MASTER OF AQUACULTURE CURRICULUM

I. Curriculum (60 credits)

- Theories and practice: 45 credits (2 terms)
- Thesis: 15 credits (1 – 2 term(s))

No	Code	Courses	Credits	Semester
I	**PHẦN KIẾN THỨC CHUNG (*General knowledge*)**		**(3)**	
1	PHIL6000	Triết học (Philosophy)	3 (3, 0)	HK1
II	**HỌC PHẦN BẮT BUỘC (*Compulsory courses*)**		**(25)**	
1	AQUA6001	Phương pháp luận nghiên cứu khoa học (Research Methodology)	2 (2, 0)	HK1
2	AQUA6002	Thống kê ứng dụng trong thủy sản (Applied Statistics in Aquaculture)	3 (2,1)	HK1
3	AQUA6003	Hệ thống nuôi thủy sản (Aquaculture Systems)	2 (2,0)	HK1
4	AQUA6004	Hệ thống sản xuất giống thủy sản (Aquatic Seed Production System)	3 (2,1)	HK2
5	AQUA6005	Dinh dưỡng và thức ăn thủy sản (Advanced Nutrition and Feed Technology in Aquaculture)	3 (2,1)	HK1
6	AQUA6006	Bệnh học thủy sản nâng cao (Diseases of Aquatic Organisms)	3 (2,1)	HK2
7	AQUA6007	Quản lý môi trường nuôi thủy sản (Environmental Quality Management in Aquaculture)	3 (2,1)	HK2
8	AQUA6008	Di truyền ứng dụng trong thủy sản (Applied Genetics in Aquaculture)	2 (2,0)	HK2
9	AQUA6019	Thực tập chuyên đề (Field visit)	2 (2,0)	HK2
10		Seminar chuyên ngành 1 (bảo vệ đề cương) Proposal Defense	1 (0,1)	HK2
11		Seminar chuyên ngành 2 (Báo cáo cơ sở) Internal Thesis Defense	1 (0,1)	HK3-4

III	**HỌC PHẦN TỰ CHỌN (*optional courses*)**		**(17)**	
1	AQUA6009	Công nghệ sinh học ứng dụng trong NTTS (Applied Biotechnology in Aquaculture)	2 (2,0)	HK1
2	AQUA6010	GIS ứng dụng (Applied Geographic Information System)	3 (2,1)	HK1
3	AQUA6011	Kinh tế và marketing thủy sản (Economics and Marketing of Fisheries)	2 (2,0)	HK2
5	AQUA6013	Sinh lý sinh thái động vật thủy sản (Aquatic Animal Ecophysiology)	2 (2,0)	HK2
6	AQUA6014	Đánh giá tác động môi trường (Environmental Impact Assessment on Aquaculture)	2 (2,0)	HK2
7	AQUA6015	Quy hoạch nuôi trồng thủy sản (Aquaculture Planning and Development)	2 (2,0)	HK1
8	AQUA6016	Quản lý nghề cá (Fisheries Management)	2 (2,0)	HK1
9	AQUA6020	Quản lý dịch bệnh thủy sản (Aquatic Animal Disease Management)	2 (2,0)	HK1
10	AQUA6021	Dinh dưỡng người nâng cao (Seafood and Human Nutrition)	2 (2,0)	HK1
11	AQUA6022	An toàn Thực phẩm Thủy sản (Aquatic Product Safety)	2 (2,0)	HK2
12	AQUA6023	Dịch tễ học Thủy sản (Aquatic Epidemiology)	2 (2,0)	HK1
13	AQUA6024	Độc chất học trong nuôi trồng thủy sản (Aquatic Toxicology)	2 (2,0)	HK2
14		Thực hành (Internship)	2 (0,2)	HK2
IV	**LUẬN VĂN TỐT NGHIỆP (*Thesis*)**		**15 (0,15)**	
1	THES6999	Luận văn Tốt nghiệp (Thesis)	15 (0,15)	HK3-4

Note:

Credits (theory, practical)

HK: semester

COURSE OUTLINES OF NEW OR IMPROVED COURSES
DEVELOPED DURING SSNS PROJECT PERIOD

FACULTY OF FISHERIES
NONG LAM UNIVERSITY-HO CHI MINH CITY, VIETNAM

Course title: Environmental Impact Assessment in Aquaculture
Course code: AQUA6014 **2(2-0)**
Semester: April

Course Objective: This course equips students with basic principles of environmental impact assessment (EIA) in all proposed activities such as development projects, programs or legislative actions, and provides them guidelines and procedures of EIA including writing EIA report.

Learning Outcomes:

On completion of this course, students will be able to:
- Lead or participate a working group for EIA of proposed projects in aquaculture
- Identify and analyze possible impacts of proposed projects
- Propose solutions to eliminate or minimize negative impacts on the environment
- Compose EIA report following the guideline from the Ministry of Natural Resources and Environment of Vietnam.

