M.F.Sc & PhD Programs in Fisheries Microbiology - Syllabus

Central Institute of Fisheries Education
Mumbai
### M.F.Sc. (Fisheries Microbiology) Major Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CORE COURSES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>FRM 501 General Microbiology</td>
<td>2+1</td>
</tr>
<tr>
<td>2.</td>
<td>FRM 501 Environmental Microbiology</td>
<td>2+1</td>
</tr>
<tr>
<td>3.</td>
<td>FRM 503 Virology</td>
<td>2+1</td>
</tr>
<tr>
<td>4.</td>
<td>FRM 504 Microbial Pathogens of Fish and Shellfish</td>
<td>2+1</td>
</tr>
<tr>
<td><strong>OPTIONAL COURSES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>FM 505 Fish Immunology</td>
<td>1+1</td>
</tr>
<tr>
<td>2.</td>
<td>FM 506 Fish Mycology</td>
<td>1+1</td>
</tr>
<tr>
<td>3.</td>
<td>FM 507 Microbial Process in the Environment</td>
<td>1+1</td>
</tr>
<tr>
<td>4.</td>
<td>FM 508 Microbial Biotechnology</td>
<td>1+1</td>
</tr>
<tr>
<td>5.</td>
<td>FM 509 Diagnostic Microbiology</td>
<td>1+1</td>
</tr>
<tr>
<td>6.</td>
<td>FM 510 Microbial Toxins</td>
<td>1+1</td>
</tr>
<tr>
<td>7.</td>
<td>FM 511 Fermentation Technology</td>
<td>1+1</td>
</tr>
<tr>
<td>8.</td>
<td>FM 512 Zoonoses and Public Health</td>
<td>1+1</td>
</tr>
</tbody>
</table>

### PhD (Fisheries Microbiology) Major Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CORE COURSES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>FM 701 Advances in Aquatic Microbiology</td>
<td>2+1</td>
</tr>
<tr>
<td>2.</td>
<td>FM 702 Molecular Techniques in Microbiology</td>
<td>2+1</td>
</tr>
<tr>
<td>3.</td>
<td>FM 703 Microbial Ecology</td>
<td>2+1</td>
</tr>
<tr>
<td><strong>OPTIONAL COURSES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>FM 707 Bio-active Compounds from Aquatic Organisms</td>
<td>1+1</td>
</tr>
<tr>
<td>2.</td>
<td>FM 708 Bioremediation</td>
<td>1+1</td>
</tr>
<tr>
<td>3.</td>
<td>FM 709 Water and Wastewater Microbiology</td>
<td>2+1</td>
</tr>
<tr>
<td>4.</td>
<td>FM 710 Bioprocess Technology</td>
<td>1+1</td>
</tr>
<tr>
<td>5.</td>
<td>FM 711 Bioinformatics</td>
<td>1+1</td>
</tr>
<tr>
<td>6.</td>
<td>FM 712 Advances in Immunology</td>
<td></td>
</tr>
</tbody>
</table>
MFSc Syllabus

1. General Microbiology 2+1

Objective: To teach the basic concepts in microbiology and the common techniques involved in isolation and identification of bacterial pathogens

Theory:
Classification of bacteria and fungi- molecular methods in taxonomy, ribosomal RNA sequences and evolutionary relationships. Microscopy – bright-field, fluorescence, phase-contrast, dark ground and electron microscopy. Staining techniques - chemistry and various types – Sterilization – principles and various physical and chemical methods.

Nutritional requirements of microorganisms – general growth media, differential media, selective media. Isolation, enumeration, preservation and maintenance of cultures - growth curve,


Practicals:
Microscopic techniques, Micrometry, staining techniques, isolation, enumeration and identification of microorganisms, serological techniques, culture of anaerobic bacteria, isolation and identification of fungi, molecular and automated techniques involved in bacterial identification.

