

**CENTER FOR INTERNATIONAL PROGRAMS & SUSTAINABILITY STUDIES**

**COURSE NAME:** Bees and Butterflies: pollinators of the Tropics

**COURSE CODE:** ENV

**TOTAL CONTACT HOURS:** 60

**LOCATION:** 3500

**INSTRUCTOR:** Dr. Francisco Gonzalez

**COURSE DESCRIPTION**

This course focuses on understanding the basic biology, identification, classification, conservation and promotion of insect plant pollinators, particularly bees and butterflies. In recent years, it has been demonstrated the devastating effects of excessive pesticide use, air pollution and habitat loss over pollinator insects, the most important ecosystem components for human survival. This course will cover the basic and applied principles of insect biology as well as provide a practical overview of the most common bees and butterflies in the Neotropical conditions of Costa Rica. From a practical point of view, we will learn how to start, maintain and use bee colonies as well as butterfly gardens, while from the theoretical side we will learn their economic and cultural importance under principles of sustainable development. This course will be based on field trips, talks, the study of multimedia, literature, visits and practical contact with insects. Therefore, this course is aimed to any student with an interest in biology, sustainability, apiculture, anthropology and entomology.

This is a course of Environmental Sciences (theoretical and practical) and answers the following question:

**What is the role of bees and butterflies in pollination of the tropics and how can we protect them?**

To answer this question the following aspects will be studied:

- Basic concepts of insect biology
- What is pollination and insect mediated pollination
- Characteristics of Lepidoptera (moths and butterflies)
- Characteristics of Hymenoptera (bees, bumblebees)
- History of Apiculture
- Beekeeping around the world
- Use of honey and bee-derived products
- Threats to bee pollination
- Butterflies conservation
- Butterfly gardens and ecotourism
- Rearing of honey-producing bees
- Rearing of butterflies
- Pests and diseases that hamper pollinators rearing
- Optimization through biological design

Along the course the following abilities and skills will be promoted:

- Analyze the historical perspectives of honey production
- Understanding of the context, reasons and motivations for conservation of pollinators
- Creativity for design
- Development of strategical thinking sensitive for sustainable development.

The following values and attitudes will be promoted in the students:

- Respect for the environment and human groups (farmers, aboriginal people).
- Logical and critical thinking.
- Innovation in a tropical setting.
- Goal-oriented thinking.
- Team work and leadership.
- Empathy and sensitivity.

### Competencies, criteria and evidence

The following defines the competencies (specific and general), the criteria and the performance evidence for their evaluation in this course.

Competency type	Criteria	Performance evidence
<b>Specific</b>  Understands the concept of insect mediated pollination and the need for protection of bees and butterflies, along with knowledge of how to promote these insects	He/she i can recognize different orders of insects.	Mind Maps
	He/she is able to explain basic biology principles of insect life cycles.	Mind maps
	He/she distinguish the reasons for the insect pollinator crisis	Round Table
	He/she can investigate and propose new uses and opportunities of bees and butterflies in the XXI century	Essay
	The students are able to conduct a report in which they develop a bees or butterfly related project.	Project Report
<b>General</b>		
Integrate concepts, nomenclature and key elements from the course to be used in his/her upcoming professional life.	Learning to learn	Mind Maps / Round Table
Develops the skills and techniques to communicate and transfer knowledge through visual, oral and wrtitten forms.	Written, visual and oral communication.	Essay / Project
Incorporates and shares knowledge interpersonally to achieve a common goal through team work and leadership.	Team work and leadership.	Project
Integrates knowledge and logical thinking in a respectful way to review his/her own work and others.	Respect for others and empathy. Conflict solving. Sensitivity and assertive criticism. Logical thinking.	Round Table / Presentation Project

## Contents

### Subject 1. What are insects?

- Insects anatomy
- Insects life cycles
- Insect orders

### Subject 2. What is pollination?

- Ecological aspects of pollination
- Different types of pollination
- Insect pollination

### Subject 3. Lepidopterans, Moths and butterflies

- Characteristics of Lepidoptera
- Moths and butterflies of the Tropics
- Most common families of Lepidoptera
- Communication between butterflies and moths

### Subject 4. Hymenopterans, Bees

- Types of social and non-social Hymenopterans
- Bees, bumblebees, stingless bees
- Communication in bees

### Subject 5. Apiculture

- History of Apiculture
- Beekeeping around the world
- Honey production and other uses