Pre-requisite: None

Course Outline:

I. Principles and procedures
1. Introduction and principles
2. Origin and development
3. Roles of EIA in sustainable development
4. Scopes of EIA in proposed activities
5. Legislative context

II. Process of EIA
1. Starting up and stages of EIA
2. Screening of proposed projects
3. EIA process
   - 3.1 Determine limits/boundaries
   - 3.2 Data collection
   - 3.3 Description and assessment of the current conditions
   - 3.4 Impact prediction
   - 3.5 Solution proposition
   - 3.6 EIA report

III. Techniques and methods

1. Techniques in impact prediction
   Aspects to be predicted
   Expert assessment
   Mathematic models
   Prediction by trials

2. Common used methods for EIA
   Tabulator analyses
   Matrix analyses
   Network analyses
   Map overlapping analyses

IV. Monitoring and auditing

1. Environmental monitoring
2. Environmental auditing

V. Problem and solution for environmental compensation

1. Polluter pay principles
2. Payment methods
3. Payment for ecosystem services
4. Case study in aquaculture

Case studies:

1. Pond aquaculture analyses (specific farm conditions will be provided)
2. Cage aquaculture analyses (specific farm conditions will be provided)

Learning Resources:

Textbooks:

1- Looijen, J.M., 2004. Environmental Impact Assessment. Research Center of Eco-environmental Sciences- Chinese Academy of Science. 68 p.
2- A handout of lecture note (powerpoint) will be provided.

Additional reading resources:

1. Tyldesley, D. and Edinburgh, A., 2005. A Handbook on environmental impact assessment- Guidance for competent authorities, consultees and other involved in the environmental impact assessment process in Scotland, second edition. Scottish Natural Heritage. 257 p.
2. Glasson, J., Therivel, R. and Chadwick, A., 2005. Introduction to environmental impact assessment , Third edition. Routledge, Taylor and Francis Group, London and New York. 460 p.

Teaching and Learning Methods: Lectures, case studies, group working and presentations

Time Distribution and Study Load:

Lecture hours = 24 h.
Case study assignments presentation = 6 h.
Self-studies = 90 h.

Scoring Scheme:

Case Study report and presentation (group work) = 20%;
Individual assignment (home-work) = 20%;
Final examination = 40%.

Students will be scored using a 10-point basis for every work evaluation.
Who performs high satisfaction on the task requirement will be marked from 9 to 10; marks of 7-8 for moderate satisfaction; 6 for low satisfaction; 5 for just pass; 4 and below for fail.

Instructor: Dr Nguyen Van Trai

Faculty Recommendation: _____ Post graduate Office Approval: _____

University Approval: _____

Annexes:

1. **Assessment**: Types of assignment and examination, and weight of assessment will be informed to students on the first introductory class

2. **Lectures:** Full lecture notes in form of PDF file will be provided in advance via online.

3. **Case study for group work and individual assignment**
   Topic / issues / problems will be given to students with specific requirements and deadline, venue. Presentation and report forms will also be informed.

4. **Videos**
   Selected videos showing fish farming activities and their impacts on the environment will be played during class hours; the length of the videos may last form 5 to 15 minutes each.

FACULTY OF FISHERIES
NONG LAM UNIVERSITY-HO CHI MINH CITY, VIETNAM

Course title: Fisheries Resources Management
Course code: AQUA6016 **2(2-0)**
Semester: April

Course objective:

This course introduces basic approaches and concepts of the different types of aquatic resources and their importance, fish population dynamics, basic fisheries assessment methods, existing management strategies, and management and planning. Good knowledge and skills in fisheries resource management are essential to enable the development of management strategies appropriate to real situations.

Learning outcomes:

At the end of this course, students will be able to:

1. Demonstrate understanding of the present fisheries resources situation (country specific)
2. Demonstrate understanding of fisheries management strategies
3. Be able to analyze fisheries statistics and assessment methods
4. Design and develop a basic fisheries programme (or research plan) using fisheries management tools and approaches.
5. Understanding the interaction roles / communicate with stakeholders

Pre-requisite: None

Course Outlines:

I. Fisheries management and its challenges in Vietnam

1. Rationale and evolution of fisheries management
2. Terms of fisheries, fisheries science and management
3. The fundamental of fisheries management
4. Key dimensions of fisheries management
5. Working principles for fisheries management
6. Characteristics and challenges of fisheries management in Vietnam

II. Fisheries resources, fishing problems and management

1. Main fisheries resource groups and its important
2. Fishing gear, methods and problems
3. Fishing management

III. Fish population dynamics and yield models

1. Fish Population Dynamic
2. Stock and catch assessment
3. Yield models

IV. Socio-economic approach in fisheries management

1. Social aspects of fisheries management
2. The broader fisheries governance in the social sciences
3. An economic approach to fisheries
4. Importance of the 'stock effect'

V. Fisheries assessment and monitoring

1. Data requirement for fisheries assessment and monitoring
2. Investigation techniques for reliable data
3. Stock size estimation methods
4. Fishery monitoring, control and surveillance (MCS)

VI. Fisheries management implementation

1. Concepts on which fishery management is based
2. Fisheries management objectives
3. Tools to accomplish fishery management goals
4. Options to regulate fishing
5. Methods of fisheries management
6. Fisheries regulation options
7. Fishery management plans (FMPs)
8. International and national fisheries policy requirements