Suggested readings:
1. Fish pathology by Roberts
2. Microbes in Action: A Laboratory Manual of Microbiology by Harry W. Seeley, Paul J. Vandemark, and John J. Lee
5. finfish and shellfish bacteriology manual-Techniques and procedures by Kimberley A. Whitman
6. Foundation in Microbiology – by Kathleen Park Talaro, Arther Talaro.

Journals
1. Aquaculture
2. Journal of Fish Diseases
3. Diseases of aquatic organisms
4. Veterinary microbiology
5. Journal of Aquatic Animal Health
Areas for research:
Molecular diagnostic techniques and molecular characterization of pathogens

2. Environmental Microbiology 2+1
Objectives: To understand the bacterial processes in the aquatic environment with particular reference to pollution

Theory
Microbial communities in the aquatic environment, kinetics of microbial population, biofilms, microbial interactions – symbiosis, antagonism and commensalisms, biogeochemical cycles

Pollution – nature and types, their effects on living organisms. Water pollution- microbial changes induced by inorganic and organic pollutants, industrial effluents and domestic sewage. Water-borne pathogens – faecal contamination; entro-viruses. Standards for various types of water, conventional wastes and their treatment – Biological pollution – algal blooms and their effect on fish production, biological and chemical control of algal bloom.

Metals as pollutants – accumulation of mercury, cadmium, lead, etc. in fishes, microbial conversion of mercury. Microbial pollution in industries-corrosion of iron, acid-mine drainage, cooling systems etc.

Practicals: Microbial pollution of water, detection and characterization of different indicator and pathogenic organisms such as S. aureus, E. coli, V. cholerae, Salmonella, Shigella, etc., by conventional and rapid methods, microbial biofilm formation and its detection, autotrophic and anaerobic organisms in the environment, microbial corrosion and fouling, microbial degradation of pollutants, study of hydrocarbon degrading and antibiotic resistant microbes in the environment.

Suggested readings
1. Soil Microbiology by Subbarao.
2. Aquatic Microbiology by Rheinheimer
3. Marine Pollution by Clark

Journals
1. Journal of Applied and Environmental Microbiology
2. General Microbiology
3. Applied Microbiology
4. Hydrobiologia
5. World Journal of Immunology and Biotechnology

Areas for research
Pollution management
Indicator organisms
3. Virology

Objectives:
To teach the morphology of viruses and their replication strategies with special reference to fish and shellfish pathogens.

Theory
Viral morphology, viral taxonomy, mode of viral entry, virus replication strategies,
Pathogenesis of important viral diseases of fish and shellfish, viral interference, cytopathic effect,
Antiviral agents, viral immunity. General principles of laboratory diagnosis of viral diseases

Practical
Cell culture; primary culture, passaging and maintenance of cell lines; Isolation of viruses using cell culture; Purification and characterization of viruses, virus titration, nucleic acid extraction, quantification of nucleic acid, molecular identification of viral diseases.

Suggested readings
1. Fish diseases and disorders: Vol 3 : viral, bacterial and fungal infections by Woo and Bruno
2. Fish Pathology by R.J. Roberts

Journals
1. Journal of fish diseases
2. Diseases of aquatic organisms
4. Veterinary microbiology
5. Journal of Virological Methods

Areas for research
Epidemiology of viral disease
Rapid diagnostics/ techniques
Chemo- and phyto-therapeutic agents
4. Microbial Pathogens of Fish and Shellfish  2+1

Objective:
The objective of this course is to make aware the students about different microbial pathogens encountered in closed and open water fisheries and ways and means for prevention and prophylaxis.

Theory
Microbial flora of finfish and shellfish, commensals and pathogens; Classification of diseases; Methods of disease prevention; Detailed study of bacteria, viruses and fungi pathogenic to finfish and shellfish with emphasis on morphology, epidemiology, pathogenesis, treatment and control;

Bacterial pathogens: Flavobacterium, Flexibacter, Edwardsiella, Pseudomonas, Vibrio, Aeromonas, Renibacterium, streptococcus, Yersinia, Mycobacteria and Nocardia. Fungus: Saprolegnia, Apahnymyces, Branchiomyces, Ichtyophonus

Viral diseases: Lymphocystis virus, Epizootic haematopoietic necrosis virus (EHNV) and other iridovirus, Herpes virus, aquareovirus, IPNV, Nodavirus, Infectious salmon anaemia virus, VHSV, IHNV, IPNV, Koiherpesvirus, WSSV, MrNV and XSV, YHV, TSV, MBV, IHHNV, HPV.

