Center for International Programs and Sustainability Studies
Course name: Marine Molecular Biology
Course code: ENV 3020
Total Contact Hours: 60
Prerequisite: None

COURSE DESCRIPTION

The use of biological-molecular tools has revolutionized research in marine sciences in recent decades. These approaches offer extraordinary potential to address ecological issues in the marine environment, ranging from species identification and deciphering reproductive behaviors to understanding the population structure and genetic connectivity among populations. This course focuses on the use of molecular markers based on mitochondrial and nuclear DNA to highlight the importance of conservation genetics and the implications on a global scale to manage marine species in danger of extinction. Activities and conferences will be carried out at the Center for International Programs and Sustainability and the Molecular Biology Laboratory (BIOMOL).

In addition, students will experience field activities to understand some controversial conservation issues related to the endangered trapezoidal marine species in Costa Rica, such as sea turtles and sharks, gathering tissue samples and later performing hands-on activities in the laboratory such as DNA extractions, PCRs, electrophoresis. Along the course students will learn to perform bioinformatics analysis from DNA sequence chromatogram reviewing and genetic database searching to genetic identification. Some analysis will be

performed to understand the genetic diversity and gene flow of natural populations of endangered marine species in Costa Rica.

CLOTHING AND FOOTWEAR REQUIREMENTS

It is necessary for foreign students to have clothes both for warm climate and for cold (not extreme), as well as closed shoes (hiking shoes and rubber boots if possible) since many field trips are made to highlands, rainy zones, and sometimes to areas with the possible presence of snakes, insects, and other animals. We've never had an accident under those circumstances, but we want our students to be as comfortable and safe as possible. The appropriate clothing and footwear also facilitate the field work of this course.

AUDIENCE

This course is structured for international students attending the Study Abroad Program at an LCI Education university campus. However, courses are not exclusive to foreigners so local degree-seeking students may enroll in this course. Some of the courses are also taught in Spanish as part of our Bachelor´s in Sustainability Management or Business Administration programs.

This is a theoretical-practical course and explores/responds to the following inquiry according to the professional/disciplinary profile:

How to apply molecular biology techniques in addressing problems regarding the conservation biology of endangered marine species?

To answer this question, the following generative topics will be studied:

- Natural history of marine species.
- Marine conservation genetics in Costa Rica.
- Basic concepts of molecular biology.

- Population genetics.
- Molecular markers in marine sciences.
- Basic bioinformatics analyses to address questions in molecular biology

Along the course, the following **skills** will be fostered:

- Capacity to recognize the main tools used in molecular biology.
- Capacity to propose solutions to conservation problems in marine species.
- Capacity to analyze the role of the use of molecular markers in marine sciences.
- Capacity to analyze and discuss results obtained from bioinformatics analyses.

Among the values and attitudes that will be promoted among the students are the following:

- Critical thinking.
- Logical and communicative intelligence.
- Interest in solving problems.
- Interest in learning to learn.
- Negotiating and knowing how to inspire trust and empathy.

COMPETENCIES, CRITERIA AND EVIDENCE

The competencies for the Veritas University are reflexive and integral actions that respond to the professional profile and to the problems of the context, with appropriateness and ethical commitment, integrating the knowledge of being, know-how and knowledge to know in an improvement perspective.

Below are both the disciplinary and general competencies, linked to their criteria and evidence of performance for this course.

Competencies	Key Competences	Learning Assessments
Disciplinary Apply molecular biology techniques to tackle conservation problems in marine organisms, according to the Standards of marine science research.	Identifies important aspects of natural history of marine organisms, considering the progress of the current research.	○ Field trip report Oral presentations Final research project
	Analyzes the use and integration of research methods in molecular biology considering the requirements of the analysis of real cases and projects.	○ Oral presentations ○ Mind maps
	Applies the use of molecular markers as a tool for management and conservation of marine species according to a research question.	○ Laboratory practice Final research project
Core/Generic		
Integrates the knowledge, skills and attitudes necessary to learn in a continuous way throughout professional life.	Learning to learn.	○ Laboratory Practice Reports ○ Project presentation ○ Scientific article analysis ○ Field trip report ○ Group and individual presentations

