IB 433 - INSECT PHYSIOLOGY

Instructor

Dr. Marianne Alleyne Department of Entomology <u>vanlaarh@illinois.edu</u> 317 Morrill Hall 217-333-8652 (office) BlueSky: @Cotesia.bsky.social *Student Hour* Tues 2-3 PM (after class)



Course Description

This course is an in-depth examination of the principal physiological and biochemical functions of insects. The course covers the history of the field of insect physiology, as well as the current status, and future directions. Connections will be made between insect physiology ("how insects work") and insect genomics, insect ecology, integrated pest management, etc.

Course duration: Full Semester

Course Information

IB 433 Insect Physiology

- Lecture: 2083 NHB, T & Th, 80 minutes
- Prerequisites: IB 202 and IB 401
- 3 hours Undergraduate
- 4 hours Graduate

This course meets for 3 hours weekly, and students are expected to work an additional six hours a week outside of class meeting times on course assignments. As a four-hour course for graduate students, these students are expected to work eight hours per week outside class.

Course Website

All assignments will be posted and submitted on the course website. (learn.illinois.edu)

Class Meeting Times and Location

1	Lecture	IB 433	T-Th — 80	2083 Natural History Building
			minutes	

Course Learning Goals

- Master an understanding of how insects function.
- Become familiar with the past, present, and future of insect physiological research.
- Synthesize information from model systems and apply what you learned to diverse insect systems.
- Understand how insect physiology relates to other fields of entomology, as well as to human society.

Student Learning Outcomes

- Discuss the relationship between biochemical processes and anatomical structures involved in allowing insects to complete various physiological processes.
- Illustrate how various biochemical, molecular, and physiological systems are interdependent.
- Evaluate seminal experiments conducted by the major players in the field of insect physiology and how their work contributed to our current understanding of insect function, while also gaining an appreciation for how a lack of diversity and inclusivity might have hampered the field.
- Analyze, interpret, critique, and synthesize classical and recent primary literature on insect physiology.
- Compare and contrast the physiological systems among insects with diverse life histories.
- Develop conclusions on to what extent insects are good model systems for studying broader biological fields and why.
- Analyze the interchange between insect species' physiology and its evolution, ecology, and behavior.
- Predict which aspects of insect physiology can be used for insect control purposes.
- Be inspired by insect physiological systems to design new technologies, materials, and structures. (Bioinspired Design)

Required Textbook

 Physiological Systems in Insects, 4th Edition. 2022. Marc J. Klowden and Subba Reddy Palli



 Journal articles, videos and other materials will be posted to the course website and/or provided in class

The book is available through the UIUC library electronic textbook access.

- 1. Go to <u>library.illinois.edu</u>
- 2. Log-in using your UIUC ID
- 3. Search for [Physiological Systems of Insects] and click on the Fourth Edition
- 4. Click on the ScienceDirect E-books link
- 5. Download the pdf of the desired chapters

Course Organization

The topic of this course is "how insects work." The great insect physiologist Sir Vincent B. Wigglesworth opened his 1934 monograph on insect physiology by stating that his goal was to describe the "fundamental processes of vital activity," but then went on to make it clear that he would begin by dealing with "physiology on the humbler plane: with the grosser functions of the organs and tissues, and with the mechanisms by which these functions are coordinated to serve the purpose of the insect as a whole." And so will it be with IB 433.

This course consists of lectures, online content, required readings, content on important classic experiments and the "famous" insect physiologists who performed them, and (for graduate students) student-created content about physiologists currently active.

Content is provided by the lectures, textbook, online lessons, as well as through recently published research and review articles. Historical context is provided by the lectures, the textbook, and biographies and classic articles of insect physiologists.

It is assumed that the students know the basics of vertebrate physiology, so review will be limited. The following biases of the instructor will be evident. First, the emphasis will be on general solutions to physiological problems rather than on specialists (however, I will try to cover interesting observations on insects that the students are working on for their own research). Second, even though the solutions reflect phylogeny, this aspect of the subject will not be emphasized. Third, physiological adaptations also reflect ecology, but this will not be emphasized. Fourth, understanding the basics of molecular biology is required, but is not the whole story, the same goes for biochemistry. Fifth, the emphasis will be on a fairly narrow range of "model" insects useful for physiological studies rather than on diversity or on specific beneficials and pests (but again, I will try to also mention some of the insects studied by the student and welcome any input). Sixth, bioinspired design is my research area, and it will be heavily featured during the lectures.

