

CENTER FOR INTERNATIONAL PROGRAMS & SUSTAINABILITY STUDIES

Course name: Marine Molecular Biology

Course code: ENV 3020

Total Contact Hours: 60

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 to understanding of 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 CPI Biomolecular 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, and introduction to bioinformatics analysis.

This is a theoretical-practical course and it seeks to clarify the following question:

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

To answer this question the following **knowledge** will be studied:

- Natural history of marine species
- Marine conservation in Costa Rica
- Basic concepts of molecular biology
- Molecular markers in marine sciences
- Basic bioinformatics concepts in molecular biology

The course will promote the following skills:

- 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 knowing how to inspire trust and empathy

Competencies, criteria and evidence

The competencies for the Veritas University are reflective 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.

Types of competencies	Performance criteria (sub-competencies)	Performance evidences
<p>Specific</p> <p>Apply molecular biology techniques to tackle conservation problems in marine organisms, according to the Standards of marine science research.</p>	<p>1_ Identifies important aspects of natural history of marine organisms, considering the progress of the current research.</p>	<p>Field trip report Mental map Oral presentations Thematic discussion</p>
	<p>2_ Analyzes the use and integration of research methods in molecular biology considering the requirements of the analysis of real cases and projects.</p>	<p>Oral presentations Essay Thematic discussion</p>
	<p>3_ Applies the use of molecular markers as a tool for management and conservation of marine species according to a research question.</p>	<p>Thematic discussion Final research report</p>
<p>Generals</p>		
<p>Integrates the knowledge, skills and attitudes necessary to learn in a continuous way throughout professional life.</p>	<p>Learning to learn.</p>	<p>Thematic discussion / Mental Maps</p>
<p>Develops the knowledge, skills and attitudes necessary to learn how to communicate orally and in writing in the different areas.</p>	<p>Communicate disciplinary thoughts in an oral and written manner.</p>	<p>Essay/ Oral presentations / Final research report</p>
<p>Integrates the knowledge, skills and attitudes necessary to learn the techniques of teamwork and leadership.</p>	<p>Teamwork and leadership.</p>	<p>Oral presentations / Final research report</p>
<p>Integrates the knowledge, skills and attitudes necessary to learn the interpersonal communication techniques.</p>	<p>Respect towards other handle and resolve conflicts. To negotiate knowing how to inspire trust and empathy. Critical and logical thinking</p>	<p>Thematic discussion / Final research report</p>

Contents

Unit 1. Marine Molecular Biology

- What is Marine Molecular Biology?
- Past and present in Molecular Biology
- Studying Genetic diversity: importance and measurement
- Resolving taxonomic issues
- Forensic and management applications of genetic identification
- Population Genetics
- Genetics and management of wild population

Unit 2. Molecular Markers

- Mitochondrial DNA
- Nuclear DNA
- Interpreting the use of molecular markers on studies of marine species

Unit 3. Let's Go to the Lab

- DNA Extraction
- Polymerase Chain Reaction (PCR)
- Electrophoresis
- Preparing samples for Sequencing and Genotyping

Unit 4. Bioinformatics analyses

- Editing sequences
- Characterizing Genetic diversity: indexes
- Analyzing the population structure

Methodology

This course promotes the interaction between the students and the teacher, in order to develop an active feedback between the two parties. The course will be composed of participatory activities through case studies where the objective is that the students can solve in an individual and group way a research question previously planned by the teacher. This in turn would allow students to learn and critical analysis in different working situations.

Learning Strategies

The following learning strategies will be carried out:

- 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 10 references and their respective connection link.
- Thematic discussions: the end of this activity is for students to make small progress on their current research project (successes and misrepresentations) in front of the rest of the class and discuss possible suggestions for improving their models.
- Mental maps: It will take advantage of the development of mental maps (systems mapping) through which students will be able to investigate, extract, summarize and expose the most important information regarding their research topic.
- Laboratory practices: Laboratory practices will be established and implemented where the student conducts several processes throughout the course: DNA extraction, DNA quantification, PCR, process related to the electrophoresis chamber, sequencing, Analysis of Chromatograms and use of bioinformatic software. In order for the student to develop skills related to the correct proceeding in a molecular biology laboratory.