Practicals:
Examination of moribund fish; Sampling techniques for microbiological investigation; Serological and molecular techniques for disease diagnosis, microbial identification.

Suggested readings
1. Fish disease diagnosis and by Edward C. Noga
2. Textbook of Fish Health by G. Post
3. Fish diseases and disorders by J. F. Leatherland and PKT Wook
4. Environment stress and fish diseases by Gary A. Wedemeyer, Fred P. Meyer and Lynnwood Smith
5. Diseases of carps and other cyprinid fishes by D. Hoole, D. Buckl, P. Burgess and I. Welby
6. Fish disease by R. J. Roberts
7. Molecular diagnosis of Salmm disease by Carey E. Cunningham
8. Health maintenance and principal microbial diseases of cultured fishes by John a. Plumb
9. Principal diseases of marine fish and shellfish by carl J. Sindermann
10. Bacteria from Fish and Other Aquatic Animals: A Practical Identification Manual (Cabi Publishing) by Nicky B. Buller and John A. Plumb

Journals
1. Journal of fish diseases
2. Diseases of aquatic organisms
1. Veterinary microbiology
2. Journal of Virological Methods

Areas for research
Molecular characterization of pathogens
Disease surveillance
**Optional courses**

1. **Fish Immunology**
   
   **Objective:** To understand the defense mechanisms in fish and shellfish

   **Theory**

   Types of immune response-humoral and cellular and the interaction between the two, immunological tolerance and memory function, activation and interaction of T and B lymphocytes. T-cell receptors, immunoglobulins, theories of antibody production, monoclonal antibodies, antigen-antibody reactions, complement system.


   **Practicals:** Collection, separation and identification of fish leucocytes, study of non-specific defence system by lysozyme assay, phagocytic activity, etc., detection of antibody producing cells, agglutination test, immunogel diffusion, immuno-electrophoretic techniques, ELISA, fluorescent antibody test, immunoperoxidase test, cell mediated immunity assessment by macrophage migration inhibition, methods of vaccine preparation and techniques of fish immunisation, methods for assessment of efficacy of vaccines.

   **Suggested readings**
   1. Immunology by Ivan Roitt
   2. Fish immune system by Iwama
   3. Fish Immunology By P.K.Sahoo, P.Swain and S.Ayyappan

   **Journals**
   1. Fish and shellfish immunology
   2. Veterinary immunology and immunopathology
   3. Journal of Immunological Methods

   **Areas for research**
   Fish immunoglobulins, Immunomodulators, immunogenetics, Crustacean defence mechanisms

2. **Fish Mycology**
   
   **Objective:** To study the characteristics of fungal agents causing diseases in fish and shellfish and their control measures

   **Theory**
   Fungi and environment; fungal classifications, biology of fungi, slime, mould, protist fungi (Chytridiomycota, Hypochitriomycota, Oomycota), true fungi (Zygomicota, Ascomycota, Basidiomycota), imperfect fungi (Deuteromycota), yeasts
Spore and its dispersal, applications of fungi in life - Role of fungi in food processing and aquaculture, the growth of yeasts and molds in fishes – effect of heat, chilling, freezing and chemical preservatives on common fungi associated with fishes.

Mycotoxins - source and conditions affecting their production. Techniques for isolation and identification of yeasts and molds.

**Practicals:** Isolation and identification of aquatic fungi, fungi involved in food spoilage and diseases, application of fungi, detection of mycotoxins.