Laboratory Session: None

Case study:

1. Addressing overcapacity in the small-scale marine fisheries of Vietnam
2. Policy recommendations to address overcapacity in the small-scale fisheries

Learning Resources:

Textbooks:

1. Cochrane, K.L., Garcia, S.M. 2009. A fishery manager's guidebook. Wiley-Blackwell and FAO, 520 p.
2. KING, M. 1995. Fisheries Biology, Assessment and Management. Fishing News Books, UK. 341 pp

Additional reading resources:

1. OLIVER, M.A.R. (Ed.), 2002. Sustainable fisheries management in Asia. Asian Productivity Organization, Tokyo. 325 pp.
2. CRUZ, D.A. (Ed.), 2002. Coastal fisheries management. Asian Productivity Organization, Tokyo. 191 pp.
3. MEYER, R.M., ZHANG, C., McCAY, B.J., HUSAK, L.J., MUTH, R.M., WOLOTIRA, R.J. (Eds.), 1996. Fisheries resources utilization and policy. Oxford & IBH, New Delhi, 535 pp.

Teaching and Learning Methods: Class room lecture, group discussion, case studies, and presentation

Lecture hours = 24 h.
Case study assignments presentation = 6 h.
Self-studies = 90 h.

Scoring Scheme:

Case Study report and presentation (group work) = 20%;
Individual assignment (home-work) = 10%;
Final examination = 70%.

Students will be scored using a 10-point basis for every work evaluation.
Who performs high satisfaction on the task requirement will be marked from 9 to 10; marks of 7-8 for moderate satisfaction; 6 for low satisfaction; 5 for just pass; 4 and below for fail.

Instructor: Dr Vu Cam Luong

Faculty Recommendation: _____ Post graduate Office Approval: _____

University Approval: _____

Annexes:

1. **Assessment**: Types of assignment and examination, and weight of assessment will be informed to students on the first introductory class

2. **Lectures:** Full lecture notes in form of PDF file will be provided in advance via online.

3. **Case study for group work and individual assignment**
   Topic / issues / problems will be given to students with specific requirements and deadline, venue. Presentation and report forms will also be informed.

4. **Videos**
   Selected videos showing fish farming activities and their impacts on the environment will be played during class hours; the length of the videos may last form 5 to 15 minutes each.

FACULTY OF FISHERIES
NONG LAM UNIVERSITY-HO CHI MINH CITY, VIETNAM

Course title: Applied Biotechnology in Aquaculture
Course code: AQUA6009 **2(2-0)**
Semester: April

Course Objective: This course equips students with basic principles of biotechnology applied in aquaculture. The applications are: diagnostics, molecular biology, genetics, biology, and microbiology.

Learning Outcomes:

On completion of this course, students will be able to:
- Understand concepts of biotechnology, including methodologies, applied in various fields of aquaculture
- Apply relevant advances in biotechnology in farming practices and biology researches

Pre-requisite: None

Course Outline:

I. **Principles and procedures**
1. Introduction and principles
2. Molecular biology applied in diagnostics
3. Molecular biology applied in genetics
4. Microbiology applied in aquaculture and bioremediation
5. Molecular biology applied in biology research

II. **Molecular biology applied in diagnostics**
1. Review of Aquatic disease pathogens
2. Samplings and sample preparation
3. DNA/RNA purification
4. Conventional PCR technique
5. Realtime PCR technique
6. LAMP, isothermal PCR techniques

III. **Molecular biology applied in genetics**

1. Genetics and breeding programs for aquatic species
2. Application of molecular biology in genetics research and genetics program

IV. **Microbiology applied in aquaculture and bioremediation**
1. Probiotics, bioremediation
2. Fermentation technology

V. **Molecular biology applied in biology research**

1. Genetics and genetic diversity
2. Metagenomics
3. Proteomics

Case studies:

1. Post larvae health assessment
2. Design a shrimp breeding program

Learning Resources:

Textbooks:
Manual of Diagnostic Tests for Aquatic Animals (2018), World Organisation for Animal Health.
Additional reading resources:

1. Shrimp Pathology Short Course handout, University of Arizona.

Teaching and Learning Methods: Lectures, case studies, group working and presentations

Time Distribution and Study Load:
Lecture hours = 24 h.
Case study assignments presentation = 6 h.
Self-studies = 60 h.

Scoring Scheme:

Case Study report and presentation (group work) = 30%;
Individual assignment (home-work) = 30%;
Final examination = 40%.

Students will be scored using a 10-point basis for every work evaluation.
Whoever performs high satisfaction on the task requirement will be marked from 9 to 10; marks of 7-8 for moderate satisfaction; 6 for low satisfaction; 5 for just pass; 4 and below for fail.

Instructor: Dr Nguyen Hoang Nam Kha, Dr. Tran Huu Loc

Faculty Recommendation: _____ Post graduate Office Approval: _____

University Approval: _____

FACULTY OF FISHERIES
NONG LAM UNIVERSITY-HO CHI MINH CITY, VIETNAM

Course title: Seafood and Human Nutrition
Course code: AQUA6021 **2(2-0)**
Semester: September

Course Objective: This course equips students with basic principles of the nutrition requirements of humans, how diet can affect overall human health and disease and the composition of seafood products that help in supplementing the requirements of humans.

