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The U.S. Government's Global Hunger & Food Security Initiative



REPORT ON

COLLATION OF MATERIALS ON *FISH PHARMACOLOGY*

FOR INCORPORATION IN THE RELEVANT COURSES OF

SPECIALIZED EDUCATIONAL INSTITUTES IN

BANGLADESH.



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REPORT ON

**Collation of materials on *Fish Pharmacology* for
incorporation in the relevant courses of specialized
educational institutes in Bangladesh.**

Implemented by
Bangladesh Shrimp and Fish Foundation (BSFF)

Supported by
Feed the Future Bangladesh Aquaculture and Nutrition Activity

March-2020



Bangladesh Shrimp and Fish Foundation (BSFF)

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BSFF Study Team

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Implemented by

Bangladesh Shrimp and Fish Foundation (BSFF)

Supported by

FtF BANA BSFF Project of USAID/WorldFish

Study period

January – March 2020

The Report

Introduction

The development of appropriate courses on fish pharmacology for Bangladeshi educational institutions and concerned government departments as well as private sector entities forms the part of the project entitled **“Work on policy consolidation, improvement in licensing, management process and effective use of aqua inputs”** with support from USAID/WorldFish funded **‘Feed the Future Bangladesh Aquaculture and Nutrition Activity (FtF-BANA)’**, being implemented by Bangladesh Shrimp and Fish Foundation (BSFF). A first consultation meeting was held on this subject on 25 January 2020 to commence the work on this component of the project during which the assigned consultant Professor Dr. Mohammad Shamsur Rahman, Department of Fisheries, University of Dhaka, Bangladesh presented a work plan and the basic objectives for which the course curriculum would be suggested. The consultant subsequently undertook extensive research and consultations to develop the course curriculum. A central workshop for validation the curriculum content compiled by Dr. Rahman was organized by BSFF on 15 March 2020.

The validation workshop was richly attended by University teachers, experts, senior DoF officials, representatives of BSFF and members of FtF-BANA. The list of participants is enclosed to this report.

At the outset of the meeting Prof. Rahman made a comprehensive presentation on his proposed course curriculum covering the following materials:

1. Disease reality in the sector and impact of disease in the fisheries and aquaculture sector in Bangladesh
2. What would be required to prepare students in Bangladesh and professionals on disease prevention and control
3. Preparatory requirements for study on fish pharmacology
4. A suitable title for the suggested course
5. Content and duration of the course

- Possible components of the course for the Undergraduate course
 - Possible components of the course for the Certificate course for existing fisheries professionals (DoF and others)
6. The desired balance of theoretical and practical components of the suggested course
 7. The recommended assessment criteria to evaluate the performance of the participants in the courses
 8. Required Training of Trainers (ToT) for teachers: Recommendation for teachers training for teachers' conduct fish pharmacology course.

The presentation was followed by a comprehensive round of discussions on the various course components and learning outcomes highlighted in the proposed course curriculum. The discussants were all of the view that any proposed course on the subject Fish Pharmacology should be comprehensive enough to enable target students to have balanced knowledge output from their course participation on the nature of diseases in the fisheries and aquaculture sector in Bangladesh, the broad therapeutic and medicinal options available to prevent and control them as well as national rules and regulations on the same and international best practices and standards for compliance. Detailed discussions were held on the most appropriate title for the course, how students should be adequately prepared with prior knowledge of specific disciplines to take best advantage of the course, the logical thematic consequences in which the course should be taught, balance of theoretical and practical content of course needed and the pedagogic approach to be adopted to suit the requirement of Bangladesh educational institutions in the country perspectives. The meeting participants also considered at length whether a separate course curriculum should be developed for the in-service government departmental officials. It was the general agreement during the validation meeting that a single course curriculum should suffice for both university level general students and in service officials.

The participants in the meeting thanked Prof Rahman for his very valuable work and also other specialists who significantly contributed to the preparation of the course content proposed with their valuable inputs. The participants also deeply appreciated the initiative

taken by BSFF and FtF/BANA for facilitating work on the development of the proposed course curriculum.