Develops the knowledge, skills and attitudes necessary to learn how to communicate orally and in writing in the different areas.	Communicate thoughts of the discipline orally, graphically, and in written form.	Laboratory Practice Reports Project presentation Scientific article analysis Field trip report Group and individual presentations
Integrates the knowledge, skills and attitudes necessary to learn the techniques of teamwork and leadership.	Execute teamwork and leadership.	Oral presentations Final research report
Integrates the knowledge, skills and attitudes necessary to learn the interpersonal communication techniques.	Respect towards other handle and resolve conflicts. To negotiate knowing how to inspire trust and empathy. Critical and logical thinking	Mind maps Final research report

COURSE CONTENT

Unit 1. Marine Molecular Biology

- What is Marine Molecular Biology?
- Past and present in Molecular Biology
- The Central Dogma of Molecular Biology
- Molecular Markers: Mitochondrial DNA and Nuclear DNA
- Interpreting mitochondrial DNA and nuclear DNA applications for studies on marine species.

Unit 2. Conservation Genetics: Let´s go to the Lab!

- Conservation Genetics
- Forensic and management applications of genetic identification
- DNA extraction
- Polymerase Chain Reaction (PCR)
- Electrophoresis

Unit 3. Population Genetics: evolutionary forces and applications for the management of endangered species

- Evolutionary forces: Natural Selection, Migration, Genetic Drift and Mutation
- Genetic diversity
- Genetic population structure: Gene flow and genetic connectivity
- Population genetics for the management of wild populations

Unit 4. Bioinformatics analyses

- Genetic database searches
- Editing DNA sequences and looking for polymorphisms in mitochondrial DNA sequences
- Characterizing the genetic diversity of natural endangered marine species populations
- Analyzing the population structure of natural endangered marine species populations

METHODOLOGY

This course promotes the interaction between the students and the teacher, in order to develop active feedback between the two parties. The course will be composed of participatory activities such as thematic discussions, oral presentations, and laboratory practices. Throughout the course the students will be immersed in hands on experiences that include: field work to collect samples, laboratory practices to process samples, and

bioinformatics practices to analyze DNA data from wild marine populations. Additionally, students will participate in current case studies in molecular biology, with which they can propose solutions for the conservation of marine endangered species. This in turn will allow students to learn and critically analyze different real life situations in which they can apply the theory to propose new ideas and strategies for conservation.

The role of the professor is to mediate, facilitate and guide the teaching and learning, allowing students to build and self-regulate learning, based on their previously collected information. The student is active, the teaching-learning process is collective and socialized. It also fosters social integration, the development of group work skills and community feeling, without neglecting individualization.

EDUCATIONAL RESOURCES

In order to guarantee a good development of the course, therefore, to guarantee learning, the following resources are available: an updated bibliographic database, multimedia equipment that students can use for their individual presentations, whiteboards and other school equipment for weekly sessions, and readings provided by the educator. All of these complement the suggested projects and provide the students with higher possibilities of knowledge ownership. Most of the lessons will take place in the classroom.

During independent work periods students will be able to attend the institution. A campus library, study rooms, and computer labs are available for the students´ independent work time. Free Wi-Fi connection for students, educators, and staff is provided on campus, which gives students the possibility to work not only in the library or computer labs, but also around campus.

LEARNING ASSESSMENT

In order to make the course or program better competencies-based evaluation compiles and evaluates evidence by taking into account feedback providing pre-established criteria. The course evaluation must be aligned with the competencies and the teaching methodology. There is a rubric for each evaluation resource, and the details will be provided in **CANVAS LMS**. Even though the rubric grants a grade, it is also a quantitative and qualitative description of the students´ performance. The rubrics include the core and discipline key competences.

