



# FISH 406: Parasite Ecology

**Instructor:**

Professor Chelsea Wood

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## Course Outline

**Lectures:** MWF, 12:30pm–1:20pm in FISH 107

**Labs:** Tuesdays, 1:30pm–4:20pm in FTR 125/129

**Office hours:** Wednesdays, 1:30pm–2:30pm in FISH 202B and by appointment

**Pre-requisites:** BIOL 180

**Credits:** 4 credits + this course counts toward the UW Additional Writing (W) requirement

**Required readings:** Foundations of Parasitology, Roberts and Janovy (used copies available from \$20 on Amazon); additional reading material (including chapters of Karban and Huntzinger's book, see below) available as pdfs through Canvas; *for graduate students only (undergrads welcome but not required to read along)* – Parasitism: The Ecology and Evolution of Intimate Interactions, Combes (used copies available from \$8 on Amazon)

**Optional (but highly recommended) readings:** Parasite Rex, Carl Zimmer (used copies available from \$8 on Amazon.com); Richard Karban and Mikaela Huntzinger's book, How to Do Ecology: A Concise Handbook, will be an indispensable resource as you develop your research proposal. You are required to read Chapters 1, 2, and 6, and these will be provided as pdfs on Canvas. But I encourage you to read the entire book, available on Amazon for ~\$5 used.

**Optional multimedia:** Two podcasts – This Week in Parasitism (TWiP; [www.microbeworld.org/podcasts/this-week-in-parasitism/archives](http://www.microbeworld.org/podcasts/this-week-in-parasitism/archives)) and selected episodes of RadioLab ([www.radiolab.org/archive/](http://www.radiolab.org/archive/))

## Course Description

Parasites are ubiquitous: no ecosystem exists without them, and among all of Earth's species, parasites outnumber non-parasites. But because they are usually small and hidden within their hosts, parasites can be easy to overlook. This course will introduce students to these rarely studied creatures, which span the entire tree of life, occupy all of Earth's habitats, and influence many ecological processes.

Our material will survey all metazoan parasites, most protozoa, and some bacteria and viruses, addressing their distribution, ecology, and physiological effects on human and wildlife hosts. Because this is an ecology course, we will survey parasite diversity in light of evolutionary diversification. Phylogenetic relationships within and among groups will provide the framework for the course.

Within this phylogenetic framework, the bulk of our time will be spent exploring general disease ecology theory through relatable case studies of individual taxa. We will explore fundamental principles of parasite populations and communities. We will investigate the effects of parasites on host populations (e.g., host population regulation), communities (e.g., parasite-mediated competition), and ecosystems (e.g., nutrient availability). We will strive to put parasites into a food-web context, assessing the impacts of parasites on food webs (e.g., connectance, nestedness, energy flow, biomass, food chain length) and of food webs on parasites (e.g., dilution effect hypothesis, biodiversity-begets-biodiversity hypothesis). Finally, we will use our accumulated knowledge to make predictions for how disease transmission might respond to human impacts like biodiversity loss, climate change, and urbanization and will evaluate the interventions available for wildlife and human disease control (e.g., vaccination, culling, environmental modification, biological control).

## Learning Goals

By the end of the semester, I expect you will be able to:

1. recognize each of the major groups of parasites and describe their basic life cycles
2. analyze and critically evaluate graphical representations of data (from the scientific literature) and raw epidemiologic datasets (presented during lab sessions)
3. interpret, evaluate, and synthesize primary literature in parasite ecology (accomplished via writing assignment and "elevator pitch" presentation)
4. apply your knowledge of disease ecology to generate novel ideas for the management of wildlife diseases (accomplished via writing assignment)
5. critique your colleagues' ideas respectfully yet substantively
6. communicate ideas about the ecology of disease effectively, in writing and speech