The meeting concluded by a general endorsement of the course content proposed for consideration of the competent authorities in Bangladesh. The details of the course contents proposed can be seen at annex 2 of present report.

Attachments:

Annex-1: Participant list

Annex-2: Power-point Presentation

Annex-3: Photographs

Annex-4: Proposed course curriculum of Fish Pharmacology

Annex-1
Participant List

Category of participants	Name of the Institutions	Serial no.	Name, Designation and addresses	Contact number & email
University academia	Bangladesh Agricultural University	1.	Prof Dr M. Mamunur Rashid Professor, Department of Aquaculture, Faculty of Fisheries, Bangladesh Agricultural University	01711377010 Mamun_aqua@yahoo.com
	Chittagong University	2.	<u>Mr. Md. Mostafa Monwar</u> Institute of Marine Science Chittagong University	01811886697 monwarimsf@gmail.com, <u>monwar@cu.ac.bd</u>
	Rajshahi University	3.	Prof. Dr. Md. Delwar Hossain Department of Fisheries Rajshahi University	01719474476 <u>delwer.ru@gmail.com</u>
	Khulna University	4.	Prof. Dr. Ghausiatur Reza Banu Assistant Professor Fisheries & Marine resources technology discipline Khulna University	+8801914067598 01733204282 <u>kugrb@yahoo.com</u>
	Noakhali Science & Technology University (NSTU)	5.	Dr. Shyamal Kumar Paul Department of Fisheries & Marine Science Noakhali Science & Technology University (NSTU)	01716024079 <u>shyamalpaul79@gmail.com</u> ; <u>skumarpaul79@yahoo.com</u>
	Jashore Science & Technology University (JSTU)	6.	Mr. Md. Sarower-E Mahfuj Assistant Professor Dept. of Fisheries & Marine BioScience Jashore Science & Technology University (JSTU)	01923396947 <u>sa.mahfuz@gmail.com</u>
	Patuakhali Science & Technology University (PSTU)	7.	Prof. Dr. Mohammad Lokman Ali Dean Dept of Aquaculture, Faculty of Fisheries, PSTU	01792171772 <u>lokman@pstu.ac.bd</u>
	Hajee Mohammad Danesh Science & Technology University (HSTU)	8.	Prof Dr A S M Kibria Chairman Department of Aquaculture, Faculty of Fisheries, HSTU	01713163418 <u>kibriahstu@gmail.com</u>

	Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	9.	Dr Dinesh Chandra Saha Associate Professor BSMRAU- Gazipur	01789366025 dinesh@bsmrau.edu.bd ; shaha.dinesh@gmail.com
	Sylhet Agricultural University	10.	Dr M M Mahbub Alam Chairman Department of Fish Health Management, Faculty of Fisheries, Sylhet Agriculture University	01718065847 mhbb_alam@sau.ac.bd mhbb_alam@yahoo.com
	Sher-E-Bangla Agriculture University	11.	MrSayedMashequl Bari Assistant Prof. & Chairman Department of Aquatic Animal Health Management Faculty of Fisheries, Aquaculture and Marine Science Sher E Bangla Agriculture University	01771283805 masheq.sau@gmail.com ; smbari.aahm@sau.edu.bd
	Chittagong Veterinary and Animal Science University (CVASU)	12.	Mrs Ishrat Jahan Anka Assistant Professor Faculty of Fisheries, Dept of Aquaculture, CVASU	01715716571 ishratanka@gmail.com
Resource persons	Dhaka University (Human Pharmacology)	13.	Dr. Md. Abdul Muhit Associate Professor Department of Clinical Pharmacy & Pharmacology Dhaka University	01733-982854 muhit@du.ac.bd
	Independent University of Bangladesh (IUB)	14.	Prof JMA Hannan, Head, Dept. of Pharmacy, IUB	01736734405 jma_hannan2002@yahoo.com
	Dhaka University Institute of Education & Research (IER)	15.	Dr Mahbub Ahsan Khan Professor, Institute of Education & Research (IER), Dhaka University	01911384036 mahsan@du.ac.bd
	Bangladesh Agriculture University (Veterinary Pharmacology)	16.	Dr. Md. Mahmudul Hasan Sikder Professor, Department of Pharmacology, Faculty of Veterinary Medicine, Bangladesh Agriculture University.	01712754945 drmsikder@bau.edu.bd
	Department of Fisheries	17. 18.	Md. Abdus Salam Pk Asstt. Director, FTA DOF, Savar Md. Nowsher Ali, Asstt Director(Aqua),	
	UGC	19	TBC	
	BFRI	20	TBC	