Learning Outcomes:

On completion of this course, students will be able to:
- Describe human nutrition and health
- Identify nutritional diseases/deficiencies in human
- Describe nutritional value of fish or seafood
- Identify seafood products and their roles in food security
- Describe seafood safety and certification processes

Pre-requisite: None

Course Outline:

I. **Background**
1. Introduction to the course/syllabus
2. Sharing knowledge/experience by students on the subject matter
3. Needs assessment – discuss and identify
4. Conclusions – what needs new topics need to be added

II. **Human nutrition and welfare**
1. Human population and hunger
2. Human nutrition and health
3. Malnutrition: children and women
4. Obesity trends, causes and prevention
5. Healthy foods: organic/natural

III. **Fish and seafood products**
1. Nutrient contents of seafood in comparison to food items
2. Quality of live, fresh fish, processed foods
3. Processing of seafood and nutrient contents
4. Seafood demand and supply: national and global
5. Sources of seafood its security

IV. **Fish production and consumption**

1. Global and country level
2. Factors affecting fish consumption
3. Tradition and beliefs
4. Problems and researchable topics

V. **Seafood markets and accessibility (guest lecturer from industry)**

1. Consumer behavior and expectations
2. Markets: domestic and international
3. Seafood prices and affordability
4. Unethical practices in seafood businesses

VI. **Seafood and nutrition essay (student assignment)**

1. Definition one or more problems of the processing plan
2. Analysis and recommendation of problem solving
3. Presentation and discussing
4. Lessons learned and continuous improvement

VII. **Wrap-up**

1. Presentation by the students
2. Evaluation of the course
3. Conclusion and recommendations

Laboratory Session: None

Field visits:

1. Shrimp and/or fish farms: as raw materials and transportation to the processing plan
2. Seafood processing factory

Learning Resources:

Textbooks: No designated textbook, but lecture notes will be provided.

Reference Books/articles:

1. Handbook of Nutrition and Food, 2014, CRC Press, Taylor & Francis Group
2. CRC desk reference for nutrition by Carolyn D Berdanie, 2011.
3. Amino Acids in Human Nutrition and Health. edited by J D'Mello
4. Thilsted, S. et. al., 2014. Maximizing the contribution of fish to human nutrition. In Second International Conference on Nutrition – Better Nutrition Better Lives.
5. Tilami, S.K. and Sampels, S. 2017. Nutritional Value of Fish: Lipids, Proteins, Vitamins, and Minerals. Reviews in Fisheries Science & Aquaculture 26(2): 1-11.
6. Beveridge, M. C. M. et al., 2013. Meeting the food and nutrition needs of the poor: the role of fish and the opportunities and challenges emerging from the rise of aquaculture. J Fish Biol. 2013 Oct; 83(4): 1067–1084.

Journal and Magazines:

1. Aquaculture economics: An overview, Springer
2. Aquaculture Economics & Management, Taylor & Francis
3. Global Aquaculture Advocate magazine, Global Aquaculture Alliance, USA
4. Aquaculture Magazine by World Aquaculture Society, USA
5. Aquaculture Asia by NACA, Bangkok

Teaching and Learning Methods: Lectures, field visits, and presentations

Time Distribution and Study Load:
Lecture hours = 22 h.
Field visits = 8 h x 2 days
Assignment and presentation = 8 h (1 day)
Self-studies = 60 h.

Evaluation Scheme:

Assignment and presentation = 20%; report (field visit) = 20%; and Final examination = 60%.

Students who display a thorough knowledge on seafood and human nutrition during the examinations, and show excellent analytical skills in proposal writing (written report + presentations) are given an A grade, and those who display a good understanding and analytical skills are given a B grade. Grade C will be awarded for those who show below average knowledge and analytical skills on the subject matter, and the grade D will be given to students who show poor understanding/analytical skills on the subject matters.

Instructor: Nguyen Hoang Nam Kha.

Department Approval: _____

Faculty Approval: _____

University Approval: _____

FACULTY OF FISHERIES
NONG LAM UNIVERSITY-HO CHI MINH CITY, VIETNAM

Course title: Advanced Nutrition and Feed Technology in Aquaculture

Course code: AQUA6005 **3(2-1)**

Semester: September

Course objective: This course provides updated and applied nutritional knowledge of different fish species, emphasizing on commercially important ones to ensure the sustainability of aquaculture industry.

Learning Outcomes:

After taking this course, students would be able to:

- **(i)** understand the biochemical processes that occur inside fish body after receiving feed, such as digestion and absorption of nutrients; metabolism and interaction among nutrients; and mechanism of the waste excretion,
- **(ii)** understand the specific nutritional requirements of different fish groups such as marine fish, freshwater fish, carnivore, omnivore and herbivore,
- **(iii)** apply knowledge and experience obtained from the course to formulat e and manufacture feed for different fish species.

