AMB Course Syllabus

- 2017~2018 -

Faculty of Agriculture
**INDEX**

Timetable for AMB Course

AMB Course curriculum Taught in English

Introduction to Aquatic Production

Introduction to Natural and Agricultural Production

Modern Agriculture and Agricultural Science

Introduction to Physiology and Ecology

An Introduction to Bioindustrial Information Processing

Reading of Scientific Paper I

Reading of Scientific Paper II

Practice on marine Bio-resources Science

Physiology of Biological Resources

Animal Ecology and Ethology

Fish Genetics and Breeding science

Field Practice of Marine and Freshwater Production

Fishery Science Practice I, II

Basic Chemistry, Practice

Basic Biology, Practice

Aqua cultural Biology

Fisheries Biology and Ecology

Aquatic Plant Ecology

Marine Biochemistry

Biological Oceanography

Marine Biotechnology

Applied Genetics in Aquatic Organisms

Aquatic Invertebrate Biology

Applied Aquatic Botany

Marine Product Technology

Seafood management

Planktology

Integrate Aquatic Biology

Marine Applied Biochemistry

Introduction to Fisheries Science

Practical Training

Marine Biology

Current topics of Agriculture Plant Science

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## Timetable for AMB Course

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<th>General Education Subjects</th>
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### 2nd Semester - Fall Semester

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<td>情報基礎B An Introduction to Information Science B</td>
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<td>地球物質科学 Mineralogy, Petrology &amp; Geochemistry</td>
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<td>歴史と人間社会 History and Human Society</td>
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<td>化学A Chemistry A</td>
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<td>哲学の世界 World of Fine Arts</td>
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<td>生理生態学概論 Introduction to Physiology and Ecology</td>
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<td>体と健康 Health</td>
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### 3rd Semester - Spring Semester

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<td>生態動物生態学 Animal Ecology and Ethology</td>
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<td>数理統計学 Probability &amp; Statistics</td>
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<td>海洋生物学 Marine Biology</td>
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<td>水産科学概論</td>
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<td>水産科学総合実験</td>
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### 4th Semester - Fall Semester

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<td>水産化学 Marine Biochemistry</td>
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<td>科学論文講読 Reading of Scientific Paper</td>
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### 5th Semester - Spring Semester

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<td>Mon.</td>
<td>水産生態工程 Fishery Science Practice</td>
<td>Basic Chemistry, Practice</td>
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## 5th Semester - Spring Semester

### Intensive course

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### 6th Semester

**Fall Semester**

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**Spring Semester**

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### 7th Semester

**Fall Semester**

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**Spring Semester**

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### 8th Semester

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**Intensive course**

- 生産フィールド実習 Field Practice of Marine Production
- 海洋応用生物化学 Marine Applied Biochemistry

**Graduation Thesis**

- 畢業論文 Graduation Thesis
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**Subjects Instructors year Categories Credits Reference**
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<th>Categories</th>
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The minimum number of credits required for graduation is 134. The credits acquired in each semester (example) are as follows:

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<th>Elective*</th>
<th>Total</th>
<th>Comments</th>
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<td>2nd -3rd Semester</td>
<td>Obligatory: Including Practice on Marine Bio-resources Science</td>
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<td>(2)</td>
<td>21 or more elective credits must be acquired from among the 30 elective credits listed in parentheses.</td>
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<td>4th Semester</td>
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<td>Elective</td>
<td>16</td>
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<td>5th Semester</td>
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<td>6th -7th Semester</td>
<td>Obligatory: Including Field Practice of Marine Production</td>
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<td>21</td>
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**Graduation Requirements**

The minimum number of credits required for graduation is 134.

1. A minimum of 113 credits from obligatory subjects
2. A minimum of 21 credits from elective specialized subjects

**Minimum credits for graduation**

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<td>General Education Subjects</td>
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<td>Japanese Language</td>
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**Free Elective Specialized Subjects**

(These two subjects do not count towards the 134 minimum credits for graduation.)

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**Cooperative Innovation Program in Science, Engineering, and Agriculture for Leading Sustainable Industry and Society**

Those who enter FGL in 2015-2017 as government-sponsored students also belong to this program. In addition to the AMB curriculum, the government-sponsored students need to fulfill the requirements of this program as well. In order to receive the government sponsorship, the students are required to take the four subjects below:

1. Introductory Seminar (Interdisciplinary Seminar) [2 credits]
2. Life and Nature (Study of Nature, Life and Environment) [2 credits]
3. Science, Technology and Industry in Japan [1 credit]
4. Multidisciplinary Internship [1 credit]

— General Education Subjects
— Specialized Subjects
— Specialized Subjects

(Students must also take 30 credits from among the 49 credits listed above.)

<table>
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<th>Instructors</th>
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**General Education Subjects**

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Introduction to Aquatic Production (水圏環境コミュニケーション論)

Day/Period: Fri./4th
Object: AMB

Instructor (Post): Ikeda M. (Assoc. Prof.), Kurita Y. (Assist. Prof.)
Categories: Specialized Subjects
Preferable Participants: 1st-year students

Position: Faculty of Agriculture (Graduate School of Agricultural Science)
Credits: 1
Semester: 3

Subject Numbering: AAL-APS202B
Language Used in Course: English/Japanese

1. Class subject
   Biological productivity in aquatic zone and restoration from tsunami disaster

2. Object and summary of class
   Onagawa Town was one of the most prosperous fishing ports in Japan. However, the 9.0- magnitude Tohoku-Pacific Ocean Earthquake generated a tsunami as high as 15 meters in Onagawa, which caused the town to subside by 1 meter, and completely destroyed its central area. The ria coast of Onagawa and coastal region along the Pacific Ocean had been severely stricken by the tsunami. Various coastal organisms have acclimated to tsunami perturbations and survived in the area. In order to promote reconstruction of tsunami-stricken areas such as Onagawa with respect to aquatic production (fish catching, aquaculture and fishery processing), it might be a promising measure to scientifically focus on the adaptability of coastal ecosystems in the area against tsunami perturbations, and to raise public awareness of the uniqueness of the coastal ecosystems and biodiversity. This subject highlights tsunami damage and the circumstance of reconstruction in Onagawa Town including coastal ecosystems, and brings to understand the importance of constructing new relationship between natural biological productivity and human activity. Field lecture will be held on April in Onagawa Town with a two-day trip. Classroom lecture will be held on May or June at Aobayama Campus.

3. Keywords
   marine biodiversity, fisheries, aquaculture, tsunami disaster, reconstruction,

4. Goal of study
   At the end of the semester, students will
   - understand about tsunami disaster.
   - understand the importance of relationship between natural aquatic production and human activity.
   - understand sustainable biological productivity and the application to reconstruction of human society.

5. Contents and progress schedule of class
   • Introduction to studies of marine science, biological productivity and restoration
   • Field lecture about tsunami damage, the restoration of coastal ecosystems, and the circumstance of reconstruction in Onagawa Town (including Onagawa Field Center)
   • Class room lecture
   • Group discussion

6. Preparation
   For more information, note our announcement in the curriculum guidance during the first week of April.

7. Record end evaluation method
   • Attendance: 40%
   • Activeness: 20%
   • Report: 40%

8. Textbook and references
   Preparing textbook

9. Self study
   None

10. In addition
    Contact e-mail address:
        • Ikeda: minoru.ikeda.a6@tohoku.ac.jp
        • Kurita: yoshihisa.kurita.b7@tohoku.ac.jp
**1. Class subject**

**Ecosystems including forest, grassland, farmland, paddy field and biological productivity**

**2. Object and summary of class**

The purpose of the course is to get understanding of agronomical thinking and sustainable biological productivity through 1 day filed trip, classroom lectures and discussion time. Field trip will be held in May and the destination is the Integrated Terrestrial Field Station (Kawatabi in Naruko area). Classroom lecture will be held in May and June.

**3. Keywords**

agronomical science, integrated terrestrial field, ecosystem, environmental issues, animal waste treatment, grasslands, farmlands, soil science, forestry

**4. Goal of study**

At the end of the semester, students will
- experience about fundamental field science
- understand agronomical thinking
- understand sustainable biological productivity

**5. Contents and progress schedule of class**

1-5. Introduction to Agronomical science (Profs. of Field Science Center)
6. Field lecture about forest ecosystem (Profs. of Forest Ecology)
7. Field lecture about farmlands on hilly and mountainous area (Profs. of Environmental Crop Science)
8. Field lecture about grasslands, farm animals and environmental issues (Profs. of Land Ecology)
9. Field lecture about animal waste treatment, biogas production and recycling system (Profs. of Sustainable Environmental Biology)
10. Field lecture about andosol (volcanic ash soil) and environmental issues on farmland (Profs. of Environmental Crop Science)
11. Field lecture about management of animal feeding and animal welfare (Profs. of Land Ecology)
12. Field observations for integrated terrestrial field (Profs. of Field Science Center)
13. Group discussion (Profs. of Field Science Center)
14. Class room lecture about agriculture and ecosystem (Profs. of Field Science Center)
15. Class room lecture about spatial science and agronomy (Profs. of Field Science and Technology for Society)

**6. Preparation**

Read books related on agronomy, soil science, animal science, forest science and environmental science before the field trip.

**7. Record end evaluation method**

Attendance and participation for field trip (40%)
Attendance and participation for classes (30%)
Report about field trip (30%)

**8. Textbook and references**

URL: http://www.agri.tohoku.ac.jp/kawatabi/index.html

**9. Self study**

Write a report after the field trip. Write down what did you see, what did you feel. We welcome your consideration based on the group discussion.

