/Preschool)- Growth & nutrient need, nutrition related problems, feeding patterns. Nutrition of school children- Nutritional requirement. importance of snacks. school lunch. Nutrition during adolescence - Growth & nutrient: needs, food. choices, eating habits, factors influencing nutritional need. Geriatric nutrition: Factors affecting- food-intake and nutrient-Use, nutrient needs. nutrition related problems.

Nutritional value of foods-cereals, fruits, milk, egg; meat.-fish. Balanced diet, Malnutrition.

Module V**4 Hrs**

Interrelationship between nutrition & health : - Visible symptoms of good health; Use of food in body - Digestion, Absorption. transport & utilization; Role of fibres in human nutrition; Effect of cooking & heat processing on the nutritive value of foods; Processed supplementary foods; Food sanitation in hygiene.

References

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First Degree Programme Double Main (Aquatic Biology and Zoology)**Semester V****Open Course 3****ABZ 1553: Environmental Impact Assessment****No. of credits:2****Total Hours: 54****Course Outcomes**

CO 1: Understanding environment and micro-environment and its concepts and principles

CO 2: Enable to plan organize and execute Environmental Impact Assessment studies

CO 3: Develop capability to sample and data analyses using statistical tools and preparation of EIA reports

Course Contents**Module I****14 Hrs**

Ecosystem and Environment: Biosphere and Hydrosphere, Environment and micro-environment. Ecosystem Concept, Homeostasis Food chain, web and niche. Population and Community Aquatic Ecosystems. Biodiversity, Ecosystem Services, Man and Environment, Pollution and sustainable development. Climate change.

Module II**12 Hrs**

EIA Approaches: History and significance of EIA/EIS, terminologies, Impact, EIA and WCED and UNCED, Principles of EIA, Life cycle of EIA.

Module III**14Hrs**

EIA Procedure and Methods: EI Statements, Scoping, ToR, Cost of EIA, EIA Auditing, Regional Environment Plans. EIA Methodologies – Optimization, Cost benefit and effectiveness analysis, Ecological evaluation, Judgment.

Module IV**10 Hrs**

Public Participation and mediation. National organizations – MoEF, NABET, NGT. |EIA notifications and regulations in India. EIA Case Studies, models

Module V**14 Hrs**

Ecosystem modeling, Role of Remote sensing in ecomodelling, merits and demerits,Prospects

References

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First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester VI

Main 1: Aquatic Biology Course 11

ABZ 1631: Aquaculture Business Management

No. of credits:4

Total Hours: 54 (T36 + P18)

Course outcomes

CO1:Acquire Knowledge and experience in economics pertain to various facets in aquaculture business

CO2:Familiarize with the Loans and insurance and preparation of bankable projects for different aquaculture ventures.

CO3: Understanding on the laws and policies in Fisheries and Aquaculture sector

CO4: Appreciate the principles, concepts and practices of fisheries extension systems

Course Content

Module I

10Hrs

Essential Concepts in Economics: Law of demand and supply, Law of diminishing returns. Stages of production, cost concepts. Aquaculture economics. Contribution of fisheries sector to National GDP.

Module II

12 Hrs

Economic evaluation of different aquaculture systems. Factors affecting economics of aquaculture. Importance of Aquaculture nutrition, Disease diagnosis and Water quality management. Socio-economic issues in aquaculture development.

Module III

12 Hrs

Loans and insurance in aquaculture sector: Schemes of State and Central Governments, Loans from Commercial Banks and Agricultural Banks. Preparation of bankable projects. Scope of insurance in aquaculture sector.

Module IV

7Hrs

Fisheries and Aquaculture policies. Agencies guiding aquaculture development; International Agencies: FAO - CCRF, NACA, World Fish Centre, etc. National Agencies: MPEDA, CAA, NFDB, etc. Research institutions. State level agencies: FFDA, KVK, ADAK, Matsyfed etc.

Module V

5Hrs

Cooperatives and Marketing in Aquaculture. Role of cooperatives in fisheries sector. Significance of aquaculture cooperatives. Case study of Matsyafed. Marketing channels and market structure for fish and fishery products. Live fish marketing. Value addition. Constraints in Fish marketing in India.