Annex-2

Power point presentation

Proposed Content of the 'Fish Pharmacology' Course

- Drugs used in hatchery operations:** breeding inducing agents, sex control agents, doses, withdrawal periods
- Preventive medicine/ Health beneficiary products:** Pre- and Pro-biotics, Immunostimulants, herbal medicines, Vaccines and adjuvants (types, development, production, administration, potency/ efficacy, marketing), antimicrobial peptides and their potential use as therapeutics in aquaculture
- Safety of aquatic medicine:** food safety regulations, toxic effects (toxicology), AMR (Anti-microbial resistance), safety of target species, operator, consumer and environment, welfare aspects of aquatic veterinary medicine, immunosuppressive drugs, drug control Acts, regulations and legislations in Bangladesh and international standards for compliance; Guidelines for the control of aquaculture medicinal products (AMPs)
- Prescription writing:** principles, types and parts of a prescription, rational use of drugs, rational and irrational prescribing, drug incompatibilities and adverse effects (reactions and interactions); drug abuse.

'Fish Pharmacology' course curriculum development, 15 March 2020 13
Date: 15 March, 2020 (Sunday) Venue: Zoya Golden Tump, Dhaka

Text Books & References

Additional Books (Veterinary Pharmacology)

- Jim E. Riviere and Mark G. Papich, 2018. *Veterinary Pharmacology and Therapeutics*: 10th Edition, Wiley-Blackwell, USA
- H. Richard Adams, 2001. *Veterinary Pharmacology and Therapeutics*: 8th Edition, Iowa State University Press/Ames, and U.S.A.
- Fiona Cunniff, Jonathan Elliott and Peter Lees, 2010. *Comparative and veterinary pharmacology*, Handbook of experimental pharmacology, vol. 199. Springer-Verlag Berlin Heidelberg.
- Walter H. Hsu, 2008. *Handbook of veterinary pharmacology*. Wiley-Blackwell.
- Janet A. Romich, 2011. *Fundamentals of Pharmacology for veterinary technicians*. 2nd edition, Delmar Cengage Learning, USA.
- Yves Ruchebusch, Pierre-Louis Toutain and Gary D. Kritz, 1983. *Veterinary Pharmacology and Toxicology*. MTP press limited, a member of the Kluwer publishers group, Boston. 825 p.

Additional Books (Basic Pharmacology)

- Laurence L. Brunton, 2018. *Goodman and Gilman's The Pharmacological Basis of Therapeutics*: 13th Edition, McGraw-Hill Education, New York, USA. 1423 p.
- Bertram G. Katzung, 2018. *Basic and Clinical Pharmacology*, 14th Edition, McGraw-Hill Education, New York, USA.
- Karen Whalen, 2019. *Lippincott illustrated Reviews: Pharmacology*, 7th Edition, Wolters Kluwer publications, New York, USA

'Fish Pharmacology' course curriculum development, 15 March 2020 16
-Loss of income
-threat to food security
-Long term effect on Livelihoods

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Purpose of the workshop

- The development of appropriate courses on fish pharmacology for Bangladeshi educational institutions & concerned government departments as well as private sector entities forms the part of the project entitled '**Work on policy consolidation, improvement in licensing, management process and effective use of aqua inputs**' with support from 'FIF/BANA', being implemented by BSFF
- A first **consultation meeting** was held on this subject on 25 January 2020 to commence the work on this component of the project
- Today's meeting will provide the opportunity to consider for **endorsement** a suggested **draft course content** for the subject fish pharmacology which have been prepared by the BSFF team assisted through an extensive consultative process

To validate the draft curriculum

'Fish Pharmacology' course curriculum development, 15 March 2020 07

What are the subject/knowledge required as background for fish pharmacology course?