**10. In addition**

Field trip will be held in May (Fri.), 8:00 - 18:30. Gathering Spot is Aobayama Campus (Faculty of Agriculture Building).
Please carry rain cape, protection against cold weather, insurance card and lunch to field trip.
E-mail address: chinatsu@m.tohoku.ac.jp
1. Class subject

Grasp of problems according to water, foods, energy, biomaterials, environment and health

2. Object and summary of class
The purpose of the course is to let participants understand and grasp the many agricultural problems such as water, foods, energy, biomaterials, environment and health through the unique lecture with laboratory tours. Students can go to more than 20 laboratories (about the half numbers of all lab. of our faculty) in the course to know and understand the characteristics of each laboratory’s state of education and research.
Students will increase knowledge step by step through explanation of stuffs and discussion with each others.

3. Keywords

4. Goal of study
At the end of the semester, students will
- have basic knowledge about the agricultural science including the academic field of plant science, animal science, fishery science, agricultural chemistry, food science at present stage in our faculty.
- have deeper understanding of the strategy for survival of humans in the future by utilizing the agriculture at high levels.

5. Contents and progress schedule of class
The education and research of our Faculty of Agriculture, and the Graduate School of Agricultural Science are operating in the six different fields of plant science, material environmental economy, applied animal science, marine bioscience, biochemistry and bioscience. In the lecture, we will explain the dairy situation in each laboratory including laboratory tours style.
Students will be separated into six groups and will take a lecture by stuffs of the lab. in the rotation system. Each student can visit one to four laboratories in one day.

1. Guidance “Introduction of agricultural sciences”
16. Examination

6. Preparation

7. Record end evaluation method
Students must be attend the laboratory tour more than 60% and take an examination (40%) of the last day.

8. Textbook and references
Textbook and references will be notified at the class.

9. Self study

10. In addition
Students who have some questions can visit to ask to each laboratory until 18:00 after lecture time.
Contact persons will be notified at the class.
Contact: skata@tohoku.ac.jp

2. Object and summary of class: A beginners course in the basics of physiology.
   Students will gain (for Animal Physiology) a broad basic knowledge of nervous and neuroendocrine organs and their functional organization; (for Plant Physiology) the basics of Plant Physiology, followed by recent examples of research in these areas.

3. Keywords: Nervous system, life functions, hormones, plant biodiversity, photosynthesis, immune systems

4. Goal of study: Learn the basics of physiology in order to be able to receive instruction in Applied Marine Biology specialist topics.

5. Contents and progress schedule of class
   (2). The nervous system. (1) Neuron structure & function.
   (3). The nervous system. (2) Sensory systems.
   (4). The nervous system. (3) Functional organization.
   (5). The endocrine system. (1). Cell signalling and endocrine regulation.
   (6). The endocrine system. (2). Oogenesis, spermatogenesis & fertilization.
   (7). The endocrine system. (3). Reproductive hormones.
   (8). The immune system.
   (9). Mid-term review and examination.
   (14). Plant body defences, environmental responses & information transmission.
   (15). End-of-term examination.

6. Preparation: Preparative studies, etc.: Before the course begins, skim through the textbooks and identify areas that you find difficult to understand. Aim to improve your understanding by the end of the course.

7. Record and evaluation method: Reports (90%). End-of-term examination (10%).


9. Self study: As appropriate. There is much to learn, so you should revise the lecture content in the evening after each lecture. Ensure you have understood the content and will be able to pass the examinations.

10. In addition: Note that this course is broad: later courses will explore these topics more deeply. Any questions, etc., should be addressed to the lecturer directly during or after lectures.
1. Class subject
   **Introduction to fundamentals of methods for processing biological sequence data**

2. Object and summary of class
   The first half deals with the methods for computing the similarity between two or more biological sequences, and the remaining half introduces various methods for other types of sequence processing.

3. Keywords
   - biological sequence, string, similarity, alignment, phylogenetic tree, gene mapping, short read assembly

4. Goal of study
   The goal is to understand the theoretical background with respect to validity or limitation of computer processing of biological sequences.

5. Contents and progress schedule of class
   1. Preliminaries
   2. Similarity between sequences
   3. Pairwise alignment (global alignment)
   4. Pairwise alignment (local alignment and alignment with affine gap penalty)
   5. Multiple alignment (star alignment)
   6. Multiple alignment (progressive method)
   7. Amino acid substitution matrix
   8. BLAST
   9. PSI-BLAST and HMM
   10. Phylogenetic tree (ultra-metric tree and additive tree)
   11. Phylogenetic tree (UPGMA and NJ method)
   12. Gene mapping
   13. Short read assembly (with reference sequence)
   14. Short read assembly (de novo)
   15. Suggested answers of the term paper

6. Preparation
   Prepare for the next lesson by conducting a Web search on the topic words related to the lesson.

7. Record end evaluation method
   Attendance: 20%
   Term paper: 80%

8. Textbook and references
   Recommended book:

9. Self study
   Review the previous lesson using the handout.

10. In addition
    Office hours: 16:30-18:00 Mon-Wed, and Fri at Room E410
    E-mail address: yoshifumi.sakai.c7@tohoku.ac.jp
### Subject
Reading of Scientific Paper I (科学論文講読 I)

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## 1. Class subject

**Reading scientific papers in English**

## 2. Object and summary of class

The purpose of the course is to let students understand the composition and critical reading of scientific paper.

## 3. Keywords

Critical reading, discussion

## 4. Goal of study

Students will

- have practical capability to read scientific paper in marine biology.
- have knowledge of technical terms on studying field of marine biology.

## 5. Contents and progress schedule of class

The course will be conducted by AMB laboratories.

- Students will take a class in each laboratory three to four times
- Scientific paper to read will be provided from each laboratory
- The format of a class follows an instruction of instructor of each laboratory

## 6. Preparation

Read the parts to be dealt in each class in advance.

## 7. Record end evaluation method

The academic achievement will be evaluated by attendance and understanding of class subject of each laboratory.

## 8. Textbook and references

Scientific paper to read will be provided by each laboratory in advance and students may be recommended to prepare well.

## 9. Self study

Read the related scientific articles in each field.

## 10. In addition

Students may visit the instructor of each class anytime.
1. Class subject

**Reading scientific papers in English**

2. Object and summary of class

The purpose of the course is to let students understand the composition and critical reading of scientific paper.

3. Keywords

Critical reading, discussion

4. Goal of study

Students will
- have practical capability to read scientific paper in marine biology.
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The course will be conducted by AMB laboratories.
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- Scientific paper to read will be provided from each laboratory
- The format of a class follows an instruction of instructor of each laboratory

6. Preparation

Read the parts to be dealt in each class in advance.

7. Record end evaluation method

The academic achievement will be evaluated by attendance and understanding of class subject of each laboratory.

8. Textbook and references

Scientific paper to read will be provided by each laboratory in advance and students may be recommended to prepare well.

9. Self study

Read the related scientific articles in each field.

10. In addition

Students may visit the instructor of each class anytime.
1. Class subject
**Observation of marine biodiversity and understanding the importance for sustainable productions.**

2. Object and summary of class
   To understand importance of marine biodiversity.
   (1) Field trip to the rocky intertidal area and observation of the biodiversity.
   (2) Observation of early development of marine invertebrates

3. Keywords
   - marine ecosystem, biodiversity, production, aquaculture

4. Goal of study
   Students will be able to understand the importance for marine biodiversity through the observation of species diversity and development of marine organisms.

5. Contents and progress schedule of class
   **Four days in 2nd semester (August)**
   - Days 1-2: Field trip to the rocky intertidal area and survey the biodiversity.
   - Days 3-4: Observation of early development of marine invertebrates.

6. Preparation
   For more information, note our announcement on June or July.

7. Record end evaluation method
   - Attendance: 40%
   - Activeness: 20%
   - Report: 40%

8. Textbook and references
   Preparing textbook

9. Self study
   None

10. In addition
    Contact e-mail address:
    - Ikeda: minoru.ikeda.a6@tohoku.ac.jp
    - Kurita: yoshihisa.kurita.b7@tohoku.ac.jp
1. Class subject: **Physiology of Biological Resources**

2. Object and summary of class
   
   This course provides a basic understanding of the principles of how animals stay alive and reproduce within an environment differing significantly from their internal state.

3. Keywords: Neuroendocrinology, reproduction, osmoregulation, immunology.

4. Goal of study: Describe the ways and means by which cells in a multicellular organism communicate to maintain the organism's integrity and ensure the production of a new generation. Describe the concept of homeostasis and its application in neuroendocrine regulation, osmoregulation and immunology.

5. Contents and progress schedule of class
   (1-4) Neuroendocrinology.
   (5-9) Endocrinology of reproduction.
   (10). Mid-term review.
   (11-12). Osmoregulation.
   Significance of the control of osmotic pressure and the function of the regulatory cells. Mechanisms of the hormonal control of osmoregulation.
   (13-14). Immunology.
   Natural immunity and the recognition and removal of foreign material from the body. Vertebrate and invertebrate immune systems.
   (15). End-of-term examination.

6. Preparation: Before attending each lecture, review the previous lecture and ensure you are ready to study.

7. Record and evaluation method: Long essay-style reports (90%). Attention and participation during lectures (10%).


9. Self study: This course covers a number of difficult topics and concepts - it is deep as well as broad. You should review each lecture at the end of the day and ensure that you have understood everything.

10. In addition: Contact the lecture any time if you have questions or any difficulty in understanding the course content.
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1. **Class subject**

   **Relationships among organisms and those between organisms and their environment as fundamental factors supporting biological production in nature.**

2. **Object and summary of class**

   More than 1500 thousand of organisms are recognized to live on the earth now. These numerous organisms maintain various interrelationships with surrounding organisms and its environmental factors, which may support biological production in nature.