Module VI

8Hrs

Fisheries and Aquaculture Extension: Principles, concepts and practices of fisheries extension systems and approaches. Information and Communication Technology (ICT) in extension

References

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First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester VI

Main 1: Aquatic Biology Course 12

ABZ 1632: Live Feed Culture Technology

No. of credits:2

Total Hours: 54 (T36+18P)

Course Outcomes

CO 1: Understand the importance of live feeds in mass production of fish seeds

CO 2: Understand the important live feeds used in aquaculture industry and its management

CO 3: Learn the methodology for isolation and mass culture of live feeds

Course Contents

Module I

10 Hrs

Algal culture techniques: Physical and chemical conditions required. Collection, identification and isolation of microalgae. Preparation of various culture media. Preparation and maintenance of stock microalgal culture. Out-door and indoor culture techniques

Module II

10 Hrs

Algae in larval nutrition and their replacements: Quantification of Algal biomass. Harvesting and preservation cultured algae. Bio-enrichment of fish food organisms. Formulation and preparation of artificial feeds for larval rearing. Microencapsulated diets. Cost of algal culture.

Module III

6 Hrs

Rotifer Culture- Morphology, biology and life history. Strains. General Culture conditions for freshwater and marine rotifers. Culture techniques. Enrichment.

Module IV

6 Hrs

Utilization of Artemia in Aquaculture-Biology and Ecology of Artemia. Cyst Production. Biology of cyst. Hatching of cyst- decapsulation, harvesting. Nutritional quality of nauplii - enrichment for nutrients and disease control. On growing techniques for Artemia

Module VI

4 Hrs

Culture of cladocerans, Oligochaetes, Nematodes and Trochophore larvae- Daphnia and Moina- nutrition and mass production, uses.

References

1. Anderson RA (Ed.) (2005). Algal culturing techniques". Academic Press. 596p.
2. Anuraj A, J Raymond Jani Angel, Venkatesh R Thakur, , T Sivaramakrishnan, A K O Ratheesh, Arun Jyothi Baruah, Kirubasankar R and Dam Roy S (2015). Live food organisms in aquaculture. CIARI, Port Blair, p 23.
3. Josianne G. Støttrup and Lesley A. McEvoy. (Eds). (2003). Live Feeds in Marine Aquaculture. Blackwell Science. 337p.
4. Lavens P and Sorgeloos P (Eds.) (1996). Manual on the production and uses of live food for aquaculture. FAO Fisheries Technical Paper No. 361. Rome, FAO. 1996. 295 p.
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First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester VI

Main 1: Aquatic Biology Course 13

ABZ 1633: Practical Aquatic Biology III

(Practical of ABZ 1531, ABZ 1532, ABZ 1631& ABZ 1632)

No. of credits:3

Total Hours: 108

Course outcomes

CO1: Knowledge in identification of cultivable brackish water and marine organisms, its basic biology and physiology with special emphasis on reproductive biology and commercial seed production

CO2: Develop a comprehensive knowledge on brackish water and marine aquaculture systems to monitor and maintain the health and growth performance of different cultured species

CO3: Develop practical management skills in an various intensive farming systems for better production and farmer extension services

CO4: Develop skills to understand the extension and business management for betterment of the services to farmers

CO5: Knowledge in live feed culture and maintenance and identification of live feeds used in aquaculture

Course Content

Practical of ABZ 1531

36 hours

1. Identification of cultivable brackishwater/marine finfishes
2. Identification of cultivable brackishwater/marine shrimps and crabs
3. Identification of cultivable bivalves
4. Identification of seaweeds
5. Monitoring of growth performance of a marine species
6. Calculation of pond fertilization
7. Water quality monitoring in brackish/marine systems
8. Visit to shrimp farms (Chemmeenketu)
9. Visit to brackishwater fish and shrimp hatcheries (Hatchery Experience)
10. Visit to brackishwater fish and shrimp farm(Farm Experience)
11. Visit to marine cages

Practical of ABZ 1532

36 hours

11. Designing and fabrication of RAS
12. Designing and fabrication of Aquaponics
13. Monitor the performance of RAS
14. Monitor the performance of Aquaponics
15. Monitor the performance of Biofloc technology
16. Value addition of fish- processing- pickles, ready to cook/eat