Lecture Schedule

It is the instructor's goal to provide an interactive learning classroom. During every in-person class meeting students will be involved in active learning projects in the class. Other times the

instructor will use the whiteboard to cover a topic. Occasionally Powerpoint presentations will be used. Lecture content will be posted on the course website shortly before class, but in abbreviated form. To complete the content the students should enter information they deem important on those electronic notes provided.

Lectures will closely follow the topics in the Klowden & Palli textbook. I encourage discussion and questions during class. Please feel free to make suggestions on how lectures may be improved. I especially welcome content in different modalities that could be shared with the rest of the class.

Lecture Modality Legend

Live face-	to-face lecture in 2083 NHB
Asynchro	nous lecture: recorded lecture available on course webpage
Synchron	ous virtual lecture: zoom link available on course webpage
Assignme	ent to be completed

Week 1 – January 16 & 18

L1-Tuesday	Course SyllabusIntroduction to Insect Physiology	
	 Homeostasis 	
L2-Thursday	 Insect Integument 	Reading for Quiz #1: It's not a Bug, It's
	Cuticle Chemistry	a Feature: Functional Materials in
		Insects. Schroeder et al. Adv. Mat. V
		30, 2018 (<u>PDF link</u>)

Week 2 – January 23 & 25

L3-Tuesday	Cuticle Chemistry (Continued)Molting	
L4-Thursday	 Endocrine System – Introduction History of Insect Endocrine System Research. 	Quiz #1 via LMS, complete before noon.

Week 3- January 30 & February 1

<i>L5</i> -Tuesday	 Endocrine System – History (Continued) PTTH 	Reading for Quiz #2: Developmental Mechanisms of Body Size and Wing- Body Scaling in Insects. Nijhout & Callier. Ann. Rev. Entomology. V 60, 2015 (PDF link)
<i>L6</i> -Thursday	 Endocrine System – Juvenile Hormone 	Submit Exam Question on Assigned Topic (Round A), complete before midnight.

Week 4 – February 6 & 8			
L7-Tuesday	• Endocrine System – Ecdysteroids	Quiz #2 via LMS, complete before midnight.	
<i>L8</i> -Thursday	 Reproductive System - Introduction 	Peer-review Exam Question on Assigned Topic (Round A), complete before midnight Reading for Quiz #3: Regulatory Pathways Controlling Female Insect Reproduction. Roy et al. Ann. Rev. Entomology V 63, 2018 (PDF link)	

Week 5 – February 13 & 15

Monday (Feb 12)		Interview Project: Subject Selection
<i>L9</i> -Tuesday	 Reproductive System – Production 	Quiz #3 via LMS, complete before midnight
<i>L10</i> -Thursday	• Digestive System - Introduction	Reading for Quiz #4: Extracellular Nutrient Digestion and Absorption in the Insect Gut. Holtof et al. Cell and Tissue Research. V 377, 2019 (PDF <u>link</u>)

Week 6 – February 20 & 22

L11-Tuesday	 Digestive System (con't) 	Quiz #4 via LMS, complete before midnight
<i>L12</i> -Thursday	 Nutrition Metabolism 	Submit Exam Question on Assigned Topic via LMS (Round B), complete before midnight Reading for Quiz #5: Lipid metabolism in Insect Disease Vectors. Gondim et al. Insect Biochem and Mol Biol. V 101, 2018 (PDF link)

Week 7 – February 27 & 29

L13-Tuesday	• Trehalose	Quiz #5 via LMS, complete before
	 Intermediary Metabolism 	midnight
L14-Thursday	 Circulatory System 	Peer-review Exam Question on
	Cellular Immune System	Assigned Topic (Round B), complete
		before midnight

×	Reading for Quiz #6: The Insect
	Circulatory System; Structure,
	Function, and Evolution. Hillyer &
	Pass. Ann. Rev. Entomology V 65,
	2020 (<u>PDF link</u>)

Week 8 – March 5 & 7

Monday (Mar 4)		Interview Project: Literature Review Post
L15-Tuesday	 Cellular Immune System – Continued Humoral Immune System 	Quiz #6 via LMS, complete before midnight
L16-Thursday	 Respiratory System - Introduction Adaptations 	Reading for Quiz #7: Functional Hypoxia in Insects: Definition, Assessment, and Consequences for Physiology, Ecology, and Evolution. Harrison et al. Ann. Rev. Entomology V 63, 2018 (PDF link) Interview Project: Literature Review Replies and Wrap-up.