   The present subject addresses fundamental concepts of ecology necessary to understand mechanisms of nature in each category of population, community, and ecosystem.

3. **Keywords**

   biological production, population, biological community, marine ecosystem, environment, interspecific relations

4. **Goal of study**

   Students can understand the structure and function of biological nature, and find an outline of the relationships between organisms and its environment.

5. **Contents and progress schedule of class**

   1. Species (binomial nomenclature, reproductive isolating, crossbreed)
   2. Clasification (five kingdoms, three domains) Biological production in each ecological category: producer, consumer, decomposer.
   3. Divergent evolution, natural selection
   4. Adaptation, Speciation, & Diversity
   5. Niche, fitness
   6. Interspecific relationships (competition, predation etc.), Gause's Law
   7. Population: definition, mode of life, population growth models, r-K strategy
   8. Category of interspecific relationships (competition, predation etc.), Gause's Law
   9. Concept of ecological niche, relationship between niche and competition
   10. Community theory, ecological succession, climax
   11. Structure and function of ecosystem
   14. Biological and physical cycle in nature
   15. Ecosystem service

6. **Preparation**

   Many books are published on ecosystem, environment, and bio-diversity, from which it is required to obtain various information about contemporary ecological problems.

7. **Record end evaluation method**

   Evaluation will depend on achievement of final examination. Furthermore, submissions of short term papers are required several times in the course.

8. **Textbook and references**


9. **Self study**

   Students should have concern over topics on nature and organisms shown in various media and consider their biological and ecological meanings.

10. **In addition**

    Office hour for inquiry about the course should be offered any time at the Laboratory of Fisheries Biology and Ecology.

    E-mail: skata@tohoku.ac.jp
1. Class subject

**Understand the basic theory of inheritance and the application methods for the genetic improvement in aquatic organisms**

2. Object and summary of class

In the aquatic organisms, not only genetics in individual level but also population level is important. Because, the position of conservation in genetic resources has very important in this subject. In this class, the basic theory of inheritance in individual level, population level, the basic theory of genetic improvement and the conservation of genetic resources will be explained and discussed.

3. Keywords

4. Goal of study

1) Understand the basic theory of genetics in both of individual and population level
2) Understand the theory of the application methods of genetics for the genetic improvement
3) Understand the basic theory of genetics for the conservation of genetic resources.

5. Contents and progress schedule of class

**Basic theory of inheritance**
1) Basic theory and various mode of inheritance
2) Genetic variations
3) Linkage and recombination
4) Basic theory of genetics in population
5) Genetic drift and inbreeding
6) Natural selection
7) Population structure and genetic diversity of population
8) Genetic markers for the analysis of populations and quantitative traits

**Basic theory of genetic improvement**
9) Basic theory of inheritance in quantitative traits
10) Heritability and breeding value
11) Basic theory of selection
12) Heterosis and hybrid vigor
13) Genetic improvement by recombinant DNA

6. Preparation

7. Record and evaluation method

Total results are evaluated by the final examination, reports and the results of the problems set at a lecture at each time.

8. Textbook and references

- Genetics for fish hatchery managers, D. Tave, An AVI Books, New York, 1992

9. Self study

10. In addition

The office will be opened from 10:00 AM to 05:00 PM to receive the question. The question is also received by e-mail, masamichi.nakajima.b6@tohoku.ac.jp
1. Class subject

**Practical field and experimental training for marine biodiversity.**

2. Object and summary of class
   To understand importance of marine biodiversity.
   (1) Observation and analysis of marine biodiversity.
   (2) Analysis of genetic diversity in marine organisms.
   (3) Comparative observation of early development and morphogenesis of marine invertebrates.

3. Keywords
   marine ecosystem, biodiversity, genetic diversity, early development, morphogenesis

4. Goal of study
   Students will be able to understand the importance for biodiversity in marine ecosystems through the observation of species/genetic diversity and development of marine organisms.

5. Contents and progress schedule of class

   **Five days in 4th semester (August)**
   - Days 1-2: Quantitative and qualitative of marine biodiversity.
   - Days 3-4: Observation of early development of marine invertebrates.
   - Day 5: Presentation

   **Five days in 6th semester (August)**
   - Days 3-4: Observation of morphogenesis of marine invertebrates.
   - Days 5: Presentation

6. Preparation
   For more information, note our announcement on June or July.

7. Record and evaluation method
   - Attendance: 40%
   - Activeness: 20%
   - Report: 40%

8. Textbook and references
   Preparing textbook

9. Self study
   None

10. In addition
   Contact e-mail address:
       - Ikeda: minoru.ikeda.a6@tohoku.ac.jp
       - Kurita: yoshihisa.kurita.b7@tohoku.ac.jp
1. Class subject

**Morphology, function and components of aquatic organisms, Analysis of substances in environment**

2. Object and summary of class

The purpose of the course is to let participants understand the taxonomy, constitution of body, function of aquatic organisms, the way to use analytical instruments and analysis of experimental data.

3. Keywords

Experiments, anatomy, microscopy, chemical analysis, statistics

4. Goal of study

Students will
- have basic knowledge for anatomical structure and components of aquatic organisms and analysis of environment.
- have deeper understanding of aquatic organisms and marine environment.

5. Contents and progress schedule of class

The course will be conducted by AMB laboratories.
- Anatomy of invertebrate and teleost
- Molecular biology and genetics
- Taxonomy of aquatic organisms
- Histology
- Physiology
- Analytical chemistry of environment and organisms
- Microbiology
- Ecology
- Statistic analysis

6. Preparation

Understand the materials and methods to be used in each class in advance.

7. Record end evaluation method

Students should attend every experiments and absence is not acceptable for any reason. Students should submit report of each by the deadline suggested in each experiment. The academic achievement will be evaluated by attendance and submitted report through entire period.

8. Textbook and references

Text for the course will be provided and students may be recommended to prepare well.

9. Self study

Refer to related books in the library for writing reports.

10. In addition

Students may visit the instructor of each experiment anytime.
### 1. Class subject
**Components of aquatic organisms, analysis of substances in environment**

### 2. Object and summary of class
The purpose of the course is for students to understand the body components of organisms and the procedures to extract and analyze chemical components in the environment.

### 3. Keywords
- Experiments, analysis, biogenic substances, chemical components

### 4. Goal of study
Students will:
- Have basic knowledge of biogenic substances from aquatic organisms and analysis of the environment.
- Have knowledge of experimental procedures.

### 5. Contents and progress schedule of class
The course will be conducted by AMB laboratories.
- Extraction and analysis of genetic material
- Analysis of components of seawater
- Evaluation of taste components
- Extraction and analysis of body components

### 6. Preparation
Understand the materials and methods to be used in each class in advance.

### 7. Record and evaluation method
Students should attend every experiment and absence is not acceptable for any reason. Students should submit a report on each theme by the required deadline. Academic achievement will be evaluated by attendance and grading of all reports submitted.

### 8. Textbook and references
Texts for the course will be provided.

### 9. Self study
Refer to related books in the library for writing reports. Prepare well before attending each practical.

### 10. In addition
Students may visit the instructor of each experiment any time.
1. Class subject
   **Body plan and function of aquatic organisms**

2. Object and summary of class
   The purpose of the course is to let students understand body plan and function of aquatic organisms studying on morphology, genetics, cell biology, physiology and statistic analysis.

3. Keywords
   Morphology, Genetics, Taxonomy, Cellular tissue

4. Goal of study
   Students will
   - have knowledge of basic biology
   - have knowledge of experimental procedure

5. Contents and progress schedule of class
   The course will be conducted by AMB laboratories.
   - Anatomy of fin fish
   - Genetics and analysis of polymorphism
   - Cell biology of aquatic plant
   - Histology of marine animals

6. Preparation
   Read textbook before the class and understand an outline of experimental procedure in advance.

7. Record end evaluation method
   Students should attend every experiments and absence is not acceptable for any reason. Students should submit report of each by the deadline suggested in each experiment. The academic achievement will be evaluated by attendance and submitted report through entire period.

8. Textbook and references
   Text for the course will be provided and students may be recommended to prepare well.

9. Self study
   Review the results of the experiment and summarize it in the report.

10. In addition
    Students may visit the instructor of each experiment anytime.
1. **Class subject**
   Underlying concept of aquaculture and overview of projects of representative aquaculture

2. **Object and summary of class**
   Restoration of natural fishery resources and growth of fish products is an urgent issue to be resolved in aquaculture. The purpose of this class is to let students understand the concept of aquaculture and specific aquaculture projects.

3. **Keywords**
   Teleost, Crustacea, Bivalve, Natural seed, Artificial seed

4. **Goal of study**
   Students will
   - cognize the importance of aquaculture for restoration and growth of fishery product.
   - have knowledge of specific issues on aquaculture.

5. **Contents and progress schedule of class**
   - Concept of aquaculture 1
   - Concept of aquaculture 2
   - Salmon 1 (life cycle)
   - Salmon 2 (artificial seed production and release)
   - Yellowtail 1 (life cycle)
   - Yellowtail 2 (natural seed collection and farming)
   - Flounder 1 (life cycle)
   - Flounder 2 (artificial seed production and release)
   - Kuruma Prawn 1 (life cycle)
   - Kuruma Prawn 2 (artificial seed production and farming)
   - Scallop 1 (life cycle)
   - Scallop 2 (natural seed collection and farming)
   - Oyster (natural seed collection and farming)
   - Chromosome manipulation and sex manipulation

6. **Preparation**
   Read textbook before the class and understand an outline of life cycle and aquaculture process of each animal in advance.