Pre-requisite: Biology, Biochemistry

Course Outline:

I. Introduction

1. Aquaculture systems
2. Development of feed formulations
3. Nutritional deficiency symptoms

II. Feeding and digestion

1. Basic ecology and practical implications for aquaculture
2. Fish digestive system morphology
3. Digestive processes of main nutrients
4. Digestibility measurement techniques

III. Metabolism

1. Biological systems
2. Energy metabolism
3. Metabolism of carbohydrates, lipids and proteins

IV. Amino acids and proteins

1. Preliminary concepts
2. Amino acid classification

3. Protein synthesis
4. Quantitative requirements of protein and amino acids
5. Protein and amino acids digestibility

V. Lipids and fatty acids

1. Classification of lipids
2. Fatty acid nomenclature
3. Lipid absorption and metabolism
4. Function of essential fatty acids
5. Lipid requirements of different fish species

VI. Vitamins

1. Vitamin classification
2. Vitamin absorption and metabolism
3. Vitamin requirements of different fish species
4. Vitamin stability during feed manufacture and storage

VII. Minerals

1. Mineral sources and fish requirements
2. Bioavailability and requirements of macro minerals
3. Bioavailability and requirements of micro minerals
4. Chelated minerals

VIII. Other dietary components

1. Fibers
2. Pigments
3. Attractants
4. Hormones
5. Antibiotics
6. Binding agents
7. Toxins and anti-metabolites
8. Fish oils
9. Antioxidants

IX. Diet formulation and manufacture

1. Science and art of feed formulation
2. General steps of feed manufacture
3. Basic standard of final product

Field visits:

1. Commercial feed mill
2. Fish farm

Learning Resources:

Textbooks: No designated textbook, but lecture notes will be provided.

Reference Books:

1. Halver, J.E. and Hardy, R.W., 2002. Fish nutrition, third edition. Academic Press, CA, USA, 769p.
2. National Research Council, 2011. Nutrient requirements of fish and shrimp. The National Academies Press, Washington, D.C., USA, 350 p.

Journals and Magazines:

1. Aquaculture Nutrition
2. Aquaculture
3. Aquaculture Research
4. Aquafeed magazine
5. Aqua Culture Asia Pacific magazine

Teaching and Learning Methods: Lectures, field visits and presentations

Time Distribution and Study Load:

Lecture hours = 30 h
Field visits = 8 hrs x 1 day
Self-studies = 60 h

Evaluation Scheme:

Seminar's report and presentation = 20%; Trip report = 10%; Mid-semester examination = 30%; and Final examination = 40%.

Instructor: Dr Nguyen Nhu Tri

FACULTY OF FISHERIES
NONG LAM UNIVERSITY-HO CHI MINH CITY, VIETNAM

Course title: Applied Statistics in Aquaculture
Course code: AQUA6002 **3(2-1)**
Semester: September

Course Objective: This course provides the advanced knowledge of collection, analysis and presentation of data; skills in experimental design and analyzing and presenting statistical data using computer-software (Excel, SPSS, etc.). Moreover, the course gives opportunity for learners to discuss and present their own research idea in aquaculture field via group working.

Learning Outcomes:

On completion of this course, students will be able to:

- describe data by table, chart and parameters such as mean, standard deviation;
- apply statistical techniques including t-tests, F-tests, correlation and simple regression, one-sample and two-sample tests;
- design experiment (one factor or multifactor) and analyze the obtained data by statistical tools such as analysis of variance (ANOVA);
- present the application of experimental methods and major experimental designs in designing final thesis course and communication research;
- identify the appropriate statistical technique for the analysis of data and use the computer (e.g., MS Excel, SPSS, etc.) for data analysis;
- apply knowledge of ethical standards to an experiment.

Pre-requisite: None

Course Outline:

I. Introduction
1. Concept "Statistics"
2. History
3. Scope and application of statistics

II. Experimental units in aquaculture
1. Background
2. Earthen ponds
3. Hapas and cages in ponds
4. Cages in lakes or reservoirs
5. Tanks
6. Aquaria
7. Farmer survey

III. Sampling and data collection
1. Concepts

2. Sampling principles and methods
3. Variables in aquaculture
4. Scales of measurement

IV. Data explorer

1. Data accuracy and precision
2. Significant numbers
3. Errors and their sources
4. Error minimization and separation
5. Exploratory data analysis
6. Presenting data in frequency tables and charts

V. Measures of central tendency and variability

1. Measures of central tendency
2. Measures of variability and dispersion

VI. Probability distribution

1. Normal distribution
2. t distribution
3. F distribution
4. Binomial distribution
5. Poisson distribution

VII. Statistical hypotheses

1. Concepts
2. One-sample hypotheses
3. Two-sample hypotheses
4. Paired-sample hypotheses
5. Non-parametric statistical methods

VIII. Experimental designs and analysis of variance (ANOVA)

1. Single-factor experimental designs
2. Factorial experimental designs

IX. Correlation and regression analysis

1. Correlation
2. Simple linear regression
3. Multiple linear regression
4. Nonlinear regression

X. Data problem and research result reporting/presenting

1. Data that violate some assumptions of the ANOVA
2. Data transformation
3. Research result reporting/presenting

Laboratory Session:

1. Introduction to SPSS
2. Data input
3. Data management
4. χ^2 test
5. One sample t test
6. Two sample t test
7. Paired t test
8. Non-parametric tests
9. Single-factor experimental designs
10. Factorial experimental designs
11. Correlation and regression analysis

Field visits: None

Learning Resources:

Textbooks: No designated textbook, but lecture notes will be provided.