World Aquatic Veterinary Medical Association
<https://www.wavma.org/>

Core Knowledge, Skills & Experience (KSE) Requirements

PRE-CLINICAL KSE	3
1. Aquatic Environment and Life Support Systems [25 credits minimum]	3
2. Taxonomy, Anatomy and Physiology [10 credits minimum]	4
3. Husbandry and Industries [25 credits minimum]	4
CLINICAL KSE	5
4. Pathobiology and Epidemiology of Aquatic Animal Diseases [25 credits minimum]	5
5. Diagnostics and Treatment of Aquatic Animal Diseases [25 credits minimum]	5
6. Clinical Veterinary Experience and Client Communications [25 credits minimum]	6
7. Public Health, Zoonotics and Seafood Safety [5 credits minimum]	6
8. Legislation, Regulations and Policies [5 credits minimum]	6
9. Principles of Aquatic Animal Welfare [5 credits minimum]	7

'Fish Pharmacology' course curriculum development, 15 March 2020 10

Proposed Content of the 'Fish Pharmacology' Course

Practical session (contents for 10-15 sessions)

- Practical application of various drugs and dose preparations; demonstration of drug administration: oral, injection, immersion and pond treatment, manufacturing medicated feed
- Demonstration, identification and use of different antibiotics used in aquatic animal treatment; Antibiotic residual assays; antibiotic sensitivity tests
- Demonstration of the use and mode of action of important **anesthetics, probiotics, immunostimulant, vaccines** on aquatic organisms
- Studies on **Histopathological changes** caused due to chemotherapy.
- Survey on commercial aqua medicines and health beneficiary products
- Collection, identification and use of common indigenous medicinal plants
- Field trip** to aqua farms (Monitoring of fish and pond health status) and **pharmaceutical companies** for practical exposures

'Fish Pharmacology' course curriculum development, 15 March 2020 14

Vibrio parahaemolyticus	Bacterial: AHPND
Enterococcus faecalis	Parasitic: EHP
Aphanomyces invadans	
Enterocytozoon hepatopenaei	

Content of the 'Fish Pharmacology' Course Certificate/Short course

Certificate Course

There may be in future a plan for intensive training of fisheries graduates — who are already in industry, universities and government departments

Need **customization** which can help the trained professionals in managing disease, advising and prescribing medicine and aqua inputs

- Introduction:** Ichthyology, Basic Anatomy and Physiology, Pathology and immunology of aquatic organisms
- ...
- ...

Duration:
Residential/intensive- 2 weeks
Regular/weekend- 3 to 6 months

'Fish Pharmacology' course curriculum development, 15 March 2020 17
Antibiotics used in aquaculture involve the development & transfer of drug resistance to pathogenic bacteria from farmed animals to humans.

'Fish Pharmacology' course curriculum development, 15 March 2020 05

What we expect from you today?

- We would very much appreciate to know from you whether **logical sequence of the course** suggested by us is the one that will help us to have a good course
- We would also like to know from you whether the course we are proposing would be **comprehensive enough** to meet our needs
- We would also like to know from you whether there are any **additionality** would be needed to enrich the course further

I have tried to incorporate all the suggestions & comments received from you

'Fish Pharmacology' course curriculum development, 15 March 2020 08

The course details suggested

We have suggested a course with following major building blocks-

Specific objectives

- To make the students familiar with various kinds of **therapeutic drugs, medicine, chemicals** used in aquaculture
- To provide in-depth knowledge on pharmacology of aquatic medicine, **pharmacokinetics and pharmacodynamics** properties of various drugs.
- To introduce students with **law and regulations** of drug use, safety issues, adverse effects, impacts of drugs on non-target organisms and the development of AMR
- To train the students with **laboratory and field level techniques of drug use** to combat with diseases.