7. **Record end evaluation method**
   The academic achievement will be evaluated by report assigned in each lecture.

8. **Textbook and references**

9. **Self study**
   Read again textbook based on the information learned at the class and review the knowledge of aquaculture.

10. **In addition**
    Students may visit the office or contact via Email (makoto.osada.a8@tohoku.ac.jp) anytime. URL of the lab “Aquacultural Biology”: http://www.agri.tohoku.ac.jp/zoshoku/english.html
1. Class subject
Life history of marine resources, biology, population dynamics and methodology of population analysis.

2. Object and summary of class
Characteristics of marine organisms are tempo-spacio fluctuations and reproduction. Especially marine resources are affected by not only environmental condition but also fishing pressure. In this lecture, after short review of world and Japanese fisheries production, life history traits and fluctuating patterns of populations are explained. Methodology of stock assessment and population are also mentioned for the fisheries management.

3. Keywords
Fish biology, life history strategy, Fisheries, Population analysis

4. Goal of study
To understand the biological characteristics of marine resources and to learn theoretical and technical methods for marine biology, stock assessment and fisheries management.

5. Contents and progress schedule of class
1. Status of world and Japanese fisheries production
2. Stock identification and population structure
3-4. Ichthyology (External and internal morphology)
5-8. Life history (Age and growth, life cycle, migration, maturing and spawning, early life history, mortality and survival)
9. Patterns of population dynamics
10-11. Data analysis and stock assessment
12-13. Surplus yield model and yield per recruit model
14. Cohort analysis
15. Fisheries management

6. Preparation
There are no particular prerequisites for this course. Basic biology capabilities will ease the learning.

7. Record end evaluation method
Score of an end-of-term exam and attendance

8. Textbook and references
Marine Fisheries Ecology, Jennings et al., 2001 Wiley-Blackwell
Fishes: An Introduction to Ichthyology, Moyle and Cech, 2004 Pearson Prentice Hall
Fisheries Biology, Assessment and Management, M. King, 2007 Wiley-Blackwell

9. Self study
Please do not lose teaching documents and your class note for the final exam.

10. In addition
Contact: skata@tohoku.ac.jp
1. Class subject

Interaction between herbivores and marine plants in coastal rocky bottoms

2. Object and summary of class

This course provides reproduction, grazing activity, population dynamics of herbivores associated with marine forest. Students will learn marine forestation, and management and enhancement means of sea urchin and abalone stocks associated with their ecological characteristics.

3. Keywords

Kelp forest, Sea urchin, Barren, Grazing, Population dynamics, Production, Rocky subtidal ecosystem, Global warming

4. Goal of study

The goal is to understand how sea urchin and abalone maintain their population associated with seaweed beds and how enhancement means of seaweed, sea urchin and abalone were developed on the basis of biological and ecological knowledge.

5. Contents and progress schedule of class

1. Structure and function of marine forest (Oct. 3, 10)
2. Reproduction of herbivore (Oct. 17)
3. Growth and gonad production of herbivore (Oct. 24)
4. Grazing activity (Oct. 31, Nov. 7)
5. Chemical defense of seaweeds (Nov. 14)
6. Mechanisms of population maintenance and fluctuation (Nov. 21)
7. Effects of sea urchin grazing on rocky subtidal communities (Nov. 28, Dec. 5)
8. Restoration of “barren” (Dec. 12)
9. Effect of ocean warming and acidification on rocky subtidal communities (Dec. 19, 26)
10. Development of enhancement means of sea urchin and abalone (Jan. 9, 16)

6. Preparation

7. Record and evaluation method

Examination, report and attendance

8. Textbook and references

Reference texts:

9. Self study

Review is required.

10. In addition

Questions, comments, and requests are accepted. Send them to Professor Agatsuma: yukio.agatsuma.c7@tohoku.ac.jp
Office hour: Tuesday 16:00–18:00 in Professor room of Laboratory of Marine Plant Ecology
1. Class subject

**Biochemical characterization of aquatic organisms and seafood**

2. Object and summary of class

The organisms inhabiting in the ocean have unique components to adapt to and survive in the environment. To utilize effectively the limited bioresources, it is essential to understand the chemical components of fish and other marine organisms and their postmortem changes. While marine organisms show beneficial effects on human health, some of them possess toxic substances and some microorganisms and parasites are responsible for food poisoning. To maximize the benefits of seafood, marine organisms should be thoroughly understood.

The class deals with the biochemical, nutritional and functional properties of the components in the organisms and the mechanisms of postharvest deterioration and health improvement. The other related topics will also be introduced.

3. Keywords

Seafood, chemical components, nutrients, physiological functions, food processing, effective utilization

4. Goal of study

To get the sufficient knowledge about the characteristics of marine organisms for biochemical viewpoint.
To understand the beneficial effects and hazardous aspects of seafood as well as the theories for preservation

5. Contents and progress schedule of class

1: Biochemical characteristics of marine organisms
2: Proximate composition of seafood
3: Proteins
4: Lipids
5: Carbohydrates
6: Vitamins
7: Minerals
8: Extractives
9: Color and flavor
10: Physical properties
11: Functional substances
12: Natural toxins and food poisoning
13: Freshness and shelf life of fish and shellfish
14: Postmortem changes in muscle
15: Report writing

6. Preparation

Collect the related information in the library and through the web

7. Record end evaluation method

Based on the final report (50%), homework (20%) and class attendance (30%).

8. Textbook and references

Flick & Martin: Advances in seafood biochemistry - composition and quality, Technomic Pub., 1992

9. Self study

Read related papers published in recent years.

10. In addition

Handouts will be provided for each class.
Questions are welcome. Please feel free to step in during the office hours (after each class).
1. Class subject
   **Review marine environment and adaptive ecology of pelagic organisms that evolved in the oceans.**

2. Object and summary of class
   Deepen understanding of the production of plankton that live in vast and deep ocean environment based on physical and chemical characteristics of the ocean.

3. Keywords
   physics, chemistry, biology, ecology, productivity, global warming

4. Goal of study
   Understand pelagic environment of the oceans and adaptation of its inhabitants, regional differences, and biological oceanographic basis that support fish production

5. Contents and progress schedule of class
   1, 2: History of Biological Oceanography
   3-5: Physical environment
   6-8: Chemical environment
   9: Primary production in the oceans
   10: Secondary production in the oceans
   11: Relationship between phytoplankton and zooplankton
   12-14: Marine plankton and global environment
   15: Current topics on Biological Oceanography

6. Preparation
   Acquire basic knowledge on oceans and organisms living in them.

7. Record end evaluation method
   short tests and term-end test

8. Textbook and references

9. Self study
   Understand cause and effect of phenomena taught in class.

10. In addition
    Office hours are from 11:00 to 16:00 on Wednesdays.
    Agricultural Research and Administration Facility, Room No. S305
    mail address: yoshinari.endo.e2@tohoku.ac.jp
1. Class subject
   1. Techniques of molecular biology
   2. Developmental engineering in fish
   3. Marine biotechnology for aquaculture
   4. Computer practice

2. Object and summary of class
   In this class, students will learn about developmental biology of fish, molecular engineering in fish, and bioinformatics using computer and web sites.

3. Keywords
   Fish development, genome, genome editing, bioinformatics, cellular multipotency

4. Goal of study
   Students will understand the fundamental issues of genetic engineering and genomics in fish, and bioinformatics necessary for future researches in the fields of marine biotechnology.

5. Contents and progress schedule of class
   1-2: Embryonic development in fish
   3-4: Forward genetics (Mutant library, Positional cloning)
   5-6: Reverse genetics (Knockout fish, TALEN, CRISPR/Cas9)
   7: Other basic techniques essential for fish biotechnology
   8: Fish genomes
   9-12: Practical training using computer (BLAST search, Multiple alignment, Phylogenetic tree, PubMed, Ensembl)
   13-14: Larval and metamorphic development
   15: Transgenic fish

6. Preparation
   Since texts for next week are passed, students should read them before class.

7. Record and evaluation method
   Attendance and test

8. Textbook and references
   Reference Books:
   Gene Cloning & DNA Analysis; An Introduction. By Brown TA. Willey-Blackwell
   Recombinant DNA; Genes and Genomics – A Short Course. Watson JD. W. H. Freeman and Company
   Developmental Biology. Gilbert SF. Sinauer Associates

9. Self study
   Students are recommended to read above textbooks.

10. In addition
   1. Office hour: Questions are accepted after class, or by e-mail. Students can also visit my office for questions and discussion.
   3. E-mail address: toru.suzuki.a8@tohoku.ac.jp
<table>
<thead>
<tr>
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1. Class subject

**Conservation and sustainable yield of marine bio-resources**

2. Object and summary of class

A variety of marine bio-resources have inhabited in the coastal areas. These are important food resources and also reproductive resources. Considering a conservation and sustainable yield of them, though ecological and physiological studies are important, genetic studies should be quite important for future.

In the present lecture, I will explain the importance of applied genetics for future managements of marine bio-resources by using actual scientific research in my laboratory.

3. Keywords

- marine organisms
- genetics and breeding science
- population structure
- conservation, aquaculture

4. Goal of study

Understanding the present condition of marine production in coastal area of Japan. Also, through the lecture, ability of consideration and problem solving are required.