17. Setting up of a demand/automatic feeder
18. Visit to commercial level RAS unit
19. Visit to commercial level Biofloc system
20. Visit to commercial level aquaponics
21. Hatchery Experience and Farm Experience

Practicals of ABZ 1631

18 hours

1. Evaluation of economics of different aquaculture systems
2. Discussion/debate on socio economic issues in aquaculture
3. Monitoring of State/Central subsidy schemes on aquaculture
4. Visit to Matsyafed, KVK for aquaculture training
5. Visit to farms running on subsidy scheme facilitated systems
6. Visit to marketing of fish through different modes- live, chain and online
7. This hours can also be utilised for Farm Experience/Internship and project work

Practicals of ABZ 1632

18 hours

1. Identification of Algal Live feeds
2. Identification of Artemia, Rotifer, cladocerans, etc.
3. Sketch the components of Live feed culture systems
4. Familiarise with components of Live feed culture systems

First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester VI

Main 1: Aquatic Biology Course 14

ABZ 1634: Project in Aquatic Biology and Farm Experience

No. of credits:4

Course Outcome

CO1: Develop an aptitude for research in Aquaculture

CO2: Inculcate proficiency to identify appropriate research topic, its execution and presentation

CO3: Equip students to become an expert in aquaculture activities through hands on experience

CO4: Mould the student to become either as an administrator, manager, consultant or as an entrepreneur in aquaculture

Specifications

Topics pertain to aquatic biology with emphasis on aquaculture related topics can be selected for the project. Project is to be done by group not exceeding 10 students. Every student should submit typed (A4 paper, 12 Font, 1.5 Space), spirally bind project report duly attested by the supervising teacher and the Head of the Department on the day of practical examination before a board of two Examiners for ESE. The viva-voce based on the project is conducted individually. Project topic once chosen, shall not be repeated by any later batches of students. List of projects submitted year wise is to be

maintained in a register and submitted before the examiners if requested. Supervising teachers are not supposed to guide topics involving biological samples and measurements on humans, unless there is clearance from the University Level Ethical Committee.

The project report may contain the following sections:

1. Preliminary (Title page, declaration, certificate of the supervising teacher, content etc.);
2. Introduction with objectives and relevant Review of Literature
3. Materials and Methods
4. Result
5. Discussion
6. Conclusion / Summary
7. References

Study tour/Farm Experience/Internship

Hands on work experience in aquaculture firms either, hatcheries or any aquaculture grow-out is mandatory. The semester vacation after fourth/fifth semesters is utilized for this purpose to gain practical job experience in aquaculture activities. The sixth semester syllabus and work hours is planned in such a way that students will get ample hours to utilize the same for farm internship. Scientifically prepared farm experience report along with certificate from concern farm/hatchery authorities and with relevant photographs of candidate must be submitted by each student for ESE on the day of the examination-of project evaluation.

First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester VI

Main 2 : Zoology Course 11

ABZ 1641: Ethology, Evolution and Zoogeography

No. of credits:4

Total Hours: 108 (T72 + P36)

Course Outcomes

CO1:To enhance the student's concept on organic evolution and appreciate the different modes of energy efficient communication systems existing in the animal world.

CO 2:To study the physiological basis of behavior.

CO 3:Study the different types of communication system among animals.

CO 4.To get a concept on organic evolution.

CO5:To get knowledge on the distribution of animals in the biosphere.

Course Content

Ethology

30 Hrs

Module I

12 Hrs

History and scope of ethology: Motivation- models of motivation (Lorenz's psycho-hydraulic model and Deutsch's model); learning- types of learning (imprinting, habituation, conditioned reflex, unconditioned reflex, latent learning); neural mechanisms in behaviour role of hypothalamus and

other brain centers. hormones and behavior; sociobiology- social groups - merits and demerits. properties of organized societies, social groups in mammals, social stress.

Perception of Senses and Communication Systems in Animals

Module II : Sounds as communication system in the Animal world 6Hrs

Vibrations of Insect Wings, Stridulation in Insects, Sound production in Cicada, Ultrasonic sounds of animals, Communication by Infrasonic sounds, Echo location, Evasion of insects to ultrasonic sounds, Sounds of Deep-sea animals, sounds for maintenance of territory, sounds and courtship behaviour.