**Suggested reading**
1. Fish diseases and disorders: Vol 3: viral, bacterial and fungal infections by Woo and Bruno
2. Fish Pathology by R.J. Roberts

**Journals:**
1. Journal of Fish Diseases
2. Diseases of Aquatic Organisms
3. Veterinary Microbiology
4. Medical Mycology

**Areas for research:**
Epidemiology of EUS
Characterization of fungi

**3. Microbial Process in the Environment  1+1**

**Objectives:** To understand the microbial metabolism associated with cycling of nutrients and wastes

**Theory**
Introduction to microbes - Cellular life: morphology, structure, macromolecules, chemistry (cell composition) - Cell function: genetics and biochemical processing (transport, enzyme function, pathways, regulation).

Cell function; energetics (flow of energy in the cell, electron acceptors), reactions - Cell function: growth (cell division, kinetics of growth, form of growth) and metabolism (kinetics, end products) – Bacterial genetics and genomics.

Microbial Diversity - Distribution and detection of microbes in the environment; - Biogeochemical cycling: C, N, S, P, Fe, Hg - Pathogens in the environment and public health microbiology, Wastewater treatment - Biodegradation, Biotechnology: industrial, agricultural, energy, nanotechnology

**Practicals:** Study of microbial processes in vitro, enumeration and identification of bacteria involved in carbon, nitrogen, phosphorus and sulphur cycles, microbial production and respiration

**Suggested readings**
Aquatic Microbiology by Rheinheimer

18/4/08
Marine Microbiology by ZoBell

**Journals**
World Journal of Microbiology and Biotechnology
Hydrobiologia
Journal of Environmental and Applied Microbiology
Anaerobe

**Areas for research**
Identification and characterization of microbes in biodegradation

**4. Microbial Biotechnology**  1+1

**Objective:**
To teach the structure and function of nucleic acids, gene expression and its regulation and the application of biotechnology in disease diagnosis.

**Theory**
Prokaryotic and eukaryotic genes, gene cloning systems, plasmids and bacteriophages as cloning vectors, detection of recombinant DNA and clones, expression vectors, cloning and expression of mammalian genes in bacteria, Structure and function of DNA and RNA; Genetic code; Transcription and translation; Gene organization, regulation and manipulation; Gene expression; Identification of gene of interest;

Restriction enzyme digestion; Recombinant DNA technology; Bacterial and phage cloning vectors; DNA fingerprinting; DNA microarrays; Ribotyping; PCR, RT-PCR, Real time PCR, RNA interference. DNA sequencing, in vitro and site directed mutagenesis, applications of genetic engineering, environmental aspects of genetically engineered organisms. Fermentation technology

**Practicals:** Molecular characterization of selected microbes by ribotyping; Isolation of plasmid vectors, modification of DNA, cloning of PCR amplified fragments, recognition of clones using lacZ system, detection of proteins by Western blotting. PCR, Recombinant DNA technology (microbes as vectors)

**Suggested readings**
5. Gene cloning and DNA analysis. An Introduction by T.A. Brown

**Journals:**
1. Journal of Marine biotechnology
2. Biotechnology
3. Journal of biotechnology
Areas for research:

Cloning, sequencing and expression of virulence genes of pathogens

5. Diagnostic Microbiology 1+1

Objectives: To learn the principles and protocols of diagnostic tests used in the diagnosis of fish diseases

Theory
Common bacterial pathogens of fishes. Handling of diseased fish for bacteriological examination, Withdrawal of blood and materials from internal organs for bacteriological examination. Diagnosis and infection experiments - Cultural and biochemical identification procedures. Mycological techniques.

Culture media for isolation of pathogens, non-selective, enriched, enrichment and selective media. Inoculation and purification techniques. Staining methods.


Practicals: Methods for examination and analysing fish for health certification/diagnosis of disease condition, techniques for sample collection and processing for bacteriological, mycological and virological agents, methods for isolation of various bacterial, fungal and viral pathogens by conventional methods, rapid nucleic acid based methods and serological procedures.