5. Contents and progress schedule of class

1st to third: the history of fisheries and how to change the concept of marine production in Japan
4th to 5th: Basic of genetics for production and conservation of marine resources
6th to 14th: Actual examples of genetic studies on aquatic resources for conservation and production.
    Example: genetic studies of crucian carp (named Tetsugyo), freshwater shrimp (*Palaemon pausidens*), Pacific abalone (*Haliotis discus hannai*), and Sea cucumber (*Palastichopus japonica*)
15Tth: Future aspects for conservation and production of marine bio-resources.

6. Preparation

No need but you should survey the technical terms in the lecture and write on your note book.

7. Record end evaluation method

Examination and Reports

8. Textbook and references

Directing on the lecture

9. Self study

10. In addition

When you have a question, please contact me by e-mail.

  e-mail address: minoru.ikeda.a6@tohoku.ac.jp
1. Class subject

On the invertebrate animals distributed in aquatic environments, basic physiology, especially immunology and feeding behavior, digestive and circulatory systems and life history will be outlined.

2. Object and summary of class

To learn the innate immune systems in marine invertebrates involved in basic innate immune systems, molecular and cellular host defense and apoptosis of immune cells.
To learn trained immunity of aquatic invertebrates based on host-parasite coevolution.
To understand structures of digestive organs, and feeding and digestive mechanisms of bivalve mollusks.
To understand structures of heart and vessels, and circulatory system of bivalve mollusks.

3. Keywords

Aquatic invertebrates, Innate immunity, Host defense, Apoptosis, Digestive organs, Circulatory systems

4. Goal of study

Understanding the basic sciences in relation to immunology, feeding behavior and life history of aquatic invertebrates.

5. Contents and progress schedule of class

1st: Guidance
2nd: Innate Immunity in Invertebrates 1: general theory
3rd: Innate Immunity in Invertebrates 2: host defense in mollusks
4th: Innate Immunity in Invertebrates 3: host defense in crustaceans
5th: Innate Immunity in Invertebrates 4: trained immunity of mollusks: model for host-parasite coevolution
6th: Apoptosis; a type of programmed cell death 1: general theory
7th: Apoptosis; a type of programmed cell death 2: hemocytes of mollusks
8th: Simple examination on cellular immunity and apoptosis (Exam 1)
9th: Feeding mechanisms of bivalve mollusks 1
10th: Feeding mechanisms of bivalve mollusks 2
11th: Digestion and nutrition in bivalve mollusks 1
12th: Digestion and nutrition in bivalve mollusks 2
13th: Circulatory system of bivalve mollusks 1
14th: Circulatory system of bivalve mollusks 2
15th: Simple examination on feeding and digestion (Exam 2)

6. Preparation

You should study basic biology, especially immunology and molluscan biology, prior to class studying.

7. Record end evaluation method

Attendance point: 300 points (20 points per one lecture time; 15 times)
Examination point: 200 points (100 points per one exam)
AA=90-100%; A=80-89%; B=70-79%; C=60-69%; D=below 60%

8. Textbook and references


9. Self study

You can study yourself to use textbooks (shown as above) getting for general knowledge of this class. These textbooks are owned by the library of Tohoku University. You can use these one.

10. In addition

E-mail: waradica@tohoku.ac.jp
Office hour: 13:00-15:00 of Tuesday and Wednesday.
1. Class subject

**Concepts and methods for the study of marine plant life**

2. Object and summary of class

Marine algae are the major primary producers at the marine coastal areas, but most of us know little about them. Object of the class is to understand the concepts and methods for the study of marine plants such as algae and seagrasses. In this series of lectures, firstly, we will try to understand the basic characteristics of marine plants. Second, the patterns in the geographical and vertical distributions of marine algae will be discussed. Next, we will overview the studies on the population and community aspects of marine plants. Analytical methods of population dynamics and the details of plant-animal interactions will also be discussed. In addition, some topics in seaweed mariculture and marine pollution will be shown. Finally, monitoring methods of marine plant communities and the actual application of them will be introduced.

3. Keywords

4. Goal of study

For students to be able to understand the basic ideas and methods for the study of marine plants.

5. Contents and progress schedule of class

- (1) At the beginning: all about WAKAME: *Undaria pinnatifida*
- (2) Geographical distribution of marine algae
- (3) Vertical distribution of marine algae: intertidal zone
- (4) Vertical distribution of marine algae: subtidal zone
- (5) Primary production of coastal marine plants-1
- (6) Primary production of coastal marine plants-2
- (7) Population analysis of marine plants-1
- (8) Population analysis of marine plants-2
- (9) Dispersal ability of marine plants
- (10) Plant-animal interactions in benthic algae communities
- (11) Mariculture
- (12) Pollution
- (13) Monitoring survey of marine plant communities
- (14) Final examination

6. Preparation

7. Record and evaluation method

Attendance rates and test scores will be recorded and evaluated.

8. Textbook and references

Handouts will be available at the beginning of each lecture.

9. Self study

10. In addition

Office phone number: 022-757-4152
Mail address: m-aoki@m.tohoku.ac.jp
### Class subject

The biochemical characteristics of marine resources and the methods for their effective utilization

### Object and summary of class

We will learn the biochemical characteristics of marine organisms as foodstuffs. We will understand the principle of production of seafood, and their processing methods.

We will have an accurate knowledge of the quality control of marine foodstuffs and seafood. So we will understand the role of marine organisms as resources for food.

And we will also learn the function of seafood for human health and the characteristics of seafood for medicinal and industrial materials.

### Keywords

Food preservation technique, Freezing and thawing technique, Postmortem change of fish,

### Goal of study

We will understand the principles and the methods of food processing, and the controls of food qualities. We will obtain the knowledge for the effective utilization of marine resources.

### Contents and progress schedule of class

1. Marine resources for food
2. Characteristics marine processing foods
3. Processing principals of typical seafood
4. Food poisonings related to seafood
5. Function of marine lipids
6. Biochemical substances from marine organisms for medicinal and industrial materials

### Preparation

It is desirable that you take a lecture on Marine Biochemistry

### Record end evaluation method

Our final grade will be calculated according to the following process: Mid-term reports and examination (40%), term-end examination (60%), and a fraction of in-class contribution.

### Textbook and references


### Self study

10. In addition
1. Class subject: **Seafood Management**.

2. Object and summary of class: Understand the features of seafood quality and its management with regard to maintaining the safety of seafood.

3. Keywords: Hygiene, HACCP, diseases, food safety, problems with seafood, legal and international issues

4. Goal of study: Explain the problems of management methods for quality and hygiene management of seafood at each stage, from harvest to the consumer's table. Describe the features of seafood quality. State the methods of maintaining quality in terms of safety. State relevant regulations and public laws for maintaining seafood quality and safety. Describe the essential points of quality management under the HACCP system.

5. Contents and progress schedule of class
   (1). Introduction. Seafood and seafood processing.
   (2). Chemistry: components of seafood affecting colour, taste and smell.
   (3). Harmful chemical substances affecting food safety (incl. histamine, etc.); harmful physical substances (foreign objects).
   (4). Harmful biological substances (1) Parasites.
   (5). Harmful biological substances (2) Bacterial & fungal infections, listeriosis, etc. [Report]
   (7). Hygiene principles.
   (8). Review of seafood-related issues.
   (9). Seafood management (1): Seafood handling regulations, legislation and public laws on seafood hygiene.
   (10). Basic seafood handling: visit to Ishinomaki Fish Landing and Market. [Report].
   (12). Practice of seafood management: visit to Sendai City Fish Market. [Report].
   (13). Seafood management (3): The HACCP system.
   (14). Practice of HACCP: visit to a food processing company. [Report].

6. Preparation: Review the previous lecture before attending the next.

7. Record end evaluation method: In-depth reports (90%). Attendance and attention during lectures (10%).

8. Textbook and references

9. Self study: The reports require careful and detailed writing, and they will be assessed in particular for their scientific approach. You must write in the context of demonstrating clearly what you have learned during lectures.

10. In addition Landing and first sales point (visit to a fishing port). Management at the resource level.
### Subject

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<thead>
<tr>
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<tr>
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### 1. Class subject

**Systematics and biology of marine plankton**

### 2. Object and summary of class

An introduction to systematics, physiology, and ecology of marine plankton

### 3. Keywords

Diatom, flagellate, ciliate, jelly fish, copepod, krill, food chain, microbial food web, vertical migration

### 4. Goal of study

Understanding structure and role of plankton community in marine ecosystem

### 5. Contents and progress schedule of class

- Definition of plankton (1)
- Historical development of planktology (1)
- Marine environmental characteristics (1)
- Systematics and biology of marine phytoplankton (3)
- Systematics and biology of marine zooplankton (4)
- Characteristics of primary production in the ocean (1)
- Characteristics of secondary production in the ocean (1)
- Vertical migration in zooplankton and its ecological role (1)
- Current topics in marine plankton (2)

### 6. Preparation

Basic knowledge of biology and ecology, basic understanding of marine ecosystem

### 7. Record and evaluation method

Presence/absence evaluation & examination

### 8. Textbook and references

Biological Oceanography: An Introduction, second edition  
Lalli and Parsons, 1997, ELSEVIER Butterworth-Heinemann

### 9. Self study

Fisheries Science

### 10. In addition

Contact email address: wsokoshi@tohoku.ac.jp

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<table>
<thead>
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<th>Planktology (プランクトン学)</th>
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### 1. Class subject

**Elementary knowledge for diversity of aquatic organisms based on genetics, evolutionary biology, ecology.**

### 2. Object and summary of class

This course is intended to provide a framework for the study of aquatic organisms, the foundation upon which all other courses in AMB will build. Using evolution as central organizing principle, we will examine the material and processes of inheritance, the forces that drive biological diversification, and the patterns and phenomena that result from these processes.