'Fish Pharmacology' course curriculum development, 15 March 2020 11

Text Books & References

Text Books

- Treves-Brown KM, 2000. *Applied Fish Pharmacology*. Kluwer Academic Publishers, Dordrecht, 310 pp, 0-412-62180-0
- Ross, LG and Ross, B. 2008. *Anesthetics and sedative Techniques for aquatic animals*. Blackwell Publishing, 222 pp.

References

- Alexandra Adams, 2016. *Fish Vaccines*, 1st edition, Springer publication
- R. Gudding, A. Lillehaug and Ø. Evensen, 2014. *Fish Vaccination*, Wiley Blackwell publication.
- Stoskopf M K. 1993. *Fish medicine*. W B Saunders company, Philadelphia. 882 p.
- Noga E.I. 1996. *Fish disease - Diagnosis and treatment*. Mosby-year book Inc., St. Louis, Missouri. 367p.
- Brown, L. 1994. *Aquaculture for Veterinarians: Fish Husbandry and Medicine* Pergamon Press, Oxford. 545 pp
- Stephens A. Smith, 2019. *Fish diseases and medicine*. CRC press, Taylor & Francis Group.
- Melba G. Bondad-Reantaso, J. Richard Arthur and Rohana P. Subasinghe. 2012. *Improving biosecurity through prudent and responsible use of veterinary medicines in aquatic food production*. FAO Fisheries and aquaculture technical paper 547.

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Analysis and Inference of Geographical Origin or New Isolate from Bangladesh

Dominique L. Chaput^{1*}, David Bass¹, Md. Mahedi Alam¹, Nazir Al Hasan¹, Grant D. Stuedel¹, Koenig van Antel¹, Karel Maas¹, John P. Rignell¹, Mohammad Mahjoub Haque¹ and Charles R. Tyler^{1,2,3,4}

Thank you very much for your valuable feedback, participation & inputs!

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Proposed name of the course

- Fish Pharmacology
- Aquatic Animal Pharmacology
- Aquaculture Pharmacology
- Aquatic Pharmacology/Aquaculture Pharmacology**
- Fish Pharmacology and Aquatic Medicine**
- Aquatic Animal Medicine
- Aquatic animal veterinary medicine/ veterinary medicine for aquatic animals
- Pharmacology and toxicology (College of Fisheries, Mangalore)

'Fish Pharmacology' course curriculum development, 15 March 2020 09

Proposed Content of the 'Fish Pharmacology' Course

Theory (Contents for 30-35 lectures)

- Introduction:** Introduction to pharmacology, pharmacological terms and definitions, scope, history and importance of pharmacology in aquaculture sector; selection criteria of appropriate drug, list of approved and prohibited aqua-drugs/medicines, aqua-drug companies, trade and generic names of major aqua-drugs
- Methods of drugs administration:** methods against bacterial, viral, fungal, parasitic diseases, advantages and disadvantages of various methods, water, in-feed medication, gavage, injection and topical application
- Pharmacokinetics:** sources of drugs, nomenclature and classification, principles of drug activities, absorption, distribution, metabolism (biotransformation) and elimination of drugs.
- Pharmacodynamics:** concept of drug receptor, dose response relationship, half-life and withdrawal period, MRL (Maximum Residue Limit) factors affecting drug effect and dosage, Molecular mechanisms of drug action, pharmacogenetics
- Anti-pathogenic/Chemotherapeutic agents:** Antibacterial, antiviral, antifungal, antiparasitic, antiseptic and disinfectant; major groups of antibiotics, their uses, abuses, mode of actions, factors influencing the clinical use of antibiotics
- Anesthetics:** anesthesia and anesthetics for aquatic organisms; Guidelines for anesthesia in aquatic organisms, stages of anesthesia & recovery, chemical and methods for anesthesia, hypnotics and sedatives

'Fish Pharmacology' course curriculum development, 15 March 2020 12

Annex-3 Photographs



Pic-1: Consultation workshop for Fish Pharmacology.



Pic-2: Consultation workshop for Fish Pharmacology.