Suggested reading:
1. Diagnostic Microbiology, 2nd, W.B. Saunders Company, 2000. de la Maza, L.M., Pezzlo, M.T., and Baron, E.J.,
3. Manual of Diagnostic Microbiology By Wadher and Boosreddy
4. Diagnostic Microbiology by Fingold

Journals
Fish and Shellfish Immunology
Journal of Fish Diseases
Diseases of Aquatic Organisms
Journal of Aquatic Animal Health

6. Microbial Toxins 1+1

Objective: To study the characters and methods of detection of toxins associated with microbes

Theory
Microorganisms important in food toxicity. Types of toxins-exotoxins, endotoxins and miscellaneous toxic factors. Factors affecting toxin production in food. Histamine toxicity. Food-borne diseases – factors influencing their outbreaks. Preventive measures to control food toxicity and food-borne diseases.
Methods of toxin and antitoxin production - Types of toxins, methods of isolation and detection of toxins produced by various pathogenic bacteria – *Staphylococcus aureus, Clostridium botulinum, Clostridium perfringens, Bacillus cereus, Vibrio, Salmonella, Eschericha coli*, etc.

Fungal toxins – aflatoxins, ochratoxins, etc., Red tides, Marine toxins, Shellfish poisoning

**Practicals:** Methods for detection of endotoxins and exotoxins, purification and characterisation of endotoxin and exotoxins from different bacteria, biological and serological methods to study toxin, setting up enzyme linked immunosorbent assay, dot blot immunmoassay, western blots to study exotoxins, extraction and detection of aflatoxins and histamines.

**Suggested readings**
2. Fundamentals of Microbiology – Frobisher et al.
3. Fundamental principles of Bacteriology – A. G. Salle.

**Journals:**
1. Journal of fish diseases
2. Diseases of aquatic organisms
3. Veterinary microbiology
4. Aquatic Toxicology

**Areas for research**
- Isolation, purification and Characterization of microbial toxins

7. **Fermentation Technology** 1+1

**Objective:** To learn the properties of various fermentation process and products from microorganisms such as bacteria, fungi, yeasts, and actinomycetes

**Theory:** Introduction to fermentation: Rate of microbial growth and death. Fermentation kinetics, mass transfer diffusion, membrane transport, dialysis, nutrient uptake.

Fermenter design, operation, measurement and control in fermentation. Aeration and agitation in fermentation. Oxygen requirement, measurement of adsorption coefficients, bubble aeration, mechanical agitation, correlation between mass-transfer coefficient and operating variables. Types of fermentation sub-merged/solid state. Sterilization-air sterilization, media sterilization.


**Practicals**
Follow up of bacterial growth in batch culture, Different methods of microbial cultivation, Mass transfer across membrane, permeability coefficient, Measurement of B.O.D., Measurement of C.O.D., Fermenter operation and measurement, Production of starter, bakers yeast culture, production of citric acid, alcohol, alcoholic beverages, enzymes, amino acids, Visit to effluent treatment plant.
Suggested Readings
1. **Principles of Fermentation Technology** by P F STANBURY, A. WHITAKER, and S. Hall

Journals:
Journal of Fermentation Technology
Journal of Fermentation and Bioengineering
Anaerobe

Areas for research:
Optimisation of fermentation parameters

8. Zoonoses and Public Health  1+1

Objective: To learn the zoonotic importance of fish pathogens and toxins produced by aquatic organisms

Theory
Introduction to food-borne diseases – Classification; food-borne infection and intoxication-microorganisms important in food borne diseases and food toxicity –economic importance of food-borne illness

Factors influencing food-borne disease outbreaks – Sources and transmission of pathogens in foods: human, animal, and environmental reservoirs; cross-contamination; food associations - Microbial detection and indicator organisms: approach and techniques; pathogen indicators - bacteria responsible for food borne infection and intoxication – bacterial toxin and miscellaneous toxic factors – factors affecting toxin production in foods – fungal toxins, aflatoxin, ochratoxin and other fungal toxins – factors affecting fungal toxin production in food – marine toxins PSP, ASP, NSP, ciguatera poisoning and other marine toxins – histamines and other bioamines toxicity


Practicals
Isolation and identification of toxin producing microorganisms and other potent human pathogens in fish and fishery products – detection of toxins using biological and immunological techniques.