Spring Break – March 9 - 13

Week 9 – March 19 & 21			
L17-Tuesday	Respiratory System –	Quiz #7 via LMS, complete before	
<i>L18</i> -Thursday	 Adaptations (Continued) Excretory System – Introduction 	midnight Submit Exam Question on Assigned	
LID-IIIUISUAy	Nitrogen Metabolism	Topic via LMS (Round C), complete	
		before midnight	
		Reading for Quiz #8: Physiology,	
		Development, and Disease Modeling	
		in the Drosophila Excretory System.	
		Cohen et al. Genetics, V 214, 2020	
		(PDF link)	

Week 10 – March 26 & 28

Monday (Mar 25)		Interview Project: Interview Proposal	
L19-Tuesday	• Excretory System – Adaptations	Quiz #8 via LMS, complete before	
		midnight	
L20-Thursday	• Muscular System – Introduction	Peer-review Exam Question on	
	Comparative Muscular Systems	Assigned Topic (Round C), complete	
	. , ,	before midnight	

	Reading for Quiz #9: Mimicking
	Nature's Flyers: A Review of Insect-
	Inspired Flying Robots. Phan & Park.
	Current Opinion in Insect Science,
	V42, 2020 (<u>PDF link</u>)

Week 11 – April 2 & 4		
L21-Tuesday	Flight Metabolism	Quiz #9 via LMS, complete before midnight
L22-Thursday	 Biomechanics – Terrestrial Locomotion 	Watch Video For Quiz #10: How Flies Fly (3 parts). Featuring Michael Dickinson

Week 12 – April 9 & 11

Monday (Apr 8)		Interview Project: Interview Date Finalized
L23-Tuesday	 Biomechanics – Flight and Aquatic Locomotion 	Quiz #10 via LMS, complete before midnight
<i>L24</i> -Thursday	 Nervous System - Introduction 	Submit Exam Question on Assigned Topic via LMS (Round D), complete before midnight
		Reading for Quiz #11: Central Pattern Generating Networks in Insect Locomotion. Mantziaris et al. Dev. Neurobiology. V 80, 2020 (<u>PDF link</u>)

Week 13 – April 16 & 18		
L25-Tuesday	 Nervous System - Brain and Ganglia 	Quiz #11 via LMS, complete before midnight
	Sensory SystemMechanoreception	Peer-review Exam Question on Assigned Topic (Round D), complete before midnight
		Reading for Quiz #12: Evolution of Insect Color Vision: From Spectral Sensitivity to Visual Ecology. Van Der Kooi, et al. Ann Rev. Entomology V 66, 2021 (<u>PDF link)</u>

Week 14– April 23 8	.25
Monday (Apr 22)	Interview Project: Final Paper/Podcast/Video Submission

L27-Tuesday	 Mechanoreception (Continued) Visual Reception 	Quiz #12 via LMS, complete before midnight
L28-Thursday	 Chemical Communication 	

Week 15– April 30

Monday (Apr 29)		Interview Project: Peer Review
		Submit Exam Question on Assigned Topic via LMS (Round E), complete before midnight
L29-Tuesday	Chemical Communication (con't)	
Wednesday (May 1)		Peer-review Exam Question on Assigned Topic (Round E), complete before midnight

Final Exam – Monday May 6th - 1:30pm - 4:30pm

Learning Assessments and Course Assignments

Quizzes

Readings Quizzes: At the end of a topic module a quiz is due before the next lecture (check schedule). The questions will cover the readings assigned for the topic module and to some extend will ask you to connect the readings to the lecture materials. The quiz will be relatively low stakes but will help assess the level of knowledge the students gained over the course of the module. The quiz will be available about 1 week prior to the due date. The quizzes will be administered through the course-website.

12 reading quizzes, each quiz is 10 points, scores of the top 10 will be counted = total of 100 points

Exam Questions Crowdsourcing

Five times during the semester you will be assigned a subtopic related to the insect physiological system that was discussed in the previous weeks. Keeping this topic in mind you are tasked to write a Final exam question for other IB 433 students. You are to use lecture material (including the history of the field), the required readings, and at least one recent (<5 year old) peer-reviewed, primary journal article to create the questions. Exam questions should:

- Assess achievement of instructional outcomes (the module's learning outcomes as stated at the beginning of each module or lecture.)
- Accurately reflect the emphasis placed on important aspects of instruction
- Measure an appropriate level of student knowledge
- Vary in level of difficulty as the student moves through the question

A final exam question should be divided into 5 sections each

- 1. Multiple choice or true/false questions testing basic knowledge
- 2. Fill in the blank questions with at least 1 blank in a statement
- 3. Short answer questions
- 4. Extended response questions

5. Problem-solving question incorporating data from a primary journal article The point distribution for this assignment is as follows:

- Creating a good-quality exam for another student following the template and instructions, with an accurate and complete key: up to 250 points.
- Peer-reviewing another student's exam, including the key: up to 100 points (*This assignment was inspired by FSHN 302 assignment created by Dr. Soo Lee.*)

5 exam questions, each question is 50 points = total of 250 points 5 peer-reviews of questions, each peer-review is 20 points = total of 100 points

Final Exam

Exam Questions created by the students over the course of the semester will be used to for the Final Exam. Please be aware that questions may not be used verbatim. For instance, in some cases values given in the question (e.g. chemical concentrations, biomechanical measurements) may be different from the original question, and would require you to show your calculations. However, reviewing all the question generated throughout the course should be a sufficient and comprehensive review for the Final exam.