- Essay: Students, individually, may issue their own opinion by formally interpreting and evaluating a specific topic. The objective is that the student correlates his/her research and his/her own knowledge and can clearly argue a possible application in real life.
- Field trip report: The field trips will be assessed by means of a written report where audiovisual material (photographs and/or video) will be included, where each of the activities performed in the field work tours are described.
- Final research report and oral presentation: At this point students will conduct a thorough investigation into the topic assigned at the beginning of the course. 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 scientific article format to the professor. At the same time students should prepare a summary for the rest of their classmates, as they will be reviewers of the students who would present their findings on the final filing date.

Educational resources

In order to guarantee 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.

Audience

This course is structured for International Students attending the Study Abroad program at Universidad Veritas. However, courses are not exclusive to foreigners so a few native students could enroll in this course. Some of the courses are also taught in Spanish as part of our Bachelors in Sustainability Management.

Attendance

Students are only allowed a total of 2 non consecutive (back to back) absences. The student will fail the course if he/she has more than two absences. Students will have a 0 on any assignment evaluated in class (presentations, evaluations, field trips, etc.) if absent unless the student presents an official document no later than one week after the absence. If the student presents an authoritative report to excuse the absence, he/she must submit the missed assignment on that same day. An unjustified absence to a field trip will immediately mean losing all of the points assigned to the field trip. If an official document is presented for the field trip absence students will have to present a research assignment to obtain 50% of the points. The only exception to this rule is when two-course field sessions collide in programming. Students can then opt for doing a research assignment not to lose any points.

Three late arrivals to class (15 minutes later) are treated as one absence. If you tend to be late for class, you will lose 25% of your total grade.

Code of conduct

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

- 1) Is disruptive in the classroom.
- 2) Behave in a disrespectful way.

- 3) Is under the influence of alcohol or even smell like alcohol.
- 4) Is under the influence of any illegal drug.
- 5) Shows hygiene problems that may disturb other students.

Electronic devices

The use of cell phones, smart phones, 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.

Learning evaluation

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. 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	Total percentage
Oral presentations: <ul style="list-style-type: none"> • Two oral presentations 	20%
Field trip reports: <ul style="list-style-type: none"> • Two field trip reports (South Pacific and North Pacific) 	20%
Essay: <ul style="list-style-type: none"> • Molecular markers: Its application in marine science and resource management. 	10%
Lab Log <ul style="list-style-type: none"> • Seven laboratory practices (DNA and bioinformatics) 	10%
Final research project: <ul style="list-style-type: none"> • Topic assigned at the beginning of the course (includes report and oral presentation). 	40%
Total grade	100%

Rubric to evaluate oral presentations

From digital presentations, from previously assigned topics, it is intended that students through teamwork 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, two oral presentations with a value of 10% for each one will be made, with a total value of 20%. These presentations will be assessed by the following rubric:

Indicator	3	2	1	Observations
Contents to be assessed in the oral presentation				
There is a mastery of concepts and these are transmitted effectively.				
It uses clear and representative images of the concept that is intended to manifest.				
The student has good projection and posture when it comes to exposing his subject. It doesn't get hard to get to the wall and it doesn't put its hands inside the pockets.				
The student expresses ideas related to the images in a fluent and clear way, without having to read support material (tokens, notes or text of the slides).				
The presentation has a logical order that allows the understanding of the subject exposed to the class.				
The student clearly and critically issues his own opinions on the assigned topic.				
The conclusion is solid and leaves the viewer with an absolutely clear idea of the issue exposed by the issuer.				
The student responds satisfactorily to the questions of the teacher and classmates regarding the subject exposed.				
The sources of information are varied and multiple (minimum 10 bibliographical sources) and contribute to the development of the topic. The information collected is related to the topic, is relevant and updated.				
Formatting aspects for oral presentation				
Includes cover with basic information (name of the students, name of the university and title of the subject).				
The bibliographical sources are in APA format (in its last edition) at the end of the presentation.				
It presents order, good spelling and punctuation.				
Total:				

Rubric to evaluate the field trip report

The idea in this case is that students have the opportunity to interact and observe some marine species, the medium in which these species are found and in turn their interaction with the local human population. Therefore, by means of a written report the students will translate their experience including audio-visual material (photographs and/or videos) where they describe each of the activities performed, which they have learned and their opinions.