### 3. Keywords

- genetics, evolution, ecology, marine biodiversity, diversification, conservation

### 4. Goal of study

Students will be able to gain the synthetic concept for conservation and utilization of aquatic organisms based on genetics, evolutionary biology, ecology and physiology.

### 5. Contents and progress schedule of class

1. Introduction
2. Genetics (I)
3. Genetics (II)
4. Genetics (III)
5. Genetics (VI)
6. Evolution (I)
7. Evolution (II)
8. Evolution (III)
9. Evolution (VI)
10. Evolution (V)
11. Form and Function (I)
12. Form and Function (II)
13. Interaction with the Environment (I)
14. Interaction with the Environment (II)
15. Interaction with the Environment (III)

### 6. Preparation

None

### 7. Record end evaluation method

- Attendance: 10%
- Activeness: 10%
- Final Exam: 80%

### 8. Textbook and references

Preparing textbook

### 9. Self study

None

### 10. In addition

Contact e-mail address:
Ikeda: minoru.ikeda.a6@tohoku.ac.jp
<table>
<thead>
<tr>
<th>Subject Numbering</th>
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<td>M. Nishikawa</td>
<td>Faculty of Agriculture (Graduate School of Agricultural Science)</td>
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1. Class subject

2. Object and summary of class

3. Keywords

4. Goal of study

5. Contents and progress schedule of class

Further details of this subject will be announced later.

6. Preparation

7. Record end evaluation method

8. Textbook and references

9. Self study

10. In addition
1. Class subject

**Introduction to Fisheries Science**

2. Object and summary of class

This course provides an overview of the fishery science. Students will learn the fishery science on the basis of marine biology in a broad sense from molecules to ecosystems.

3. Keywords

Fisheries science, basics & outlines

4. Goal of study

The goal is to understand the fishery science basically from ecology, physiology, genetics, molecular biology and evolution, and to appreciate the fishery science as the applied marine biology.

5. Contents and progress schedule of class

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<thead>
<tr>
<th>Topics on marine ecology and oceanography</th>
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<tr>
<td><strong>Lab Marine Plant Ecology</strong></td>
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<tr>
<td>Oct. 6 ---- “Introduction to rocky subtidal communities” (Y. Agatsuma)</td>
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<tr>
<td>Nov.10 ---- “The ecology of floating seaweeds” (M. Aoki)</td>
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<tr>
<td><strong>Lab Fisheries Biology &amp; Ecology</strong></td>
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<tr>
<td>Oct. 20 ---- “How to know the fish age” (S. Katayama)</td>
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<tr>
<td>Oct. 27 ---- “How to know the fish migration” (S. Katayama)</td>
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<tr>
<td><strong>Lab Biological Oceanography</strong></td>
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<tr>
<td>Oct. 13----“Marine environment for marine organisms” (W. Sato-Okoshi)</td>
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<tr>
<td>Nov.17 ---- “Plankton and benthos in the ocean” (W. Sato-Okoshi)</td>
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<tr>
<th>Topics on biology and biochemistry of aquatic organisms</th>
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<tr>
<td><strong>Lab Aquacultural Biology</strong></td>
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<td>Nov. 24 ---- “Manipulation of reproduction in bivalve mollusks” (M. Osada)</td>
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<tr>
<td>Dec. 1 ---- “Immunity in marine invertebrates” (K. Takahashi)</td>
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<td><strong>Lab Marine Biochemistry</strong></td>
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<td>Dec. 8 ---- “Function of marine lipids” (T. Yamaguchi)</td>
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<tr>
<td>Dec. 15 ---- “Food chemistry of fish and shellfish” (Y. Ochiai)</td>
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<table>
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<th>Topics on fish genetics and biotechnology</th>
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<td><strong>Lab Marine Life Science &amp; Genetics</strong></td>
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<tr>
<td>Dec. 22 ---- “Fish development and biotechnology“ (T. Suzuki)</td>
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<tr>
<td>Jan. 5 ---- “Genetic conservation and sustainable use of resources in aquatic organisms“ (M. Nakajima)</td>
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<td><strong>Lab Integrative Aquatic Biology</strong></td>
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<td>Jan. 12 ---- “Conservation genetics for fishery resources -1” (M. Ikeda)</td>
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<tr>
<td>Jan. 19 ---- “Conservation genetics for fishery resources -2” (A. Kijima)</td>
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6. Preparation

Refer to the recent topics in each field.

7. Record end evaluation method

Attendance and report. The report should be directly submitted to the instructor of each lecture by the next lecture.

8. Textbook and references

No textbook. Reference books will be introduced.

9. Self study

Summarize the content of each class promptly.

10. In addition

Questions, comments, and requests accepted.

Send them to the representative instructor, Prof. Agatsuma: yukio.agatsuma.c7@tohoku.ac.jp
1. Class subject

**Practical training at the point of fishery production and research**

2. Object and summary of class

This course provides the tours at the point of fishery production and research. Students will learn fisheries science practically.

3. Keywords

Field trip, investigative tour

4. Goal of study

The goal is to increase awareness of students to learn fisheries science.

5. Contents and progress schedule of class

This course provides the practical tours as below:

1. Research institute of fishery
2. Marine food company
3. Fish market
4. Aquarium
   etc.

6. Preparation

Collect information before starting each tour.

7. Record end evaluation method

Attendance and report. The report should be submitted by the designated deadlines.

8. Textbook and references

No textbook. Reference books will be introduced

9. Self study

Refer to related books in the library after each tour.

10. In addition

Questions, comments, and requests accepted. Send them to the representative instructor, Prof. Ochiai: yochiai@tohoku.ac.jp
1. Class subject: Marine Biology: **Taxonomy and biodiversity of marine plants and animals.**

2. Object and summary of class: Survey the different types of organisms in the sea, providing a basic understanding of marine biodiversity, emphasizing those organisms exploited by Man.

3. Keywords: Marine biodiversity, plankton, Ecdysozoa, Lophotrochozoa, Phylogenetics, Fisheries species, Identification

4. Goal of study: Describe the main types of living organisms and, for animals, the basic types of body plan for, and distinguishing features of, the major groups of marine life, particularly those exploited for fisheries and aquaculture.

5. Contents and progress schedule of class
   Each lecture will provide basic information about the different groups of marine organisms, relating form and function. Students are expected to build up a file of comprehensive notes on the special features of each group and the characteristics of specific organisms, ready to supplement practical work on surveying and identifying locally available species. Groups not covered during this course will be dealt with in the courses Life & Nature, Planktonology and in Basic Seminars.
   (1). Introduction. Marine organisms and the food web; producers, consumers, detritivores; the major groups & their spatial and bathymetric distributions; solar-dependent and solar-independent (hydrothermal) systems.
   (2). Plants. Phytoplankton: major groups & their characteristics. Macrophytic seaweeds.
   (6). Crustacea (3) Parasitic forms.
   (8). Mollusca (1) Monoplacophora, Polyplacophora, Scaphopoda, Bivalvia.
   (9). Mollusca (2) Cephalopoda.
   (10). Echinodermata.
   (11). Chaetognatha, Hemichordata, Urochordata, Cephalochordata.
   (15). Review and discussion. Final submission of reports and notes file.

6. Preparation: Read what you can about different kinds of marine life.

7. Record and evaluation method: Reports (90%). Notes file (10%).


9. Self study: The course is very intensive. In order to learn efficiently, it is important to review each lecture in the evening when you return home, otherwise you will forget what you have learned. You are required to write nine reports. These must be handed in on schedule, otherwise you may not pass the course.

10. In addition
    You do not need to buy the textbooks. You will have access to these during the course.
1. Class subject

Professors and associate professors in Course of Plant Science introduce current topics of agricultural plant science.

2. Object and summary of class

The purpose of this class is to enhance students' interests on crop science, horticultural science, soil science, plant pathology, plant breeding and genetics, insect science and bioregulation, environmental plant biotechnology, environmental crop science and forest ecology.

3. Keywords

Crop, Plant, Soil, Insect.

4. Goal of study

The goal of this course is for students to understand and broaden the knowledge of agricultural plant science, and to have great interests in our studies on plant production science, environmental plant biotechnology, and applied plant science. Students will want to study in our course of Graduate School of Agricultural Science.

5. Contents and progress schedule of class

Each week there will be lectures and discussions of the following topics:

1) Introduction (Prof. Konno)
2) Basic entomology (Prof. Konno)
3) Crop science (Prof. Homma)
4) Horticultural science-1 (Prof. Kanayama)
5) Horticultural science-2 (Assoc. Prof. Kato)
6) Soil science (Assoc. Prof. Kanno)
7) Plant pathology-1 (Prof. Takahashi)
8) Plant pathology-2 (Assoc. Prof. Ando)
9) Plant breeding and genetics (Assoc. Prof. Kitashiba)
10) Insect science and bioregulation (Assoc. Prof. Hori)
11) Environmental plant biotechnology-1 (Prof. Toriyama)
12) Environmental plant biotechnology-2 (Assoc. Prof. Ito)
13) Environmental crop science (Assoc. Prof. Ito)
14) Forest ecology-1 (Prof. Seiwa)
15) Forest ecology-2 (Assoc. Prof. Suyama)

6. Preparation

Briefly understand each field on the website below.

7. Record end evaluation method

Attendance (30%), class participation (30%), and report (40%).

8. Textbook and references

http://www.agri.tohoku.ac.jp/en/about/organization/faculty/index.html

9. Self study

Study the above website in detail and understand the contents of research in each field. If you want to study in more detail, ask each faculty for reference books.