Suggested reading
Public Health Laboratory Service- Practical Food Microbiology, most recent edition (PHLS, London)
Eley A R - Microbial Food Poisoning, most recent edition, (Chapman & Hall)

**Journals:**
Public Health
Public Health Forum

**Areas for research:** Zoonotic diseases of fish and shellfish
Syllabus for PhD programme

Core courses

1. Advances in Aquatic Microbiology          2+1

Objective: To introduce the students to the recent developments in aquatic microbiology, the distribution, interactions microbes with each other and with other biota, methods of study and sampling procedures

Theory:
Microbial communities in the aquatic environment: distribution; nutrients, oxygen and pH gradients; open and heterogenous systems; microbial consortia; surface attachment and biofilm development. Oligotrophy, autotrophy and heterotrophy - Methods of study Sampling procedures: collection and processing. Detection of microbial populations: culture-dependent analyses; ELISA; ATP detection; biosensors; signature chemicals. Direct observation: light microscopy and fluorescence techniques (FAT, INT, DAPI, acridine orange); ESEM and SEM; Confocal Laser Scanning Microscopy; Atomic Force Microscopy.

Activity measurements: enzyme assays; radioisotopes; isotopic fractionation; use of microelectrodes. Molecular analysis of aquatic communities: signature sequences; phylogenetic probes and genetic stains; FISH; PCR; microbial community analyses. Biodegradation and methanogenesis in aquatic ecosystems. Nanotechnology - The microbial loop; diversity and exploitation of marine fungi and microalgae.

Extremophiles: halophilic, pyschrophilic and barophilic bacteria; nutrient cycling at hydrothermal vents. Thermophilic microbes in hot springs. Food Webs, Bacterial Energetics, Marine Bacteriophage, Marine Bacteriovors, Symbiosis and Mixotrophy - Impact of pollution: consequences of eutrophication; toxic blooms; microbial responses to water pollution by sewage, halocarbons, oil, heavy metals and toxic waste, including acid mine drainage. Microbial fouling of surfaces - Waste stabilization ponds; artificial wetlands.

Practicals: Sampling procedures, Microscopic examination – light, Fluorescence and phase contrast. Culture of microbes, enzyme assays, molecular detection and characterization – FISH, PCR, ribotyping, bacterial response to heavy metals and toxic wastes.

Suggested reading:
1. Microbial Ecology of the Oceans, David Kirchman,ed. Wiley-liss
2. Freshwater Microbiology: Biodiversity and Dynamic Interactions of Microorganisms in the Aquatic Environment by David Sigee
3. Aquatic Microbiology by Gerhard Rheinheime

Journals:
Aquatic Ecosystem Health Management
Aquatic Ecosystems
Aquatic Living Resources
Areas for research:
Extremophiles, pollution management, biodegradation, optimization of biogeochemical cycles in managed ecosystems

2. Molecular Techniques in Microbiology  2+1
Objective: To understand the molecular techniques used in genetic manipulation

Theory:
Microbial genetics – chemical nature and structure of genetic material; forms of DNA; Basic concepts- gene, genome, genotype, phenotype; Genetic code – definition and properties

Techniques for isolation of DNA, determination of G+C content, restriction fragment length polymorphism and significance, isolation and characterisation of plasmid DNA, plasmids as cloning vectors, gene transfer by conjugation, transformation, transduction. Gene expression, detection of proteins, immunoblotting.

Detection of genes by polymerase chain reaction, use of gene probes. Non-radioactive probes for DNA and proteins, molecular epidemiology.

Practicals
Isolation of DNA and RNA; Quantification of DNA and RNA, gene amplification, primer designing, gene cloning-restriction digestion, ligation and transformation, gene sequencing, gene expression, immunoblotting, design and application of gene probes.