Reference Books:

1. Bhujel, R.C. 2008. Statistics for aquaculture. Wiley-Blackwell. 376 p.
2. Gomez K.A., Gomez A.A., 1984. Statistical procedures for agricultural research, 2nd ed. John Wiley & Sons, United States, 704 p.
3. Zar, J.H., 2010. Biostatistical Analysis. 5th ed. Pearson, 960 p.

Journal and Magazines:

1. Aquaculture, ScienceDirect
2. Aquacultural Engineering, ScienceDirect
3. Aquaculture International, Springer
4. Journal of the World Aquaculture Society, Wiley
5. Aquaculture Research, Wiley
6. Aquaculture Nutrition, Wiley

Teaching and Learning Methods: Lectures, lab session and presentations (description attached)

Time Distribution and Study Load:

Lecture hours = 30 h
Lab session = 30 h
Group working = 15 h
Assignment = 15 h
Self-studies = 60 h.

Evaluation Scheme:

Working group report and presentation = 20%; Assignment = 20%; Mid-semester examination = 20%; and Final examination = 40%.

Students who display a thorough knowledge on concepts of statistics and experimental design during the examinations, and show excellent skills in interpreting statistical analysis and drawing conclusions in context (written report + presentations) are given an A grade, and those who display a good understanding and analytical skills are given a B grade. Grade C will be awarded for those who show below average knowledge and analytical skills on the subject matter, and the grade D will be given to students who show poor understanding/ analytical skills on the subject matters.

Instructor: Dr Nguyen P C Tu

Department Approval: _____

Faculty Approval: _____

University Approval: _____

Annexes:

1. **Needs Assessment**:
   One-page form to be developed and given to students on the first introductory class

2. **Lectures** – lecture notes, 3 hours each, PDF file of the lectures and also reference materials to be provided in advance via online (https://sites.google.com/a/hcmuaf.edu.vn/nguyentukts1972/lecture/thong-ke-sinh-hoc-ung-dung)

3. **Group discussions**
   - Topic / issues / problems
   - Group plan
   - Date and venue
   - Presentation & Report

4. **Laboratory work** – a lab session guidance with clear learning objectives to be prepared and provided to the students.
   - Methodology
   - List of equipment and materials
   - Reports to be submitted by students (format with deadline)

5. **Evaluation and Feedback**
   An evaluation form to be developed to give to the students to get feedback. Scoring methods for each chapter and teaching methods etc, and also open questions can be included what they like the most, what they did not like and what are missing.

FACULTY OF FISHERIES
NONG LAM UNIVERSITY-HO CHI MINH CITY, VIETNAM

Course title: Aquatic Animal Ecophysiology
Course code: AQUA6013 2(2-0)
Semester: April

Course Objective: This course provide knowledge of a biological discipline which studies the adaptation of organism's physiology to environmental conditions. Moreover, this subject also propose some aspects on using eco-physiological studies in pollution monitoring and predicting the effects of anthropogenic factors on aquatic animals' populations.

Learning Outcomes:

On completion of this course, students will be able to:

- Understand physiological characteristics of aquatic animals and their responses to environmental impacts.
- Apply water quality monitoring by deep-understanding of ecophysiology. Three categories of monitoring can be identified: (1) routine surface water monitoring, (2) periodic special surveys, and (3) special surveys performed to assess the extent of a pollution problem

Pre-requisite: Aquatic animal physiology, aquatic ecology

Course Outline:

I. **Bioenergetics: feed intake and energy partitioning**
1. Introduction
2. Basic principles
3. Factors influencing ingestion (R)
4. Factors influencing fecal losses (F)
5. Products of nitrogenous excretion (U)
6. Factors influencing metabolism (M)
7. Factors affecting growth and production (P)

II. **Biochemical correlates of growth rate in fish**
1. Introduction
2. Protein synthesis and growth
3. Perturbations in the general model
4. Protein synthesis and energy consumption
5. Free amino acids and protein turnover
6. Growth and its correlates in the tissues
7. Biochemical indices of growth rate
8. Linkage between aerobic enzymes and RNA
9. Body size effects on protein growth, synthesis and RNA concentrations
10. Temperature
11. Estimation of growth rate of fish in the North Sea

III. **Growth, reproduction and death in lampreys and eels**

1. Introduction
2. Lampreys
3. Eels
4. Discussion

IV. **Salmonid smolting: a pre-adaptation to the oceanic environment**

1. Introduction
2. Changes during parr-smolt transformation
3. Role of environmental factors
4. Conclusion

V. **Role of peptide hormones in fish osmoregulation**

1. Introduction
2. Growth hormone (GH)
3. Angiotensin II (ANGII)
4. Argininеb vasotocin (AVT)
5. Urotensins (UI and UII)
6. Vasoactive intestinal peptide n(VIP)
7. Natriuretic peptides