10. In addition

Contact: Prof. Yasuhiko Konno
E-mail: Yasuhiko.konno.e8@tohoku.ac.jp
Office: Room E406
1. Class subject: Introduction to Applied Animal and Dairy Science

2. Object and summary of class:
   This class object is to study the basic concepts of applied animal and dairy science. More than ten Professors and Associate Professors will give the lectures weekly to introduce their specific research fields.

3. Keywords:

4. Goal of study:
The goal of this class is to obtain the background knowledge about animal and dairy science including comparative physiology, anatomy, nutrition, genetics, reproduction, animal product, immunology, microbiology, environment biology, and animal behavior.

5. Contents and progress schedule of class:
   1) Overview of Animal Reproduction (Prof. Kentaro Tanemura, Assoc. Prof. Kenshiro Hara)
      Major interest is to elucidate the physiological mechanism controlling reproduction and development in mammals and to develop biotechnology in reproduction of domestic, laboratory and endangered animals.
   2) Overview of Animal Nutrition (Prof. Masaaki Toyomizu)
      Introduction to metabolism of protein, fat and carbohydrate; energy metabolism with emphasis on mitochondrial ATP production; metabolic regulation in response to environmental stress in farm animals.
   3) Overview of Animal Breeding and Genetics (Assoc. Prof. Yoshinobu Uemoto)
      For the genetic improvement of economically important traits in livestock population, the concepts of animal breeding theory with quantitative genetics and genomic information are studied.
   4) Overview of Animal Physiology (Prof. Fuminori Terada, Assoc. Prof. Sanggun Roh)
      Our research area offers the new information about the basic principles of animal physiology and their applications, in order to investigate the molecular mechanism of the endocrine and metabolic systems in the ruminant.
   5) Overview of Animal Cell Biology (Prof. Hisashi Aso, Assoc. Prof. Tomonori Nochi)
      Our research is focused on mutual relationship of the structures and functions of cells and tissues during myogenesis, development and growth of farm animals to utilize animal production.
   6) Overview of Animal Microbiology (Assoc. Prof. Hiroshi Yoneyama)
      Life of all organisms depends on microorganisms, especially bacteria. Our laboratory is interested in bacterial genetic engineering, bacterial flora and zoonotic diseases. Our goal of research and education is the production of healthy animals including human.
   7) Overview of Animal Food Science (Assoc. Prof. Haruki Kitazawa)
      Basic and application studies on probiotic/immunobiotic lactic acid bacteria to produce physiologically functional foods and feeds will be introduced, and their future prospects will also be discussed.
   8) Overview of Grazing Management (Prof. Shin-ichiro Ogura, Assoc. Prof. Michiru Fukasawa)
      Grazing systems have various functions on animal production and ecological conservation. We introduce the outline of herbivore grazing and refer to its effects on animal welfare and bio-diversity.
   9) Overview of Animal Health and Management (Prof. Yutaka Nakai, Assoc. Prof. Chika Tada)
      Zoonotic microorganisms and pathogenic microorganisms in the environment of the animal production as well as functional microorganisms in animal waste treatment systems are studied.

6. Preparation:

7. Record and evaluation method: Attendance to the lectures 50%, reports 50%

8. Textbook and references: Textbook and references will be introduced by each professor.

9. Self study:

10. In addition:
1. Class subject: **Biochemistry and chemistry of food and bioactive natural products**

2. Object and summary of class: This class object is to study the basic concepts of biochemistry and chemistry of food and related bioactive natural products. More than ten Professors and Associate Professors will give the lectures weekly to introduce their specific research fields.

3. Keywords:

4. Goal of study: The goal of this class is to obtain the background knowledge concerning biochemistry and chemistry as well as the basic principles of food science and natural products chemistry.

5. Contents and progress schedule of class:

1. Bioactive food components (Assoc. Prof. Tsuyoshi TSUDUKI)
   Some bioactive food components related to human health are outlined.

2. Novel functions of dietary vitamins and minerals and its contribution to our health.
   (Prof. Michio KOMAI, Assoc. Prof. Hitoshi SHIRAKAWA)
   This lecture will focus on physiological roles of vitamins and minerals in food, and also will mention about the recent knowledge of their functions for health maintenance.

3. Food and bioactive natural products for human health (Prof. Kiyotaka NAKAGAWA, Assoc. Prof. Takahiro EITSUKA)
   This lecture will give you basic understanding of the roles of food and bioactive natural products to prevent against ageing and oxidative damages (e.g., dementia, cancers, atherosclerosis). This lecture will also address the development of food for human health.

4. Chemistry and biochemistry of marine toxins (Prof. Mari YAMASHITA, Assoc. Prof. Keiichi KONOKI)
   Some of the marine animals contain highly toxic compounds which could cause food intoxication. Isolation, structural determination, analytical methods and pharmacology of these compounds will be presented.

5. Application of high pressure to food processing and terahertz spectroscopy in biological systems
   (Prof. Tomoyuki FUJI, Assoc. Prof. Masae TAKAHASHI)
   High pressure technique is one of non-thermal processing of food. In this lecture, the quality of the pressurized food will be discussed from the viewpoint of the high pressure effect on food structure.
   Terahertz (THz) spectroscopy has attracted significant interest in biological systems. This lecture will give some recent examples of THz spectroscopy related to biomolecules, biomedicine, and pharmaceuticals.

6. Protein chemistry (Prof. Yoshikazu TANAKA)

7. Carbohydrate Chemistry and Glycobiology (Assoc. Prof. Tomohisa OGAWA)
   Structure, properties and function of Carbohydrates. Recognition of cells via carbohydrates: cell-cell and cell-pathogen (toxin, virus) interactions.

8. Chemistry and biology of plant hormones (Prof. Shinjiro YAMAGUCHI)
   Plant hormones are bioactive compounds that regulate various aspects of growth and development in plants. This lecture will cover how plant hormones are made and act in plants and how they have contributed to food production.

9. Medicinal chemistry of antibacterial and antiviral agents (Prof. Hirokazu ARIMOTO)
   Selected topics in anti-infective agents will be discussed with an emphasis on how organic chemistry is used in the drug development process.

6. Preparation:
7. Record and evaluation method: Attendance to the lectures 50%, reports 50%
8. Textbook and references: Textbook and references will be introduced by each professor.
9. Self study:
10. In addition
### Subject: Current topics of Shellfish Physiology (先端海洋生物生理学)

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<th>Object</th>
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<th>Kazue Nagasawa (Assistant Prof.)</th>
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1. **Class subject**
   - Recent research topics of aquatic animal physiology

2. **Object and summary of class**
   - Studies on aquatic animal physiology have contributed to not only fishery and food production, but also—basic science including material and medical sciences. In this course, recent findings on aquatic animal physiology (mainly germ cell biology and neuroendocrinology) will be introduced.

3. **Keywords**
   - Germ cells, Reproduction, Neuropeptides, Fish, Shellfish

4. **Goal of study**
   - Learning recent research activities, scientific interests with impacts, and further application.

5. **Contents and progress schedule of class**
   1. Introduction: What is "shellfish" and what is "physiology"?
   2. Germ cell biology in aquatic animals 1 (germ cell classification/identification)
   3. Germ cell biology in aquatic animals 2 (germ cell development)
   4. Germ cell biology in aquatic animals 3 (germ cell transplantation)
   5. Neuroendocrinology in aquatic animals 1 (Teleosts)
   6. Neuroendocrinology in aquatic animals 1 (Marine invertebrates)
   7. Examination

   *Contents of the class and instructor may be changed without prior notification.

6. **Preparation**
   - Read handout before the class and understand an outline of each topic in advance.

7. **Record end evaluation method**
   - Evaluation is based on class attendance and the final examination.

8. **Textbook and references**
   - Handouts are used.

9. **Self study**
   - Read again handouts based on the information learned at the class and review the knowledge of physiological topics.

10. **In addition**
    - Students may visit the office or contact by Emailing (kna@tohoku.ac.jp) anytime.
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1. **Class subject**

**Current topics of Fish Ecology**

2. **Object and summary of class**

**Objective:** Understanding of structure and function of aquatic ecosystem and learning of new approach to be aware importance of biological production system.

**Summary:** This course will introduce current topics and practical studies on aquatic ecosystem through the use of new approach on ecology. It is important to learn ecosystem for sustainable utilization of fishery resources. They are members of biological production system in nature, and they have functional linkage among in various aquatic community and physicochemical environment. Based on stable isotope ecology, explanation of food web structure and environmental interactions will be provided.

Finally, all students will discuss about consideration for relationship between human activity and ecosystem.

3. **Keywords**

Marine Ecosystem, Biological production, Environmental condition, Stable Isotopes

4. **Goal of study**

Understanding of structure and function of aquatic ecosystem through the use of new approach on ecology

5. **Contents and progress schedule of class**

1. Overview of special properties of global environment and meaning of fish ecology
2. Explanation of structure and function of aquatic ecosystem
3. Basic principle on stable isotope ecology
4. Introduction of current topics on food web analysis in waters through the use of new approach
5. Introduction of recent study on functional relation between aquatic organisms and environment
6. Discussion on consideration for relationship between human activity and ecosystem
7. Examination

6. **Preparation**

Reading of handouts given within class

7. **Record and evaluation method**

Attendance and examination

8. **Textbook and references**

Recent papers or handouts are given within class.

9. **Self study**

Thinking about current topics on Marine Ecology through textbooks and recent papers

10. **In addition**

E mail: kinuko.ito.c6@tohoku.ac.jp
<table>
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<tr>
<th>Subject</th>
<th>Current topics of Fish Biochemistry (先端海洋生物化学)</th>
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<td>T. Nakano (Assist. Prof.)</td>
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1. Class subject
**Marine Biochemistry & Seafood Science**

2. Object and summary of class
This course will provide students with an understanding of the importance of biochemistry, physiology and food science in the field of fisheries sciences.