Suggested readings:
5. Gene cloning and DNA analysis. An Introduction by T.A. Brown

Journals:
1. Journal of Marine biotechnology
2. Biotechnology
3. Journal of biotechnology

Areas for research: To identify, clone, sequence novel genes form fish and microbes

3. Microbial Ecology  2+1

Objective: To understand the basic principles and interactions in microbial systems and their roles in the broader ecology of earth

Theory:
Introduction: History, Microorganisms and their Environments, Microbial Evolution, Phylogeny and Taxonomy of Microorganisms, The Chemical Basis of Microbial Life - Microbial Cell: Prokarya vs.

Practicals:

Identification of bacteria, fungi, algae, protests; periphyton, benthos; estimation of production, respiration, indicator organisms; estimation of DOM

Suggested reading:

Madigan et al. (1999) Brock’s Biology of Microorganisms. 9th Edn

Journals:

1. Aquatic ecosystems health management
2. aquatic ecosystem
3. Aquatic living resources

Areas for research:

Community and bacterial metabolism, biofilms and their uses

Optional courses

1. **Bio-active Compounds from Aquatic Organisms**  1+1

   **Objective:** To realize the potential of aquatic organisms as a source of bio-active compounds

   **Theory:**
   Antibacterial compounds from aquatic sources. Marine toxins – paralytic shellfish toxins, diarrhetic shellfish toxins, amnesic shellfish toxins, neurotoxic shellfish poisoning, venerupin shellfish
poisoning, ciguatera toxins, tetrodotoxins and their origin. Production of emulsification products, polysaccharides, fatty acids from marine organisms.

**Practicals:** Testing antibacterial activity of compounds, assay for marine toxins, detection of microbial polysaccharides, fatty acids and other bioactive compounds.

**Suggested readings:**
1. *Natural Compounds as Drugs, Volume I (Progress in Drug Research)* by Frank Petersen and René Amstutz
2. *Bioactive Compounds in Foods: Effects of Processing and Storage (Acs Symposium Series)* by Tung-Ching Lee and Chi-Tang Ho
3. *Biologically Active Natural Products: Agrochemicals* by Horace G. Cutler and Stephen J. Cutler

**Journals:**
Toxicon
Toxicology and applied pharmacology
toxicology

**Areas for research:**
Isolate, identify and characterize various toxins from aquatic organisms

---

2. **Bioremediation**

**Objectives:**
To learn the natural decomposition processes that take place in the environment and the possible interventions

**Theory:**

**Practicals:**
Decomposition of model substrates, isolation of active bacteria and fungi, phytoremediation, preparation of consortia

**Suggested reading**
Areas for research:
Bioremediation of pollutants and metabolites, isolation and development of microbial consortia

3. Water and Wastewater Microbiology 2+1

Objectives:
To learn the impact of microbes in water quality and use of them for treatment of wastewater

Theory:
Introduction to water and waste water microbiology, Microbial growth kinetics, microbial enzyme kinetics; metabolic pathways; Microbial metabolism for waste and pollutions; Pollutants and their types, nature, sources; Pretreatment and handling of hazardous wastes, microbiological and biochemical aspects of waste treatment, characteristics of waste water, aerobic and anaerobic waste water treatment processes; Activated sludge process; trickling filter; lagooning process; rotary disc biological contractor, two stage biomethanation process, Biological treatment of wastes; effluent disposal and reuse; Downstream processing of biological waste treatment processes. Bioconcentration - bioaccumulation - bio-magnification - bioassay - biomonitoring.- Microbial degradations and biotransformations: Degradation of biopolymers: cellulose, xylan, starch and other glucans, pectin, lignin and chitin, protein, nucleic acids, lipids and fats, and polyhydroxy alkanoates (bioplastics). Microbial degradation of hydrocarbons: Methane, ethane, propane, butane and other long chain alkanes, alkenes, alkynes and aromatic compounds. Microbial degradation of halogenated and sulfonated compounds. Biodegradation of pesticides