Pic-3: Validation workshop for recommended Fish Pharmacology course curriculum.



Pic-4: Validation workshop for recommended Fish Pharmacology course curriculum.

Annex-4
Proposed course curriculum of Fish Pharmacology

Fish Pharmacology Course Curriculum

Bachelor of Science (BS) in Fisheries/Marine Science: 4 years undergraduate degree

- ❖ **Course Code and Title:** FSH-405 (as per university guideline); **Aquatic Pharmacology**
- ❖ **Credit Hours:** 45 hours (3/4 credits/ 75/100 Marks)
- ❖ **Year/Semester:** 4th year/ Level-3/4, Semester-2
- ❖ **Prerequisite courses:** Ichthyology, Anatomy and Physiology of Aquatic Organisms, Fisheries Microbiology, Fish Pathology, Fish Parasitology, Fish Immunology and Aquatic Animal Health Management
- ❖ **Course description**

Disease is one of the most important risk factors with serious consequences for the aquaculture sector in Bangladesh. Owing to disease outbreaks, huge losses in terms of production and compromised food security occur worldwide. During recent decades, fish farmers in Bangladesh have contributed significantly to sustained production gains in the aquaculture sector. However, they often face losses due to the incidence of diseases. Disease prevention and mitigation, therefore, is a matter of utmost importance for Bangladesh. In this specific context, the need for professionals who are well informed about aquatic pharmacology is of vital importance for the continued development of aquaculture sector. The present course content has been developed to fill in a much-felt need for trained professionals with a comprehensive knowledge on aquatic animal diseases and pharmacology. This course is so designed to provide the target learners with knowledge on aquatic pharmacology which is needed to enable professionals to deal with disease and pharmaceutical substances. During lecture sessions, students will be introduced to different groups of drugs and their pharmacokinetics, pharmacodynamics properties and usage. During lab sessions, students will gain 'hands-on', practical knowledge to identify dose-response of various drugs against specific fish and shrimp pathogens.

❖ Course Objectives

- To make the students familiar with various kinds of therapeutic drugs, medicine, chemicals used in aquaculture
- To provide in-depth knowledge on pharmacology of aquatic medicine, pharmacokinetics and pharmacodynamics properties of various drugs
- To introduce the students with law and regulations of drug use, safety issues, adverse effects, impacts of drugs on non-target organisms, environment and the development of anti-microbial resistance (AMR)
- To train the students with laboratory and field level techniques of drug use to combat with diseases.

❖ Course Contents:

Theory

1. **Introduction:** Scope, history and importance of pharmacology in aquaculture; pharmacological terms and definitions, dose, dosage, bioequivalent; selection criteria of appropriate drugs, aqua-drug companies, trade and generic names of major aqua-drugs
2. **Methods of drugs administration:** Various routes- water, in-feed medication, gavage, injection and topical application; considerations in selecting specific routes, advantages and disadvantages of various methods; drug administration against bacterial, viral, fungal and parasitic diseases
3. **Pharmacokinetics:** Sources of drugs, nomenclature and classification, principles of drug activities, absorption, distribution, metabolism (biotransformation) and elimination of drugs, bioavailability of drugs
4. **Pharmacodynamics:** Concept of drug-receptor, dose-response relationship, half-life and withdrawal period, Maximum Residue Limit (MRL), factors affecting drug effect and dosage; molecular mechanisms of drug action, drug resistance, pharmacogenetics
5. **Anti-pathogenic/Chemotherapeutic agents:** Antibacterial, antiviral, antifungal, antiparasitic agents; major groups of antibiotics, their uses, abuses, mode of actions, factors influencing the clinical use of antibiotics; antiseptic and disinfectant
6. **Anesthetics:** Anesthetic agents and desirable features; methods and guidelines for anesthesia in aquatic organisms, stages of anesthesia and recovery; hypnotics and sedatives
7. **Drugs used in hatchery operations:** Drugs used in finfish, shrimp, prawn, crab