### Subject 6. Pollinators crisis

- Effects of pesticides
- Habitat loss and pollinators abundance
- Countermeasures

### Subject 7. Butterflies conservation

- History of butterflies conservation
- Methods to promote butterfly abundance and diversity
- Studies of butterfly ecology and conservation
- Butterfly rearing and eco-tourism

### Subject 8. Rearing of honey-producing bees

- Types of bees
- Hive design
- Members of the hive
- Beekeeping and management

### Subject 9. Rearing of butterflies for garden

- Specimen collection
- Needs of each physiological state
- Food sources

### Subject 10. Health of pollinators rearing

- Ecology of natural enemies
- Pests and diseases of bee production

### Subject 11. Biological design to optimize production

- Examples of nature-inspired optimization of honey production
- Design of targeted pollination through human manipulation

## Methodology

This is a course of active interaction between the students and the professor, where knowledge is developed through the participation of both parts. Attendance is compulsory, although two unexcused absences are allowed.

Assistance to visits is compulsory. Emergency absence will be excused when proper documentation is provided.

This course utilizes the PBL (problem-based learning) and the TBL (team-based learning) as educational strategies. This means that students are expected to solve research questions individually and in groups through the different activities planned by the professor. Additionally, students will learn and perform critical analysis of their own as well as others work.

### **Performance activities**

The following activities will be used as evaluating evidence of student performance:

- Mind Maps: the students will prepare, summarize, extract and present the most important aspects related to the subject assigned.
- Round Tables: the students will prepare arguments and questions to participate in each one of subjects designated as controversial presenting different aspects of the same subject.
- Essay: each student will correlate the acquired knowledge with his or her own studies and predict applications on their professional careers.
- Project: students will analyze, gather literature, consult experts, prepare and present a project that has to be complemented with the field trip. In parallel, they will study the assignment of other students of the class and prepare to be their reviewers during the final presentation date.

### **Educational Resources**

Lessons will take place in a laboratory/classroom with the essential equipment for teaching and learning of this subject. There is going to be a visit to at least one butterfly farm and bee production site. Visits will also include most of the essential elements for learning. Reading material will be provided by the professor and the university. In case of other needed literature the student will have the availability of the university library to check books and online resources.

### **Evaluation**

The evaluation of the course will be based on the performance evidence (items) produced by the student and the examination by the teacher using the criteria mentioned above. The following shows the details of each one.

<b>Items</b>	<b>Percentage</b>
Mind Maps	10%
Round Tables	10%
Essay	20%
Class assignments and participation	30%
Project	30%
TOTAL	100%

The following extends on the evaluation criteria of each part:

### Mind Maps

This strategy helps to learn, summarize, code, organize, memorize, analyze and discriminate among the different aspects of new knowledge. Mind maps will be produced in small groups and will be presented to the class. This activity will take place twice and the subjects will be given by the teacher. Each mind map will have a value of 10% and the evaluation criteria will be the following:

<b>Indicator</b>	<b>Excellent (100-90%)</b>	<b>Very Good (89%-80%)</b>	<b>Good enough (79%-70%)</b>	<b>Insufficient (69% or less)</b>
The main idea and concepts are represented by clear images and relations Value 3	The full image is direct, relevant and unambiguously represent the main idea and concepts	The full image is close to represent the main idea and concepts	The full image contains related concepts but their relation is not clear	The full image does not represent the assigned main idea and concepts
Starts from the centre and then irradiates the concepts and ideas related to the main subject Value 2	Full agreement with the indicator	Follows the idea of the indicator but some sides are not evenly distributed	The main idea is not in the centre, but some other ideas are properly distributed	The main idea is not centred and the others are not properly distributed
There is a clear hierarchical organization of the ideas and concepts Value 1	Full agreement with the indicator	Most of parts follow a clear hierarchy	At some parts the hierarchy is not clear	The hierarchy is not properly used
Uses lines, arrows, icons, images or any others to differentiate and clarify different categories and to form relationships among ideas Value 2	Full agreement with the indicator	Most of visual aids are properly used and transfer a sense of organization	Some of the visual aids cause confusion or are not used properly	The visual aids cause confusion and are not used properly making the map unintelligible
The quality of the final map is of the best standards: visually attractive, with no spelling mistakes, organized and clear Value 2	Full agreement with the indicator	Design and contents are attractive but there are spelling mistakes	Design and contents are not in their best form, there are multiple spelling mistakes, unknown acronyms and instead looks like a draft	Design and contents are not inviting at all and there are multiple spelling mistakes, acronyms and others that are unintelligible