Rubrics	Weight
Oral Presentation: ○ Group/individual oral presentations	**15%**
Mind map: ○ Mind map of basic concepts in molecular biology	**5%**
Field trip report: ○ Methods in the field and processing of samples	**10%**
Bioinformatics analyses: ○ 5 bioinformatics practice reports	**20%**
Lab Report ○ Laboratory practice ("CIS Forensic on illegal trade of shark fins")	**25%**
Final research project: ○ Topic assigned at the beginning of the course (includes scientific article and oral discussion)	**25%**
TOTAL:	**100%**

LEARNING STRATEGIES

The following learning strategies will be carried out:

1. **Oral presentation:**

By means of digital presentations (power-point) each group of students will explain the content pertaining to a research topic assigned in advance by the teacher. The students must present at the end of this presentation the bibliographic sources in APA format, Sixth Edition, with a minimum of 5 references and their respective connection link. It is intended that students through teamwork or individually can be able to formulate critical and logical ideas that can then be transmitted orally and encourage the rest of the audience (classmates) to issue different points of view.

For the purposes of this course, one oral presentation will be performed with a value of **15%**

- For the oral presentation, the student will be assigned a scientific article that details a current molecular biology application to marine conservation. They will research this article and complement it with other resources such as scientific journals, technical reports, etc. to perform a PowerPoint presentation.

2. **Mind map:**

Creating a mind map in groups is evidence of performance that integrates the required knowledge, skills, and abilities to learn continuously and to generate information collaboratively. It develops competencies related to writing communication, critical thinking, idea association, and responsible, relevant, and timely participation. A mind map regarding the basic concepts of molecular biology will be performed, worth 5%, and scored based on the following rubric.

3. **Video Field trip report:**

The field trip will be assessed by means of a video report where audiovisual material (photographs and/or video) will be included. Each of the activities performed in the field trip and the processing of samples will be included in this report. The idea, in this case, is that students have the opportunity to interact and observe some marine species, and collect samples for processing in the lab. Therefore, all the information and experience acquired during the field trip will be translated into an audio-visual material (videos) where they will describe each of the activities performed, what they have learned, results, discussions, and their opinions.

4. **Laboratory practice:**

This fascinating experience will be implemented throughout the subject of the course "Conservation Genetics". Four lab practices will focus on the activity "CIS Forensic on the illegal trade of shark fins", where the student will learn how to extract DNA, PCR, and Electrophoresis techniques to identify shark species from fin samples. Laboratory session will be performed in the Molecular biology laboratory (BIOMOL).

The laboratory session will be assessed with a value of **25%** based on the information acquired and evaluated on the understanding from application tools to prevent the illegal trade of endangered species, such as the genetic approaches demonstrated during the lab sessions.

Instructions for the students regarding to the different sections of this report are the following:

- **Introduction**: this section provides the reader the general knowledge of the topic related to each laboratory practice, which include a summary of each section written in an understandable and logic way. Use scientific articles from recognized journal as a reference. It must be one page (1.5 spaced).

- **Objectives**: lab objectives will be provided by the professor during the lab, include them in your reports. It must be 1 general and 2-3 specific objectives.
- **Methodology**: this section describes how the activity in the lab was performed, detailing the materials used in the lab (for example: DNA extraction kit, pipettes, centrifuges, tissues samples, etc.), include the specimens where the tissues samples were extracted (use common and scientific names) presented in the lab.
- **Results**: this section includes the observations learned during the lab session (quantification of the DNA extraction, PCR, electrophoresis gel, special personal observations, etc.).
- **Discussion and conclusions**: this section is most important for the report. It means to compare and contrast the observations against the information provide in the literature, providing differences and similarities between the observations and the information researched about the results obtained. It is expected to read after class about the techniques and methodologies used in the practice in order to be able to provide logic conclusions about the procedures. The discussion must be written in prose and conclusion as a list. References use a APA style. Make sure to use only reliable scientific sources.

For each laboratory session the students will prepare a small report in which they describe the reagents (general description and function) that are going to be used in that session. This will have a total value of **5%,** one point (if handed in in time) for each laboratory session.