- hatcheries; breeding inducing agents, sex control agents, dose and dosage, mechanisms of action, withdrawal periods; chemicals used to maintain biosecurity in hatcheries
8. **Preventive medicine/ Health beneficiary products/ Prophylaxis products:** Pre- and Pro-biotics, immunostimulants, herbal medicines; vaccines and adjuvants (types, development, production, mechanism of action, administration, potency/ efficacy, marketing), commercially available vaccines; antimicrobial peptides and their potential use as therapeutics in aquaculture
 9. **Safety of aquatic medicine:** Food safety regulations, toxic effects (toxicology), antimicrobial resistance(AMR) issues- safety and welfare aspects of target species, operator, consumer and environment; immunosuppressive drugs; drug control acts, regulations and legislations in Bangladesh, and international standards for compliance; list of approved and prohibited aqua-drugs/medicines, guidelines for the control of aquaculture medicinal products (AMPs), drug control and certification authorities
 10. **Prescription writing:** Principles, types and parts of an ideal prescription, rational use of drugs, rational and irrational prescribing, drug incompatibilities and adverse effects (reactions and interactions), drug abuse

❖ **Practical Sessions**

Students would be expected to maintain a record of everything done in the practical and field sessions in a practical notebook to be signed and checked by the course teacher.

- a) Practical application of various drugs and dose preparations; demonstration of drug administration: oral, injection, immersion and pond treatment, manufacturing medicated feed
- b) Demonstration, identification and use of different antibiotics used in aquatic animal treatment; antibiotic residual assays; antibiotic sensitivity tests
- c) Demonstration of the use and mode of action of important anesthetics, probiotics, immunostimulants, vaccines on aquatic organisms
- d) Studies on histopathological changes caused due to chemotherapy
- e) Survey on commercial aqua medicines and health beneficiary products
- f) Collection, identification and use of common indigenous medicinal plants important for aquaculture

- g) Field trip and internships to aqua farms (monitoring of fish and pond health status) and pharmaceutical companies for practical exposures

❖ **Learning Outcomes**

At the end of the course, students will be able to-

1. Explain the basic concepts of fish pharmacology
2. Apply various methods of drugs administration processes for disease control in the aquatic environment
3. Describe the process by which a drug is absorbed, distributed, metabolized and eliminated by the body
4. Describe the interactions of a drug and the receptors responsible for its action in the body
5. Compare various anti-microbial agents those are useful to protect from diseases; choose and ensure approved drugs and recognize illegal aqua drugs with their consequences
6. Develop a guideline to use anesthetic agents in aquaculture sector
7. Describe various drugs that are especially used in hatchery operations
8. Describe the use of various preventive medicines and health beneficiary products to aquatic organisms
9. Implement different acts, rules, legislations, national and international laws regarding the safe use of aqua drugs and chemicals
10. Write the prescription for various diseases of aquatic organisms suggesting specific drugs and chemicals

❖ **Unit-wise title and sub-title and number of classes per unit (Theory 30-35 lectures, Practical 10-15 sessions)**

	Title	Sub-title	No. of classes (35)
	Introduction	Scope, history and importance of pharmacology in aquaculture; pharmacological terms and definitions, dose, dosage, bioequivalent; selection criteria of appropriate drugs, aqua-drug companies, trade and generic names of major aqua-drugs	4