Practicals:

Suggested reading

Journals:
Journal of Applied and Environmental Microbiology
Anaerobe
Pollution Research

Areas for research:
Biochemical and microbial handling and treatment of wastewater
Bioassays for bioaccumulation and biomagnification

4. Bioprocess Technology 1+1

**Objectives:** To learn the techniques for bulk processing, production and purification of biologicals

**Theory:**
Raw materials for bioprocessing, comparison of chemical and biochemical processing based on energetics and environmental issues. Development of inocula, kinetics of enzymatic and microbial processes, optimisation studies, sterilization of media, air and equipment, modes of cell cultivation, general principles of bioreactor design and their operation - Downstream processing, separation and purification techniques, quality assurance testing, representative examples of microbial products, vaccines and vaccine development, immobilization of cells and enzymes: principles, methodology and applications, disintegration of cells, separation of solid and liquid phases, isolation and purification techniques for proteins and other products based on different physico-chemical properties, eg., precipitation, adsorption, chromatographic separations, bioaffinity based methods - Principles of bioprocess control, bioprocess automation and application of computers in bioprocessing, recombinant products with representative examples, biosafety and environmental monitoring of GEMs, Introduction to patents, Intellectual Property Rights in Biotechnology.

**Practicals:**
Downstream processing, separation and purification of compounds, Preparation of vaccines, Purification of protein and enzymes by precipitation, adsorption, chromatography and bioaffinity based methods.

**Suggested readings:**
1. Biofertilizers by Vyas and Vyas
2. Pharmaceutical Microbiology By Hugo and Russell
3. Enzyme Biotechnology By G. Tripathi
4. Biofertilizers by Aruna Sharma
5. Industrial Microbiology by Agarwal/Parihar

**Journals:**
Toxicology and applied pharmacology
Journal of Fermentation and Bioengineering

**Areas for research:**
Purification and characterization of bioactive compounds for aquatic animals and microbes

5. Bioinformatics 1+1

**Objectives:** To understand the uses of information technology and computer for the analysis and documentation of biological information.

**Theory**
general principles involved, global/local, tools available like BLAST - Application aspects and bioinformatics historical development, Useful things from Internet to analyze molecular biology information to be used in microbiological fields. Gene bank, database structure, DNA sequencing analysis, methods for DNA sequence prediction and protein information, use of many application programs related to bioinformatics, biological function of DNA and protein sequences.

**Practicals:**
DNA sequencing analysis, methods for DNA sequence prediction and protein information, using Genbank, BLAST analysis, literature search

**Suggested readings:**
1. Bioinformatics : A primer, Narayan P.
2. Text Book of Bioinformatics, Subramanian C.
3. Bioinformatics methods and applications by Rastogi, Mediratta N. I.

**Journals:**
Bioinformatics
Journal of Biomedical Informatics

6. **Advances in Immunology** 2+1

**Objectives:** To learn the recent developments in the field of fish and shellfish immunology

**Theory**
Phylogeny of fish immune system, specific and non specific immunity, agglutinins, precipitins, C reactive proteins, complement, humoral and cell mediated immunity, cells and organs of immune system, cytokines, prophylaxis and treatment of diseases, vaccines, immunostimulants, hybridoma, polyclonal and monoclonal antibody production, immune tolerance and auto immune diseases; Invertebrate immunology.

**Practical**
Preparation of antigen, raising of antibodies, separation of immunoglobulins, agglutination test, agar gel precipitation test, immunodiffusion, chromatography, preparation of conjugates, ELISA, Dot ELISA, LAT, Western blotting, isolation and separation of lymphocytes.

**Suggested readings:**
1. Immunology by Ivan Riott
2. Fish immune system by Iwama
3. Fish Immunology By P.K.Sahoo, P.Swain and S.Ayyappan

**Journals**
1. Fish and shellfish immunology
2. Veterinary immunology and immunopathology

**Areas for research**
Fish immunoglobulins, Immunomodulators, immunogenetics, Crustacean defence mechanisms