5. **Bioinformatics analyses:**

The student will develop throughout the course different skills in bioinformatics including: searching in online data repositories, analysis of chromatograms, DNA sequence identification, genetic diversity, and gene flow analyses of natural marine species populations. These practices will be conducted during class.

6. **Final research report:**

Students will conduct a thorough investigation into the topic assigned at the beginning of the course. This report will be an analysis of molecular biology of a natural endangered marine species population. They will have to carry out the analysis of their own results, consult literature and if possible, consult experts on their research topic. At the end of the course students will present the information collected and analyzed in a scientific article format to the professor.

ATTENDANCE

Regarding classes:

1. Students are only allowed a two (2) **non-consecutive (back-to-back) class absences**. A student shall fail the course if more than two absences are registered by the professor. Administration does not control attendance.
2. Three **late arrivals** to class (arrival after the first 15 minutes) are treated as one absence. Attending class 30 minutes late without an official justification will also count as an absence.
3. In the case of an **absence from any assignment evaluated in class** (presentations, evaluations, field trips, etc.) a student will be given a grade of zero unless an official document is presented within **one week** of the absence.
4. If a student presents an official document to excuse the absence, the missed assignment is to be presented on that same day.

Regarding field trips:

5. An unjustified **absence on a field trip** will immediately result in the loss of all points assigned to that specific trip. However, if an official document justifying the absence is presented, 50% of the assignment points may be obtained upon presentation of a

complementary research assignment, to be agreed upon with the professor, within one week of the field trip.

6. An absence on a field trip may be justified should two course field trips coincide. In such a case, and to avoid losing points, students shall be able to opt for carrying out a research assignment.

CODE OF CONDUCT

Professors have the right to expel a student from the classroom should he / she/ they:

1. Be disruptive in the classroom.
2. Behave in a disrespectful way.
3. Be under the influence of alcohol.
4. Be under the influence of any illegal drug.
5. Shows hygiene or odor problems that may disturb other students.

ELECTRONIC DEVICES

The use of cell phones, smartphones, or other mobile communication devices is disruptive and is therefore prohibited during class. **Please turn all devices OFF and put them away** when class begins. Devices may be used only when the professor assigns a specific activity and allows the use of devices for internet search or recording. Those who fail to comply with the rule must leave the classroom for the remainder of the class period. Using devices while the professor or other peers are lecturing, or presenting is perceived as a lack of interest and disrespectful.

STUDY ABROAD PROGRAM POLICIES

The student must comply with the provisions of the Study Abroad Program Policies available on the Canvas/Omnivox platform.

BIBLIOGRAPHY

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Wyneken, J., Lohmann, K. J., & Musick, J. A. (2013). The biology of sea turtles. Volume II. CRC Press.

CHRONOGRAM

Week	Contents	Learning strategies
1	**Introduction to Molecular Biology: The Central Dogma**	Thematic discussions, mental maps
2	**Introduction to Molecular Biology: Molecular markers**	Reports and discussion, Mind maps, Bioinformatics practice
3	**Introduction to Molecular Biology: Genes, inheritance and change**	Oral presentation, Reports and discussions
4	**Conservation genetics**	Reports, Thematic discussions, Bioinformatics practice
5	**Lab: "CIS Forensic on illegal trade of shark fins"**	Laboratory practice

6	**Lab: "CIS Forensic on illegal trade of shark fins"**	Laboratory practice
7	**Population genetics: Evolutionary forces: Natural Selection, Genetic Drift, Migration and Mutation**	Research, Reports and discussions
8	**Population genetics: Genetic Diversity**	Reports and discussions, Research, Case Study, Bioinformatics practice
9	**Population genetics: Gene flow and genetic connectivity**	Reports and discussion, Research, Case Study, Bioinformatics practice
10	**Lab: "Processing of fieldtrip samples"**	Reports and discussions, Research, Laboratory Practice, Bioinformatics practice, Case Study
11	**Work on Final Research Project**	Reports and discussions, Research, Laboratory practice
12	**Final Research Discussion**	Case study, Thematic discussions, Research

Please note that this chronogram is tentative and subject to change.