Methods of drugs administration	Various routes- water, in-feed medication, gavage, injection and topical application; considerations in selecting specific routes, advantages and disadvantages of various methods; drug administration against bacterial, viral, fungal and parasitic diseases	3
Pharmacokinetics	Sources of drugs, nomenclature and classification, principles of drug activities, absorption, distribution, metabolism (biotransformation) and elimination of drugs, bioavailability of drugs	4
Pharmacodynamics	Concept of drug-receptor, dose-response relationship, half-life and withdrawal period, Maximum Residue Limit (MRL), factors affecting drug effect and dosage; molecular mechanisms of drug action, drug resistance, pharmacogenetics	4
Anti-pathogenic / Chemotherapeutic agents	Antibacterial, antiviral, antifungal, antiparasitic agents; major groups of antibiotics, their uses, abuses, mode of actions, factors influencing the clinical use of antibiotics; antiseptic and disinfectant	5
Anesthetics	Anesthetic agents and desirable features; methods and guidelines for anesthesia in aquatic organisms, stages of anesthesia and recovery; hypnotics and sedatives	3
Drugs used in hatchery operations	Drugs used in finfish, shrimp, prawn, crab hatcheries; breeding inducing agents, sex control agents, dose and dosage, mechanisms of action, withdrawal periods; chemicals used to maintain biosecurity in hatcheries	2
Preventive medicine/ Health beneficiary products/ Prophylaxis products	Pre- and Pro-biotics, immunostimulants, herbal medicines; vaccines and adjuvants (types, development, production, mechanism of action, administration, potency/ efficacy, marketing), commercially available vaccines; antimicrobial peptides and their potential use as	4

		therapeutics in aquaculture	
	Safety of aquatic medicine	Food safety regulations, toxic effects (toxicology), anti-microbial resistance (AMR) issues- safety and welfare aspects of target species, operator, consumer and environment; immunosuppressive drugs; drug control acts, regulations and legislations in Bangladesh, and international standards for compliance; list of approved and prohibited aqua-drugs/medicines, guidelines for the control of aquaculture medicinal products (AMPs), drug control and certification authorities	4
	Prescription writing	Principles, types and parts of an ideal prescription, rational use of drugs, rational and irrational prescribing, drug incompatibilities and adverse effects (reactions and interactions), drug abuse	2

❖ **Instructional strategies:** Class lectures, assignment, question-answer, guided-discussion, group discussion, practical

Theory lectures: Lectures based on oral, power point presentations, videos. Course materials will be available during all classes.

Practical classes: Experiments on drug doses, antibiotic susceptibility test, field trip to pharmaceutical company

❖ **Assessment:** Objectives- True/ False, MCQ, fill in the gaps, matching; subjective-descriptive, short note, assignments

❖ **Text Books**

1. Ross, L.G., Ross, B., 2008. Anesthetics and Sedative Techniques for Aquatic Animals, third ed. Blackwell Publishing.
2. Treves-Brown, K.M., 2000. Applied Fish Pharmacology. Kluwer Academic Publishers, Dordrecht.

❖ **Relevant Books/ References**

1. Alexandra, A., 2016. Fish Vaccines, 1st edition, Springer publication

2. Austin, B., Newaj-Fyzul, A., 2017. *Diagnosis and Control of Diseases of Fish and Shellfish*. John Wiley & Sons Ltd.
3. Bondad-Reantaso, M.G., Arthur, J.R., Subasinghe, R.P., 2012. Improving biosecurity through prudent and responsible use of veterinary medicines in aquatic food production. *FAO Fisheries and Aquaculture technical paper 547*.
4. Brown, L., 1994. *Aquaculture for Veterinarians: Fish Husbandry and Medicine*. Pergamon Press, Oxford.
5. Gudding, R., Lillehaug, A., Evensen, Ø., 2014. *Fish Vaccination*, Wiley Blackwell publication.
6. Noga, E.J., 1996. *Fish Disease - Diagnosis and Treatment*. Mosby-Year book Inc., St. Louis, Missouri.
7. Smith, S.A., 2019. *Fish Diseases and Medicine*. CRC press, Taylor & Francis Group.
8. Stoskopf, M.K., 1993. *Fish Medicine*. W B Saunders Company, Philadelphia.

❖ Additional Books (Veterinary Pharmacology)

1. Cunningha, F., Elliott, J., Lees, P., 2010. *Comparative and Veterinary Pharmacology, Handbook of Experimental Pharmacology*, vol. 199. Springer-Verlag Berlin Heidelberg.
2. Hsu, W.H., 2008. *Handbook of Veterinary Pharmacology*. Wiley-Blackwell.
3. Riviere, J.E., Papich, M.G., 2018. *Veterinary Pharmacology and Therapeutics*, 10th ed. Wiley-Blackwell, USA
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