Two field trips represent 10% each are carried out, for a total value of 20% and evaluated by the following rubric:

Indicator	3	2	1	Observations
Report content				

The report has a logical sense as the different activities in the field trip are presented.				
The introduction has information obtained from books and/or scientific journals that supports the information within this report.				
The methodologies applied in each field tour activity (previously explained by the professor) are detailed in the report in written form.				
The methodology is supported by means of audiovisual and/or photographic material obtained specifically during the field trip.				
Relevant observations and conclusions are included around the activities performed on the field trip.				
Format aspects				
The report includes cover with the basic data (name of the students, name of the university, title, dates, location of the tour, etc.).				
Organization of the report: the structure of the work includes introduction, description of activities, audiovisual material obtained (photographs and/or edited videos), bibliography and/or annexes.				
The bibliographical sources are in APA format in latest edition.				
Presents order, has good spelling and punctuation.				
It presents space between lines (1.15) and source (Arial_11) according to the format requested by the teacher.				
Total:				

Rubric to evaluate an argumentative essay

Students, individually, may issue their own opinion by formally interpreting and evaluating a specific topic. The objective is that the student correlates the research and his/her own knowledge, and can clearly argue a possible application in real life. The essay is strictly individual and student authorship. The topic to be assessed with the essay is "Molecular markers: its application in marine science and resource management". The value is 10% and is evaluated by the following rubric:

Indicator	3	2	1	Observations
Introduction: Includes purpose, general theme exhibition and clear objectives.				
The main idea names the essay theme and outlines the main points to be discussed.				

Coherent, serious and convincing personal contributions are presented on the subject of the essay. At least two original and applicable contributions to the subject are presented.				
The secondary arguments and ideas are presented in a logical order that makes the author's ideas easy and interesting to follow.				
The structure or the order of the words (syntax) in the sentences is logical. Use punctuation and pronouns correctly. Carefully select the words (does not use slang).				
All the ideas presented are related to the topic. Ideas are presented with clarity and objectivity. These are not repeated nor do they show gaps. It did not use copying and pasting.				
The conclusion is solid and leaves the reader with an absolutely clear idea of the author's position.				
It has no spelling errors, accentuation or verb conjugation.				
Meets the following requirements: cover, margin size, intelligible font, character size, paragraph spacing, title congruent with content, student and subject information, appointments are clear and accurate.				
The sources of information are varied and multiple (minimum 10 bibliographical sources) and contribute to the development of the topic. The information collected is related to the topic, is relevant and updated.				
Total:				

Rubric to evaluate laboratory practices

Laboratory practices will be established and implemented for the students to perform several processes throughout the course: DNA extraction, DNA quantification, PCRs, amplicons amplification in the electrophoresis chamber, sequencing, analysis of chromatograms and use of bioinformatics software. In order for the student to develop skills related to the correct proceeding in a molecular biology laboratory.

For the evaluation of the reports, two very similar rubrics will be used; (1) The first will serve to evaluate the reports with laboratory activities that include the manipulation of specialized equipment (furnaces, centrifuges, thermocyclers, fluorimeter and electrophoresis chamber) In addition, this section includes other materials As: pipettes, Petri dishes, tweezers, scissors, reagents and plastics; (2) the second rubric will evaluate aspects related to laboratory work, in this case, with the support of bioinformatics software which are to be developed in computers.

The Seven (7) group laboratory practices have a total value of 10%, in the end will average the score obtained between all practices and then that will be the equivalent of 10%, for this will be used the following rubrics:

Rubric for Laboratory activity reports

Indicator	3	2	1	Observations
The students are responsible and careful in the manipulation of the laboratory equipment, respect the established laboratory rules and show solidarity, fellowship and respect for other classmates and teachers.				