**Round Tables**

This strategy promotes research techniques, logical and critical thinking and oral transfer of knowledge among peers. There will be three round tables that will allow students to comprehend and to participate in the discussion of controversial subjects related to pollinators. The week previous to the session, the teacher will provide basic literature for the students to prepare, but each group is responsible to extend in the knowledge for better performance during the round table. Each round table session will have a value of 10% and the evaluation criteria will be the following:

<b>Indicator</b>	<b>Excellent (100-90%)</b>	<b>Very Good (89%-80%)</b>	<b>Good enough (79%-70%)</b>	<b>Insufficient (69% or less)</b>
The students read the literature and further read other associated literature that they found Value 3	The student has a clear knowledge of what scientific literature has to say about the subject (assigned and self-found)	The student has a wide knowledge of the assigned literature and some other references	The student read the assigned literature but did not look for anything else	The student did not read any material for the round table
All the students of the group have discussed the subject and know the most important aspects of their participation in the round table Value 2	Full agreement with the indicator	Most of students discussed the subject and know the main points of their participation in the round table	Students read the literature but did not discuss among them the participation in the round table	The students did not read and did not discuss the subject
Students have prepared appropriate questions for other groups and are able to argument against or in favour of each position Value 5	Students respectfully and critically formulated questions to discuss with other groups and are able to formulate positions about the subjects	Students have prepared questions for others and can defend their own positions	Students have prepared questions but are not able to defend a position	Students did not prepare for the questions round.

**Essay**

This assignment aims to make students reflect, integrate and think logically of the relevance of the course in respect to their own professional careers. This essay will be individual and will have a value of 20% of the final mark. The criteria will be evaluated as follows:

<b>Indicator</b>	<b>Excellent (100-90%)</b>	<b>Very Good (89%-80%)</b>	<b>Good enough (79%-70%)</b>	<b>Insufficient (69% or less)</b>
The essay includes 10-12 pages that contain: cover page (1 page), introduction (1 page) essay body (7-9 pages), conclusions (1 page) and references (as many pages as needed) Value 0.5	The essay fully includes all the necessary parts	All the most relevant information is included	Some less important information (such as some references) might be missing	Any fundamental part is missing
The introduction clearly states the main facts of the background, the research question that the essay aims to answer and the objectives of the essay Value 3.5	Full agreement with the indicator	Some aspects of the background and research questions are not completely clear at the beginning	Although the background is not so clear, the main question and objectives are clear	The background, research question and objectives are not clear
The essay follows a logical order with interconnected ideas that respond to the objectives of the essay Value 5	Full agreement with the indicator	Most of parts follow a clear hierarchy	At some parts the hierarchy is not clear	The hierarchy is not properly used
There is a clear argumentative input that correlates literature, theory and the personal learning experience of the student Value 5	Full agreement with the indicator, the student manifests an opinion based on literature and own observations whenever possible	The student the student manifests an opinion based on literature and own observations in some particular cases	There is some input of personal opinion at some level	There is not personal argumentative opinion or the opinion does not have a verifiable base
Grammar and spelling follow high standards Value 1	Full agreement with the indicator	There are some grammatical or spelling mistakes	There are multiple grammatical and spelling mistakes	There are many grammatical and spelling mistakes that make reading difficult

<p>Conclusions are fact-based, clear and reflect the opinion, findings and position of the author</p> <p>Value 5</p>	<p>Full agreement with the indicator</p>	<p>Conclusions reflect at some degree authors opinion in the light of the findings</p>	<p>Conclusions are fact based but do not state the opinion of the author</p>	<p>Conclusions do not indicated the opinion of the author and are not logical from the findings of the essay</p>
<p>References are properly cited (APA format) and all references are from verifiable, serious sources (preferably scientific journals, books, avoiding websites)</p> <p>Value 3</p>	<p>References are properly cited on text, properly described in the references section and all sources are from scientific sources (natural and social sciences books and journals)</p>	<p>Most of references are properly cited and obtained from scientific sources</p>	<p>At least the most important sources in which the essay is based on are properly cited and obtained from scientific sources</p>	<p>The student based his/her essay in a non-scientific reference and/or did not follow the citation format (APA)</p>
<p>The essay follows the following specifications: Font Arial 10, 1.5 spacing, titles and subtitles properly categorized following a logical order (bold, capital letters, italics, etc.), scientific names are italics, figures and tables properly presented</p> <p>Value 2</p>	<p>Full agreement with the indicator</p>	<p>There are a few of format changes but do not compromise the understanding of the document</p>	<p>Some changes in the format compromise the understanding of the document</p>	<p>The student did not follow the recommendations of format</p>