1 Final Exam, total of 10 questions, each question 20 points = total of 200 points

Interview Project

Graduate Students are required to complete this assignment. Undergraduate students do not have to complete this assignment but they can earn extra credit points by serving as peer-reviewers (see point 6 below).

The final project for the course will focus on the work of a currently active insect physiologist. The activity consists of multiple parts, some of which you may have to conduct concurrently:

- Select an active insect physiologist to research (list of possible laboratory PIs will be provided by the instructor. A PI should not be contacted without checking first with the instructor. Not more than 1 student can pick a particular PI.). (Subject Selection – Monday, February 12th, 2024, missing deadline will result in deduction of points for literature review post)
- Write a post (1000-1500 words) about the current research this physiologist you chose is conducting based on (a minimum of) 3 recent peer-reviewed papers, their website, news articles, blog posts, or postings regarding their work. Review other students' posts. (Literature Review – Main post due Monday, March 4th, 2024, replies and wrap-up due Thursday, March 7th)
- 3. Submit an interview proposal to the instructor. This proposal should include at least 5 possible questions and a justification for why you want to ask that question. The proposal should also include a plan for how you will conduct the interview, remember

that this interview has to leave a professional impression with the scientist being interviewed. (Interview Proposal – Monday, March 25th, 2024)

- Contact the researcher and interview them (Interview Date Finalized Monday, April 8th, 2024)).
- Create ~10-page paper or ~10 min podcast or video of what you have learned and what you want your peers to know about the researcher and their work. (Paper/Podcast/Video – Monday, April 22nd, 2024)
- (assigned) Peer review of other students' final projects. (Peer review of Project Monday, April 29th, 2024)

!!! Undergraduate students can receive a maximum of 50 points of extra credit for also peer-reviewing the papers/podcasts/videos created by the graduate students. Please indicate to the instructor prior to Friday, April 19th, that you would like to serve as a peer-reviewer.

Undergraduate Students

Peer review of project = total of 50 points EXTRA CREDIT

Graduate Students

Literature review post = total of 75 points Interview Proposal = total of 25 points Paper/Podcast/video = total of 150 points Peer review of project = total of 50 points

Overall Course Grading

Undergraduate Student (3 credit hours)

Assignment	Points
Reading Quizzes (Top 10 scores out of 12 quizzes – 10p each)	100
Exam question (generation (5x50), peer-review (5x20)	350
Extra Credit: Peer Review Interview Project (1x50)	50
Final Exam (1x200)	200

Total points = 650 (+50 Extra Credit)

Graduate Students (4 credit hours)

Assignment	Points
Reading Quizzes (Top 10 scores out of 12 quizzes – 10p each)	100
Exam question (generation (5x50), peer-review (5x20)	350
Interview Project (literature review (75), proposal (25),	300
paper/podcast/video (150), peer-review (50))	
Final Exam (1x200)	200

Total points = 950

Grading for this course is based on absolute scale, such that:		
97% ≤ A+,	91% ≤ A < 97%,	89% ≤ A- < 91%
87% ≤ B+ < 89%,	81% ≤ B < 87%,	79% ≤ B- < 81%

Class Attendance & Participation

Attendance: 100% attendance is expected, and absences will detract from your grade. Absences are excused in special cases or due to illness. Please let me know immediately about conflicts due to conferences, research responsibilities, or prior scheduling conflict. Also, please email me if you are ill or have a family or medical emergency that will keep you from class. Illness protocols: Everyone's safety is the number one. If you are showing symptoms of any illness, please err on the side of caution and stay home. The instructor can meet with you virtually to go over the material.

Participation and preparation: Rather than a traditional bell-to-bell lecture, I want this course to be a dialogue or lively discussion of fascinating topics among close colleagues. In order to create this kind of learning environment, you MUST participate fully in each class. I expect you to have thoughtfully read the assigned material before each meeting. You should expect me to call on you; better yet, volunteer or raise your hand! Please feel free to ask me questions, add insights, correct my inaccuracies, and ask for clarification at any time during class.