The report includes a heading with the name of the students and the following sections of the report are complete: introduction, objectives, methodology and materials, results, discussion and conclusions and bibliography (the latter as requested by the professor).				
The introduction provides a general idea of the contents of the report. Presents a general and minimum objective a specific. The methodology describes each activity performed during the session and the materials used.				
The results should be presented in prose or in a table. In both cases, the name of the species studied and the observations made during the session must be detailed.				
The discussion compares, contrasts and discusses the observed results and the information found in the literature.				
The conclusions are presented in a list and are directly related to the objectives and the discussion.				
The report is clean and organized, and shows good spelling and punctuation.				
Total:				

Rubric for Laboratory activity using software

Indicator	3	2	1	Observations
The students are responsible and careful in the manipulation of the laboratory equipment, respect the established laboratory rules and show solidarity, fellowship and respect for other classmates and teachers.				
The report includes a heading with the name of the students and the following sections of the report are complete: introduction, objectives, methodology and materials, results, discussion and conclusions and bibliography (the latter as requested by the professor).				
The introduction provides a general idea of the contents of the report. Presents a general and minimum objective a specific. The methodology describes each activity performed during the session and the materials used.				
A section is shown where the students explain, in prose, the observations made during the session. This section should include a description of the progress of the student group in that session.				
Students must create a folder in the computers with the necessary software for the session of the day; they must also make a "Screenshot" on the work corresponding to that day where the date and time of the class appear in the laboratory.				
Se presentan posibles auto-sugerencias puntuadas donde se mencionan debilidades del grupo de trabajo con el fin de ser retomadas en la siguiente				

clase.				
The report is clean and organized, and shows good spelling and punctuation.				
Total:				

Rubric to evaluate the final research project

This work aims to confront the student to a scientific investigation, which implies introducing and familiarizing each person with the different activities that are carried out in an investigation in the real life. Constructive critique and cooperativism are also promoted. The research carried out by the student groups will be developed in phases throughout the course. By means of molecular biology tools and their respective procedures, complemented with current bioinformatics software to edit genetic sequences and their subsequent interpretation. All of his findings will be presented and explained to the rest of the class through a group oral presentation.

This group research project has a total value of 40%, has three evaluation rubrics which have a different evaluation percentage: **1)** the first rubric has a scale of 1 to 5 and has a percentage of 25% where the work will be assessed formal writing; **2)** the second part, with a scale of 1 to 3 with a percentage of 5%, the format of the written work will be assessed and an self-assessment will be carried out with respect to performance throughout the research project; **3)** a third rubric with a scale of 1 to 3 will evaluate an oral presentation related to the research project. Each one will be evaluated according to the indicator in each table in the following way:

Rubric for project structure and content

Indicator	5	4	3	2	1	Observations
Project structure and content						
The project is presented by a document written in the scientific article format.						
It includes the summary (<i>abstract</i>) of all the parts of the research summarized, as established in a scientific article (development, results, discussion and conclusion/recommendations).						
The work contains an introduction (2 pages), methodology (between 1 and 2 pages). Contains results (minimum 1 page), Discussion (minimum 1 page), conclusions and recommendations (minimum 1 page).						
The introduction is clear and coherent it has logical order, which truthfully explains the contents of the investigation. It has bibliographic citations.						
The methodology explains step by step, in logical order, the procedures that were carried out throughout the investigation. It has bibliographic citations within the text in APA format in its last edition.						
Relevant results are presented for the						

investigation. Includes discussion, conclusions and bibliographic citations in the text.						
In the discussion there is a logical comparison of the results obtained and the information found in literature. Manages to analyze and explain possible differences between the consulted bibliography and the results obtained, when necessary.						
The sources of information are varied and multiple (minimum 10 bibliographic sources) that contribute to the development of the topic. The information collected is related to the topic, is relevant and updated.						
Total:						

Rubric for Project format and self-assessment

Indicator	3	2	1	Observations
Project Format				
It has the space between lines (1.15) and the font (Arial_11) according to the format requested by the teacher.				
The project includes cover with the basic data and an executive summary (digital) for classmates and teachers.				
The results section presents pictures, figures, or other resources to represent them consistently.				
The bibliographical sources are in APA format in their latest edition.				
There's order, good spelling and punctuation.				
Self-assessment				
I was responsible for the advances (oral and/or written) requested by the teacher, as I developed my research project.				
I devoted the time and effort necessary since the beginning of the course for research development.				
I did a thorough search of scientific information to give real support to my research.				
In my laboratory work, from the DNA extraction process, DNA quantification, PCR, electrophoresis and sequencing chamber were elaborated with great care and passion.				
I really followed the indications and advice of my teacher in the different phases of my final research.				
Total:				