### **Project**

This assignment aims to familiarize students with real-life cases of an entomology project. At the same time, it promotes cooperative work and constructive criticism. To do this, the students will pick to work with either bees or butterflies and explore their chances to develop a sustainable productive project with demonstrative evidence in a report and an oral presentation to the rest of the class. This is a team-based project and will have a value of 30%. It will be evaluated as follows:



<b>Indicator</b>	<b>Excellent (100-90%)</b>	<b>Very Good (89%-80%)</b>	<b>Good enough (79%-70%)</b>	<b>Insufficient (69% or less)</b>
The report includes: cover page (1 page), introduction (1 page), methodology (1-2 pages), recommendations (1-5 pages), supporting information and references (as many pages as needed)  Value 1	The report fully includes all the necessary parts	All the most relevant information is included	Some less important information (such as some references) might be missing	Any fundamental part is missing
The introduction clearly states the main facts of the background and the main problem to solve  Value 2	Full agreement with the indicator	Some aspects of the background and the main problem to solve are not completely clear at the beginning	Although the background is not so clear, the main question and objectives are clear	The background, and the main problem to solve are not clear
The methodology states clearly what was the strategy followed to find solutions to this problem  Value 5	The methodology details all the resources used to come up with solutions (expert consulted, literature, data bases, online tools, etc.)	The methodology is detailed in some aspects but not in others	The methodology at least mentions (with no details) the main sources used to come up with solutions	The methodology does not state the sources for the solutions proposed
The conclusions are realistic, ready to implement, detailed but explicit, are based on scientific sources and demonstrate analysis, discussions and extensive use of the available resources  Value 5	Full agreement with the indicator	Most of recommendations are explicit and ready to implement with verified scientific sources	Some recommendations are not clear, realistic or ready to implement, but most are based on scientific sources	The recommendations are not relevant or based on scientific sources
Grammar and spelling follow high standards  Value 2	Full agreement with the indicator	There are some grammatical or spelling mistakes	There are multiple grammatical and spelling mistakes	There are many grammatical and spelling mistakes that make reading difficult

Supporting information provides all the necessary data for the client to proceed. For example, if microorganisms, genes or tools are recommended, the most important information must be provided in this section (sequences, similar studies, specific protocols, etc)	Full agreement with the indicator, all the recommendations are supported with a wide range of supporting data	Supporting information is extensive in the most important recommendations	There is some relevant supporting information	There is not supporting information
Value 5				
References are properly cited (APA format) and all references are from verifiable, serious sources (preferably scientific journals, books, avoiding websites)	References are properly cited on text, properly described in the references part and all sources are from scientific sources (natural and social sciences books and journals)	Most of references are properly cited and obtained from scientific sources	At least the most important sources in which the essay is based on are properly cited and obtained from scientific sources	The student based his/her essay in a non-scientific reference and/or did not follow the citation format (APA)
Value 3				
The project report uses the following specifications: Font Arial 10, 1.5 spacing, titles and subtitles properly categorized following a logical order (bold, capital letters, italics, etc.), scientific names are italics, figures and tables properly presented	Full agreement with the indicator	There are a few of format changes but do not compromise the understanding of the document	Some changes in the format compromise the understanding of the document	The student did not follow the recommendations of format
Value 2				
The students are able to confidently present their recommendations for an entomology project, including background, main problem to solve, their methodology to find answers and the recommendations, as well as being able to review the research assignment of another group of students	All the students are able to properly show and defend all the parts of their assignment in a talk, and at the same time to evaluate, review and give feedback to another group	Students can show and defend their assignment, but are not properly evaluating the research of the classmates, or the other way around	Students can barely show and defend the logic behind their research and can barely evaluate others	Students cannot properly defend their research or evaluate others
Value 5				

**Bibliography:**

Bonebrake, T.C., Ponisio, L.C., Boggs, C.L. and Ehrlich, P.R., 2010. More than just indicators: a review of tropical butterfly ecology and conservation. *Biological conservation*, 143(8), pp.1831-1841.

Goulson, D., Nicholls, E., Botías, C. and Rotheray, E.L., 2015. Bee declines driven by combined stress from parasites, pesticides, and lack of flowers. *Science*, 347(6229), p.1255957.