Electronic device policy: Full participation in class activities is crucial for our learning and success. Electronic devices can enhance participation, but they can also become a distraction. Texting, taking phone calls, accessing social media, writing emails and conducting web searches on unrelated topics are not appropriate. Using your laptop, tablet or smart phone to make calculations, access relevant databases and take notes are encouraged. However, research studies have shown that students learn more and do better when they take notes by hand; therefore, I strongly encourage you to write out your notes.

Academic integrity: According to the Student Code, It is the responsibility of each student to refrain from infractions of academic integrity, from conduct that may lead to suspicion of such infractions, and from conduct that aids others in such infractions.' Please know that it is my responsibility as an instructor to uphold the academic integrity policy of the University, which can be found here.

<u>Expectations</u>: Academic dishonesty will not be tolerated. Examples of academic dishonesty include the following: Cheating, Fabrication, Facilitating infractions of academic integrity, Plagiarism, Bribes & Threats, Academic interference, Examination by proxy, Grade tampering, Non-original works

<u>Guidelines</u>: Should an incident arise in which a student is thought to have violated academic integrity, the student will be processed under the disciplinary policy set forth in the Illinois Academic Integrity Policy. If you do not understand relevant definitions of academic infractions, contact the instructor for an explanation within the first week of class.

To ensure that disability-related concerns are properly addressed from the beginning of the course, students with disabilities who require assistance to participate in this class are asked to see the instructor as soon as possible. Also, to obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES you may visit 1207 S. Oak St., Champaign, call 333-4603 (V/TTY), or e-mail a message to disability@illinois.edu.

Netiquette Statement (Courtesy of CITL)

In any social interaction, certain rules of etiquette are expected and contribute to more enjoyable and productive communication. The following are tips for interacting online via email or discussion board messages, adapted from guidelines originally compiled by Chuq Von Rospach and Gene Spafford (1995):

- Remember that the person receiving your message is someone like you, deserving and appreciating courtesy and respect
- Avoid typing whole sentences or phrases in Caps Lock
- Be brief; succinct, thoughtful messages have the greatest effect
- Your messages reflect on you personally; take time to make sure that you are proud of their form and content
- Use descriptive subject headings in your e-mails•
- Think about your audience and the relevance of your messages
- Be careful when you use humor and sarcasm; absent the voice inflections and body language that aid face-to-face communication, Internet messages are easy to misinterpret
- When making follow-up comments, summarize the parts of the message to which you are responding
- Avoid repeating what has already been said; needless repetition is ineffective communication
- Cite appropriate references whenever using someone else's ideas, thoughts, or words

Inclusivity Statement (Courtesy of Robyn Deterding (AHS))

The effectiveness of this course is dependent upon the creation of an encouraging and safe classroom environment. Exclusionary, offensive or harmful speech (such as racism, sexism, homophobia, transphobia, etc.) will not be tolerated and in some cases subject to University harassment procedures. We are all responsible for creating a positive and safe environment that allows all students equal respect and comfort. I expect each of you to help establish and maintain and environment where you and your peers can contribute without fear of ridicule or intolerant or offensive language.

Support Resources and Supporting Fellow Students in Distress

As members of the Illinois community, we each have a responsibility to express care and concern for one another. If you come across a classmate whose behavior concerns you, whether in regards to their well-being or yours, we encourage you to refer this behavior to the Student Assistance Center (1-217-333-0050) or online at odos.illinois.edu/community-of-care/referral/Based upon your report, staff in the Student Assistance Center reaches out to students to make sure they have the support they need to be healthy and safe. Further, as a Community of Care, we want to support you in your overall wellness. We know that students sometimes face challenges that can impact academic performance (examples include mental health concerns, food insecurity, homelessness, personal emergencies). Should you find that you are managing such a challenge and that it is interfering with your coursework, you are encouraged to contact the Student Assistance Center (SAC) in the Office of the Dean of Students for support and referrals to campus and/or community resources. The SAC has a Dean on Duty available to see students who walk in, call, or email the office during business hours. For mental health emergencies, you can call 911 or contact the Counseling Center.

Misconduct Policy and Reporting

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX and Disability Office. In turn, an individual with the Title IX and Disability Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options. A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: https://wecare.illinois.edu/resources/students/#confidential

Other information about resources and reporting is available here: wecare.illinois.eduUIUC

Helpful note to students: Remember, the instructor will try to help you in any way to make you successful in this course. Please don't hesitate to make an appointment to see me virtually or in person, if you need any guidance or assistance to make learning from this course as meaningful as possible to you.