VI. **Environmental perturbations of oxygen transport in teleost fishes: causes, consequences and compensations**

1. Introduction
2. Hypoxia
3. Combined hypoxia-hypercapnia
4. Temperature
5. Salinity change
6. Effects of toxicants
7. Conclusions

VII. **Cardiovascular and ventilatory control during hypoxia**

1. Introduction
2. Chemoreceptors
3. Mechanoreceptors
4. Catecholamine release
5. Methods of studying ventilation in water-breathing animals
6. Ventilatory responses to hypoxia
7. Circulatory responses to hypoxia
8. Conclusions

VIII. **Acid-base regulation in response to changes of the environment: characteristics and capacity**

1. Introduction
2. Environmentally induced changes of the acid-base status
3. Characteristics of regulatory responses

4. Capacity of acid-base relevant ion-transfer mechanisms as a function of environmental conditions
5. Conclusions

IX. **Environmental effects on fish gill structure and function**
1. Introduction
2. Environmental ions
3. Morphological component to acid-base regulation
4. Environmental pH and oxygen

X. **Effects of water pH on gas and ion transfer across fish gills**
1. Introduction
2. Proton excretion
3. Effect of water pH on proton transport
4. Interactions between proton, carbon dioxide and ammonia excretion
5. Sodium uptake
6. Chloride uptake
7. Carbon dioxide transfer
8. Oxygen transfer
9. Ammonia excretion
10. Swimming performance

XI. **Endocrine responses to environmental pollutants**
1. Introduction
2. Adrenocortical response
3. Adrenergic responses
4. Prolactin
5. Thyroid response

XII. **Branchial mechanisms of acclimation to metals in freshwater fish**
1. Introduction
2. Effects of metals on gill morphology
3. ‘Shock’ phase
4. Branchial defenses against acute metal toxicity
5. Recovery and the origin of metal tolerance
6. Increased tolerance via decreased metal accumulation by the gills
7. Increased tolerance via increased metal storage and detoxification in gill tissue
8. Increased tolerance via increased resistance of metal-sensitive processes
9. Conclusions

XIII. **Phenotypic plasticity of fish muscle to temperature change**
1. Introduction
2. Muscle function and temperature
3. Temperature acclimation of swimming performance
4. Plasticity of muscle phenotypes
5. Muscle contractile properties

6. Muscle metabolism

XIV. **Recent advances in the ecophysiology of Antarctic notothenioid fishes: metabolic capacity and sensory performance**
1. Introduction
2. Respiration and metabolism
3. The cardiovascular system
4. The blood oxygen transport system
5. Responses to stress
6. Sensory ecophysiology of notothenioid fishes
7. Ecophysiology and evolution of notothenioid fishes

XV. **Ecophysiology of intertidal fish**
1. Introduction
2. The intertidal environment
3. Temperature
4. Osmoregulation
5. Respiratory adaptations

Case studies:
Assessment of the physiological characteristics of some aquatic species in estuaries.

Learning Resources:

Textbooks:
Fish Physiology, 1972. W.S. Hoar, David J. Randall. Academic Press, 558 pp.
Fish Ecophysiology, 2012. J.C. Rankin, Frank B. Jensen. Springer Science & Business Media, 421 pp.

Additional reading resources:
ATKINSON R. J. A. , PELSTER B. , BRIDGES C. R., TAYLOR A. C. & MORRIS S., 1987. Behavioural and physiological adaptations to a burrowing lifestyle in the snake blenny, Lumpenus lampretaeformis and the red band-fish, Cepola rubescens. J. Fish Biol. 31: 639-659
BRIDGES C. R., 1976. The respiratory physiology of Galathea strigosa (L) and Corystes cassivelaunus (Pennant). Ph. D. Thesis, University of Liverpool. pp 168.
BRIDGES C. R., 1979. Adaptations of Corystes cassivelaunus to an arenicolous mode of life. In:- "Cyclical phenomena in marine plants and animals". (ed. E. Naylor & R. G. Hartnoll). Proc. 13th Europ. Mar. Biol. Symp. Pergamon Press, Oxford. pp 317-324.
BRIDGES C. R. & BRAND A. R., 1980. The effect of hypoxia on oxygen consumption and blood lactate levels of some marine Crustacea. Comp. Biochem. Physiol. 65A: 399-409.
BRIDGES C. R. & BRAND A. R., 1980. Oxygen consumption and oxygen independence in marine crustaceans. Mar. Ecol. Prog. Ser. 2: 133-141.
BRIDGES C. R., 1993. The ecophysiology of intertidal fish. In: "Fish Ecophysiology" ed. C. Rankin & F. Jensen Chapman and Hall, London, pp. 375-400.