Module III : Light as a device for Animal Communication 4Hrs

Light of Visible spectrum, Colour vision, Black and white vision, UV vision, Infra-red vision Phosphorescence, Fluorescence, Bio luminesce-in Insects, Mollusca, Deep Sea fish, Energy efficiency of Bioluminescent organs. Physiology of Bioluminescence, Bioelectricity.

Module IV: Transmission of Information through Chemicals 8Hrs

Pheromones, Signalling pheromones in rodents and population control, Scent markings of Carnivores, Civet, Musk, Musth in elephants, Urine markings of dogs, Jacobsons organ. Insect pheromones Aggression pheromones, Trail pheromones, Sex attractants, Bombykol, Gypsilure, Pheromones for pest management, Pheromones for colony maintenance in honeybees, Dufours gland secretion, Allomones, Kairomones.

Evolution 32 Hrs

Module V 4 Hrs

Theories of organic evolution: Lamarck's theory. its criticism (Weismann's germplasm theory) Darwin's theory of natural selection (mention the contributions of Wallace). Mutation theory (self-study)

Module VI 5Hrs

Geological timescale, fossils, fossilization, paleontological evidences of evolution, fossil dating and significance of fossils.

Module VII 12Hrs

Modern concept of organic evolution: (Neo Darwinism) - genetic basis of evolution- gene pool, gene frequency, mutation, role of mutation in evolution, neutral mutation (Kimura). genetic drift. genetic equilibrium; factors affecting genetic equilibrium and Hardy -Weinberg law.

Natural selection: types of selection (brief account of the observation in *Bistonbetularia*). isolation and isolating mechanisms: speciation - sympatric speciation and allopatric speciation. Hybridization-adaptive radiation with special reference to Darwin's finches.

Module VIII 4 Hrs

Evolution above species level: Adaptive radiation, Micro-evolution, Macroevolution, Mega evolution, Co-evolution.

Module IX 7 Hrs

Evolution of human: Organic and cultural, examples of trends in human evolution, fossil men brief accounts of Parapithecus, Propliopithecus, Dryopithecus, Ramapithecus, Australopithecus, Neanderthal. Cromagnon and Modern human.

Zoogeography 10Hrs

Module X 4Hrs

Animal Distribution: Geographic distribution of animals-cosmopolitan distribution, discontinuous distribution, bipolar distribution and isolated distribution, factors affecting animal distribution, barriers to animal distribution- physical and biological barriers.

Module XI

6Hrs

Zoogeographical Realms: (Brief account of each realm mention the areas included, physical features and fauna) Palaearctic- region; Australian region, Ethiopian region, Nearctic region, Oriental region and Neotropical region. Biogeographical Classification of India. Western -Ghats, Eastern Ghats and Himalayas. Insular Fauna: Brief account of oceanic islands and continental islands (with one example each)

References

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Perception of Senses and Communication system in Animals.

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First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester VI

Main 2: Zoology Course 12

ABZ 1642: Zoology Practical III

(Practical of ABZ 1341, ABZ 1541, ABZ 1542 & ABZ 1641)

Ecology, Physiology and Biochemistry, Developmental Biology, Ethology, Evolution and Zoogeography

No. of credits:3

Total Hours: 144 Hours

Course Outcomes

CO1:To familiarize the experiments and observations in ecology

CO2:Demonstrate basic principle in physiology and biochemistry

CO3:To learn clinical procedures for blood & urine analysis

CO4:To make the student skillful in simple biochemical laboratory procedures.