Rubric for oral presentation

Indicator	3	2	1	Observations
Contents to be assessed in the oral presentation				
There is a mastery of concepts and these are transmitted effectively.				
It uses clear and representative images of the concept that is intended to manifest.				
The student has good projection and posture when it comes to exposing his subject. It doesn't get hard to get to the wall and it doesn't put its hands inside the pockets.				
The student expresses ideas related to the images in a fluent and clear way, without having to read support material (tokens, notes or text of the slides).				
The presentation has a logical order that allows the understanding of the subject exposed to the class.				
The student clearly and critically issues his own opinions on the assigned topic.				
The conclusion is solid and leaves the viewer with an absolutely clear idea of the issue exposed by the issuer.				
The student responds satisfactorily to the questions of the teacher and classmates regarding the subject exposed.				
The sources of information are varied and multiple (minimum 10 bibliographical sources) and contribute to the development of the topic. The information collected is related to the topic, is relevant and updated.				
Formatting aspects for oral presentation				
Includes cover with basic information (name of the students, name of the university and title of the subject).				
The bibliographical sources are in APA format (in its last edition) at the end of the presentation.				
It presents order, good spelling and punctuation.				
Total:				

Bibliography:

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- Allendorf, F. W., & Luikart, G. (2007). *Conservation and the Genetics of Populations*. Blackwell Publishing.
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Lutz, P. L., Musick, J. A., & Wyneken, J. (2002). *The biology of sea turtles*. Volume II. CRC Press.

Shivji, M., Clarke, S., Pank, M., Natanson, L., Kohler, N., & Stanhope, M. (2002). Genetic Identification of pelagic shark body parts for conservation and trade monitoring. *Conservation Biology* 16:1036–1047.

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

Chronogram

Week	Sub-competencies	Contents	Teaching strategies
1	Identifies important aspects of natural history of marine organisms, considering the progress of the current research.	Unit 1. Marine Molecular Biology - What is Marine Molecular Biology? - Past and present in Molecular Biology	Thematic discussion Mental maps
2		Unit 1. Marine Molecular Biology - Studying Genetic diversity: importance and measurement	Mental maps
3		Unit 1. Marine Molecular Biology - Resolving taxonomic issues - Forensic and management applications of genetic identification	Field trip report #1 Mental maps Thematic discussion
4		Unit 1. Marine Molecular Biology - Population Genetics	Mental maps
5	Analyzes the use and integration of research methods in molecular biology considering the requirements of the analysis of real cases and projects.	Unit 1. Marine Molecular Biology - Genetics and management of wild population	Essay Thematic discussion
6		Unit 2. Molecular Markers - Mitochondrial DNA - Nuclear DNA	Mental maps
7		Unit 2. Molecular Markers - Interpreting the use of molecular markers on studies of marine species	Oral presentation #1 Mental maps Field trip report #2
8		Unit 3. Let's Go to the Lab - DNA Extraction	Lab reports Mental maps
9		Unit 3. Let's Go to the Lab - DNA Extraction - Polymerase Chain Reaction (PCR)	Lab reports Mental maps Thematic discussion
		Unit 3. Let's Go to the Lab	Lab reports

10		<ul style="list-style-type: none"> - Polymerase Chain Reaction (PCR) - Electrophoresis - Preparing samples for Sequencing and Genotyping 	Mental maps Oral presentation #2
11		<u>Unit 4. Bioinformatics analyses</u> - Editing sequences	Lab reports Mental maps
12	Applies the use of molecular markers as a tool for the management and conservation of marine species according to a research question.	<u>Unit 4. Bioinformatics analyses</u> - Editing sequences - Characterizing Genetic diversity: indexes	Lab reports Mental maps Thematic discussion
13		<u>Unit 4. Bioinformatics analyses</u> - Characterizing Genetic diversity: indexes	Lab reports Thematic discussion
14		<u>Unit 4. Bioinformatics analyses</u> - Characterizing Genetic diversity: indexes - Analyzing the population structure	Lab reports Mental maps
15		<u>Unit 4. Bioinformatics analyses</u> - Analyzing the population structure	Lab reports Final research report Thematic discussion

General observations

The student must comply with the provisions of the Veritas University student regimen regulation. To consult it you should go to the student self-management Portal at the following address: <http://autogestion.veritas.cr/> and download it.