3. Keywords
- Lipid; Protein; Bioactive Substance; Freshness; Quality Assessment; Stress; Transgenic Fish

4. Goal of study
To understand biochemical and physiological phenomena in fish and functional substances for our health from marine natural products and seafood.

5. Contents and progress schedule of class
1. Introduction “Current research topics in our lab at a glance”
2. Functional substances from marine products 1
3. Functional substances from marine products 2
4. Quality of seafood 1
5. Quality of seafood 2
6. Stress, growth, and nutrition in fish
7. Examination

6. Preparation
TBA (Preparation will be notified at the class)

7. Record end evaluation method
Class attendance, presentation, and examination

8. Textbook and references
References will be notified at the class.
(tentative) Dietary Supplements for the Health and Quality of Cultured Fish by Nakagawa, Sato and Gatlin, CABI, 2007.

9. Self-study
TBA (Self-study will be notified at the class)

10. In addition
Questions, comments, and requests will be accepted during office hours.
1. Class subject
   I introduce some recent studies of genetics in aquatic organisms.

2. Object and summary of class
   To discuss the future area of active research in the fisheries science, I briefly introduce the recent topics of genetics
   (e.g. deep-sea organisms, gene editing technics etc.)

3. Keywords
   Genetic diversity, Gene editing, Applied fisheries science, Aquaculture

4. Goal of study
   Touching the current topics in the genetics of aquatic organisms, and understanding the role of these studies and
   new technics for the fisheries and aquaculture.

5. Contents and progress schedule of class
   The topics will be changed by depending the hot topics of the year. I am going to lecture the topics about aquatic
   organisms as below.

   - General introduction of this class
   - Basic and new technics of DNA sequencing
   - Gene knockdown and gene editing
   - Reconstruction of molecular phylogeny
   - Deep-sea environment, organisms and its evolution
   - Sustainability and genetic diversity

6. Preparation

7. Record end evaluation method
   I evaluate by the attendance rate and a report.

8. Textbook and references

9. Self study

10. In addition
    If you have any question about my class, you can contact me by e-mail (yoshihisa.kurita.b7@tohoku.ac.jp)
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<tr>
<th>Subject</th>
<th>Current topics of Coastal Ecology (先端沿岸生態学)</th>
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<td>Y. Agatsuma (Professor) M. Aoki (Associate Prof.)</td>
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1. **Class subject**

   Ecology of marine temperate reef communities.

2. **Object and summary of class**

   Some current topics in ecology of marine temperate reef communities will be introduced.

3. **Keywords**

   seaweed, kelp bed, herbivore, grazer, sea urchin, gastropod, plant-animal interactions, benthos, parasite, symbiosis,

4. **Goal of study**

   To learn the factors affecting the complex networks in marine temperate reef communities.

5. **Contents and progress schedule of class**

   1) Plant-animal interactions in marine benthos
   2) Biology and ecology of sea urchins
   3) Phase shift in rocky subtidal ecosystem
   4) Biology and ecology of marine crustaceans
   5) Parasitic and symbiotic relationships
   6) Marine mesograzers
   7) Examination

6. **Preparation**

7. **Record and evaluation method**

   Attendance (50%) and examination (50%)

8. **Textbook and references**

   Recent papers are given within class.

9. **Self study**

10. **In addition**

    yukio.agatsuma.c7@tohoku.ac.jp

    m-aoki@m.tohoku.ac.jp
1. Class subject
**Fish Molecular Biology -- Fish as a Model System**

2. Object and summary of class
   In recent decades, fish became more and more used as excellent model system to investigate fundamental questions not only in aquaculture, but also in basic biology, medicine, and environmental science. This class will discuss why they are favored and how the model system developed, by showing examples of fish and other animals used as experimental model system.

3. Keywords
   Experimental model animal, genetics, developmental biology, non-conventional model animal

4. Goal of study
   Students will understand the potential of fish and the reason why fish are used as an excellent experimental model in various fields. Some of learned strategies would be helpful for students to design their own research projects in any fields.

5. Contents and progress schedule of class
   Molecular biology as a tool for the research in biology and medicine
   Advantage of nematode and fly as model system: development, genetics and mutagenesis
   Advantage of fish as a model system: developmental genetics, genomics and mutagenesis
   Advantage of frog and chicken as model system: development and micro-surgery
   Advantage of mouse as a model system: development and stem cell technology
   Advantage of using multiple model system: comparative approach and evolutionary biology
   Experimental model system: past, present and future

6. Preparation
   Review the previous classes. Please feel free to ask during the class, if you have any ambiguous points.

7. Record end evaluation method
   Attendance, participation, quiz and final exam.

8. Textbook and references
   Developmental biology (Scott F Gilbert)
   Others will be introduced in the class.

9. Self study
   Have a look at the Nature or Science magazine to see how model organisms are used in the latest biological research, and read some articles if you find them interesting.

10. In addition
    Contact, hayokoi@m.tohoku.ac.jp
### 1. Class subject
**Molecular Ecology and utilization of plankton**

### 2. Object and summary of class
Plankton is a very small organism and its morphology cannot be observed without using a microscope. However, plankton is one of the most important components and significantly contributes to the marine ecosystem. In this class, several researches on plankton ecology using the latest molecular techniques will be introduced.

### 3. Keywords
Plankton, Larvae of shellfish, Harmful and Useful species, Molecular ecology, Utilization

### 4. Goal of study
Students will learn that molecular methods are effective and are important tools for plankton research. Moreover, students will also understand that plankton improves or worsens human health.

### 5. Contents and progress schedule of class
1. Classification and biology of toxin-producing plankton
2. Molecular Ecology of toxin-producing plankton
3. Classification and biology of useful plankton
4. Molecular Ecology of useful plankton
5. Applications of useful plankton for human health
6. Food analysis in the gut contents of oyster and octopus larvae
7. Examination

### 6. Preparation
Understand an outline of each topic in advance

### 7. Record end evaluation method
Attendance and examination

### 8. Textbook and references
All handouts will be given within class

### 9. Self study
Read handouts again and review the molecular topics in plankton. If you are interested in some plankton species, learn more in details from the literature and using Internet, etc.

### 10. In addition
E-mail: ni5@tohoku.ac.jp
### 1. Class subject

**The past, present, and future of industry, science, technology and their relationships and integration in Japan**

### 2. Object and summary of class

This class is a newly developed multidisciplinary course that was organized by the faculties of science, engineering, and agriculture. Except for the first class, each class will feature a talk by a specialist in his/her field. The topic of each talk will be the "past, present, and future of industry, science, and technology, and their relationships and integration in Japan."

Students will obtain fundamental problem-solving abilities, proactiveness, understanding of different cultures, and a multidisciplinary perspective. Registered students are expected to apply what they learn from this course in the newly developed class titled "Multidisciplinary Internship."

### 3. Keywords

### 4. Goal of study

The goal of this course is to give students a multidisciplinary perspective and open-minded attitude.

### 5. Contents and progress schedule of class

**Schedule of the course**

- **#1 Guidance**
- **#2-8 Lectures by guest speakers who are specialists in the fields of science, technology, and industry.**
- **(#9) Group presentations and/or individual essay on "The project to integrate the fields of science, technology, and agriculture" by students**

### 6. Preparation

### 7. Record end evaluation method

Attendance and active participation (50%), a group presentation or an essay on "Our/My project: how we/I will integrate the fields of science, technology, and agriculture" (50%)

### 8. Textbook and references

NA

### 9. Self study

### 10. In addition

The guest speakers and topics will be announced in timely manner. This course is opened to Japanese students, too.
1. Class subject

**Biological productivity in aquatic zone and restoration from tsunami disaster**

2. Object and summary of class

   Onagawa Town was one of the most prosperous fishing ports in Japan. However, the 9.0- magnitude
   Tohoku-Pacific Ocean Earthquake generated a tsunami as high as 15 meters in Onagawa, which caused the town
   to subside by 1 meter, and completely destroyed its central area. The ria coast of Onagawa and coastal region
   along the Pacific Ocean had been severely stricken by the tsunami. Various coastal organisms have acclimated to
   tsunami perturbations and survived in the area. In order to promote reconstruction of tsunami-stricken areas such
   as Onagawa with respect to aquatic production (fish catching, aquaculture and fishery processing), it might be a
   promising measure to scientifically focus on the adaptability of coastal ecosystems in the area against tsunami
   perturbations, and to raise public awareness of the uniqueness of the costal ecosystems and biodiversity. This
   subject highlights tsunami damage and revival situation in Onagawa Town including coastal ecosystems, and brings
   to understand the importance of constructing new relationship between natural biological productivity and human
   activity. You will join this subject for two days (20 and 21 September 2017) with staying at Onagawa Field Center.

3. Keywords

4. Goal of study

   Students will
   - learn about tsunami disaster.
   - understand the importance of relationship between natural aquatic production and human activity.
   - understand sustainable biological productivity and the application to reconstruction of human society.

5. Contents and progress schedule of class

   - Introduction to studies of marine science, biological productivity and restoration
   - Field lecture about tsunami damage and regeneration of coastal ecosystems
   - Field lecture about tsunami damage and revival situation in Onagawa Town

6. Preparation

7. Record end evaluation method

   Attendance, Activeness, Report

8. Textbook and references

9. Self study

   Detailed schedule will be circulated in July 2017.

10. In addition

    Contact: minoru.ikeda.a6@tohoku.ac.jp (Ikeda M.)