BRIDGES, C.R. (1993) Adaptation of vertebrates to the intertidal environment. In: " The vertebrate gas transport cascade: Adaptations to environment and mode of life" ed. E. Bicudo, CRC Press, Boca Raton, pp.12-22.
BRIDGES, C.R. (1997) Water/Air Transitions in Biology.(ed. B.Eddy, A.J.Mittal and D. Munshi) Academic Press Dehli, India (In Press)
BRIDGES, C. R. , TAYLOR, A. C. & ATKINSON, R. J. (1982) Respiratory properties of the blood of the burrowing Red Band fish, Cepola rubescens L. J. exp. Mar. Biol. Ecol. 59: 51-60.
BRIDGES, C. R. , TAYLOR, A. C. , MORRIS, S. J. & GRIESHABER, M. K. (1984) Eco-physiological adaptations in Blennius pholis (L.) blood to intertidal rockpool environments. J. exp. Mar. Biol. Ecol. 77: 151-167.
BRIDGES C. R., 1986. Environmental extremes - The respiratory physiology of intertidal rockpool fish and sublittoral burrowing fish. Zool. Beitrg. N.F. 30, 65-84.
BURNETT L. E. & BRIDGES C. R., 1981. The physiological properties and function of ventilatory pauses in the crab Cancer pagurus. J. Comp. Physiol. 145: 81-88.
BERSCHICK P., BRIDGES C.R. & GRIESHABER M.K., 1987. The influence of hyperoxia, hypoxia and temperature on the respiratory physiology of the intertidal rockpool fish Gobius cobitis Pallas. J. exp. Biol. 130: 369-387
BRIDGES C. R., 1988. Respiratory adaptations in intertidal fish. Amer. Zool. 28: 79-96.
BRIDGES C.R., BERENBRINK M., MÜLLER R. and WASER W., 1998. The Physiology and Biochemistry of the Pseudobranch - An Unanswered Question? Comp. Biochem. Physiol. 119A: 67-77.
HARDER V., SOUZA R.H.S., SEVERI W., RANTIN F.T. and BRIDGES C.R., 1997. Respiratory and cardiovascular adaptations in the South American lungfish – a paradox revisited. Experimental Biology Online 1997: 2 (suppliment) Abstract A13.4. The Society for Experimental Biology Annual Meeting General University of Kent at Canterbury 7-11 April 1997
HARDER V., PINTO-SILVA V. and BRIDGES C.R., 1998. Aspects of the respiratory physiology of the South American lungfish, Lepidosiren paradoxa - a field study. Experimental Biology Online 1998: 3 (supplement) Abstract A6.1. The Society for Experimental Biology Annual Meeting General University of York 23-27th March 1998
MARTIN K. & BRIDGES C.R., 1997. Respiration in Water and in Air In Intertidal Fish Ecology, Physiology and Behavior (Ed. Horn, Martin and Chotkowski) Academic Press, San Diego (In Prep)
PELSTER B., BRIDGES C.R. & GRIESHABER M. K., 1988. Physiological adaptations of the intertidal rockpool teleost Blennius pholis L. to aerial exposure. Respir. Physiol. 71: 355-374.
PELSTER B., BRIDGES C.R., TAYLOR A.C, MORRIS S. & ATKINSON R.J.A, 1988. Respiratory adaptations of the burrowing Marine Teleost - Lumpenus lampretaeformis (Walbaum) I. O2 and CO2 transport, acid base balance - A comparison with Cepola rubescens. J. exp. mar. biol. Ecol. 124: 31-42.
PELSTER B., BRIDGES C.R. & GRIESHABER MK., 1988. Respiratory adaptations of the burrowing Marine Teleost - Lumpenus lampretaeformis. II. Metabolic adaptations. J. exp. mar. Biol. Ecol. 124: 43-55.
PULLIN R. S. V., MORRIS D. J. , BRIDGES C. R. & ATKINSON R. J., 1980. Aspects of the respiratory physiology of the burrowing fish Cepola rubescens L. Comp. Biochem. Physiol. 66A: 35-42.
STEEGER H. U. & BRIDGES C. R., 1994. Respiration of the intertidal fishes Blennius pholis and Periophthalmus barbarus during simulated intertidal conditions. J. Fish Biol.47: 308-320.

Teaching and Learning Methods: Lectures, case studies, group working and presentations

Time Distribution and Study Load:

Lecture hours = 24 h.
Case study assignments presentation = 6 h.
Self-studies = 90 h.

Scoring Scheme:

Case Study report and presentation (group work) = 20%;
Individual assignment (home-work) = 30%;
Final examination = 50%.

Students will be scored using a 10-point basis for every work evaluation.
Who performs high satisfaction on the task requirement will be marked from 9 to 10; marks of 7-8 for moderate satisfaction; 6 for low satisfaction; 5 for just pass; 4 and below for fail.

Instructor: Dr Luu Thi Thanh Truc

Faculty Recommendation: _____ Post graduate Office Approval: _____

University Approval: _____

Annexes:

1. **Assessment**: Types of assignment and examination, and weight of assessment will be informed to students on the first introductory class

2. **Lectures:** Full lecture notes in form of PDF file will be provided in advance via online.

3. **Case study for group work and individual assignment**
   Topic / issues / problems will be given to students with specific requirements and deadline, venue. Presentation and report forms will also be informed.

4. **Videos**
   Selected videos showing molecular techniques will be played during class hours; the length of the videos may last form 5 to 15 minutes each.