Course Content

Practical of ABZ 1341

36 Hrs

Ecology (1-4 Compulsory)

1. Estimation of dissolved oxygen of water sample.
2. Estimation of CO₂ in water sample.
3. Primary productivity using dark and light bottle
4. Turbidity using Secchi disc
5. Estimation of hardness of three different water samples.
6. Extraction of soil organisms- Berlese funnel, Baerman's funnel [Any one]
7. Construction of food web .
8. Study of ecological adaptations - any three

Practical of ABZ 1541

36 Hrs

Physiology and Biological Chemistry Practicals [1-9 Compulsory]

- 1) Kymograph apparatus and explanation of simple muscle twitch.[Demonstration]
- 2) Measurement of oxygen consumption of cockroach using. Fen's respirometer.[Experiment set up]
- 3) Study of tonicity of blood cells
- 4) Paper chromatographic separation of amino acids
- 5) Estimation of haemoglobin of blood using. Haemoglobinometer.
- 6) Effect of temperature / pH on salivary amylase activity
- 7) Detection of abnormal constituents (glucose and albumin) in urine[two test each].
- 8) Detection of excretory products - ammonia (Nessler's test). urea (Ammonia generation/ Biuret test) and uric acid (Phosphotungstic acid test)
- 9) Preparation of blood smear and study of blood cells of human.
- 10) Isolation of casein from milk 12-13.[Any one]
- 11) Effect of temperature on the opercular activity of fish.

Practical of ABZ 1542

36 Hrs

Developmental Biology and Experimental Embryology [Any six]

1. Study of different types of eggs-Amphioxus, frog, chick, human based on models/charts {Any three]
2. Study of blastula- Amphioxus, frog- slide / model [Any one]
3. Study of gastrula Amphioxus/frog-yolk plug stage - slide / model. [Any one]
4. Mounting, sketch and label of 24Hrs/48Hrs chick blastoderm.[Any one]
5. Study of placenta(model/specimen) - any two types.
6. Stained preparation of grass hopper sperm (demonstration)
7. Mount few eggs of Culex from the egg raft and record the life cycle of Mosquito
8. Mount the egg of yellow crazy ant (an alien invasive ant) *Anoplolepis* and describe the type of egg.

Practical of ABZ 1641

36 Hrs

(This hour is also utilised for project preparation and finalisation)

Ethology

1. Pheromones for pest management
2. 11(a) Mango fruit fly trap (*Dacus dorsalis*) by Methyl eugenol
3. 11(b) Melon fly trap (*Bactrocera cucurbitae*) by cue lure trap

Environment Movements

1. Photo of Rachel Carlson, Sunderlal Bahuguna, Medha Patkar. (Photo of Eminent persons, Identify and comment on their contributions)

Evolution

1. Photo of Darwin and Lamark - Identify the scientists and mention the contribution.

Zoogeography

1. Study different zoogeographical realms with fauna.

First Degree Programme Double Main (Aquatic Biology and Zoology)

Semester VI

Main 2: Zoology Course 13

ABZ 1643: Project in Zoology and Field Study

No. of credits:4

Course Outcomes

CO1: Develop an aptitude for research in Zoology

CO2: Inculcate proficiency to identify appropriate research topic, its execution and presentation

Specifications

Topics of biological interest can be selected for the project. Project is to be done by group not exceeding 10 students. Every student should submit typed (A4 paper, 12 Font, 1.5 Space), spirally bind project report duly attested by the supervising teacher and the Head of the Department on the day of practical examination before a board of two Examiners for ESE. The viva-voce based on the project is conducted individually. Project topic once chosen, shall not be repeated by any later batches of students. List of projects submitted year wise is to be maintained in a register and submitted before the examiners if requested. Supervising teachers are not supposed to guide topics involving biological samples and measurements on humans, unless there is clearance from the University Level Ethical Committee.

The project report may contain the following sections:

1. Preliminary (Title page, declaration, certificate of the supervising teacher, content etc.);
2. Introduction with relevant literature review and objective
3. Materials and Methods
4. Result
5. Discussion
6. Conclusion / Summary
7. References

Field Study and Study tour

A total of eighteen hours (1 hour/week) has to be allotted to field study in the fifth semester. Study tour of minimum 4 days is compulsory. Students are directed to visit one research institute and one wild life sanctuary / museum / zoo, preferably within the state of Kerala. Scientifically prepared hand written study tour report along with photographs of candidate at the places of visit must be submitted by each student for ESE on the day of the examination-of project evaluation. Study tour can be conducted separately during the period of three years (such as one day visit to an ecologically important habitat or in a Research Institution) or continuously for four to six days.