## Evaluation

	<b>Assessment</b>	<b>Due</b>	<b>Proportion of your final grade</b>
<b>Exams</b>	Exam 1	29 Oct, 12:30p-2:30p	20%
	Exam 2 (partially cumulative)	7 Dec, 12:30p-2:30p	20%
<b>Term project</b>	You are assigned a focal parasite/disease	16 Oct	n/a
	You pitch your ideas for managing the transmission of your assigned parasite	30 Oct	0% – this is to encourage you to be as creative as possible! No ideas are too far-fetched.
	You submit a first draft of your 10-page term paper for peer review by a classmate	6 Nov	n/a
	Classmate provides peer review of your draft	13 Nov	n/a
	You provide peer review of classmate's draft	13 Nov	10% – peer review makes the science world go 'round. Here, you get to practice providing constructive suggestions to colleagues.
	You revise and give me the second draft	21 Nov	0% – your work on the term paper will not be graded until you submit the final version. This should give you the opportunity to put together a stellar paper, and lets you experience the iterative process of scientific writing.
	I hand draft back to you with feedback	28 Nov	0%
	You give a 5-minute oral presentation of your findings (an "Elevator Pitch")	4 Dec	10%
	You hand in your final draft (10 pages double-spaced)	13 Dec	20%
<b>Participation</b>	Lab notebook	4 Dec	10% – getting to know the parasites can be daunting. Careful scientific illustrations that are well-annotated help you to see the similarities, differences, and relationships among taxa, helping you to remember them.
	In-class, in-lab, and online participation	n/a	10% – see below for a detailed grading breakdown.

## Grading Scale\*

LETTER	PERCENT	GPA	NOTES
A	≥95	4.0	
A	94	3.9	
A-	93	3.8	
A-	92	3.7	
A-	91	3.6	
A-	90	3.5	
B+	89	3.4	
B+	88	3.3	
B+	87	3.2	
B	86	3.1	
B	85	3.0	
B	84	2.9	
B-	83	2.8	
B-	82	2.7	
B-	81	2.6	
B-	80	2.5	
C+	79	2.4	
C+	78	2.3	
C+	77	2.2	
C	76	2.1	
C	75	2.0	
C	74	1.9	
C-	73	1.8	
C-	72	1.7	
C-	71	1.6	
C-	70	1.5	
D+	69	1.4	
D+	68	1.3	
D+	67	1.2	
D	66	1.1	
D	65	1.0	
D	64	0.9	
D-	63	0.8	
D-	62	0.7	Lowest passing grade
E	<62	0.0	Academic failure, no credit earned

\*Note that there will be no curve.

### **Exam Policy**

Exams are scheduled for 12:30pm–2:30pm on Monday, 29 October and Friday, 7 December. Note that the end time (2:30pm) is one hour and ten minutes past regularly scheduled class time (which normally ends at 1:20pm). If you have a conflict – do not worry! Talk to me ahead of time and we can schedule an alternative exam time for you.

For unscheduled conflicts with exam times (e.g., medical emergency), make-ups will be available only if the emergency can be verified. If you miss an exam due to illness or other emergency, make sure that you or a friend contacts the instructor, Dr. Wood, by email at [chelwood@uw.edu](mailto:chelwood@uw.edu) within 24 hours of the exam. Documentation of illness will be required for any missed exam. To preserve the academic integrity of the course, the instructor reserves the right to alter the content and/or format of the original test in creating a make-up exam.

### **Extra Credit**

There will be bonus questions on exams that will require you to think hard, synthesize your knowledge, and creatively generate hypotheses for patterns. These questions will draw heavily from the textbook and pdf readings and from content presented by Guest Speakers.

### **Regrade Policy**

If you believe that an exam or assignment has been graded incorrectly, or that the grade entered is incorrect, you must contact me within one week of when the assignment was returned to you. Such a request must be submitted in writing (e-mail is fine) and must be accompanied by the original, unaltered assignment.

### **Academic Integrity**

Students at the University of Washington are expected to maintain the highest standards of academic conduct, professional honesty, and personal integrity. Plagiarism, cheating, and other misconduct are serious violations of the University of Washington Student Conduct Code (WAC 478-120). I expect you to know and follow the university's policies on cheating and plagiarism. Any suspected cases of academic misconduct will be handled according to University of Washington regulations. For more information, see the University of Washington Community Standards and Student Conduct website.

I don't expect anyone in this class to engage in academic misconduct – parasite ecology is a window into a new and exciting world, and cheating robs the cheater of the opportunity to explore and know that world. But just in case, I will state up front my policy for addressing academic misconduct: if you are caught cheating, falsifying data, plagiarizing, collaborating on assignments in a manner that is prohibited, or committing any other kind of academic misconduct as defined in the Student Conduct Code, you will receive an automatic zero on the assignment and the case will be referred to the College of the Environment for a Student Conduct Process hearing. If you are caught twice, you will receive a zero in the course and the case will be referred for an additional hearing.

## Posting of Grades

You will be able to access your grades via Canvas. All graded material (exams and essays) will be returned promptly during scheduled class or lab times. If you find that there is a clerical error in a posted score, please contact me as soon as you notice the error. Exam scores will be posted no more than 10 days after the exam date.

## Labs

Lab exercises are a key part of learning about parasites. You will work with a variety of living representatives of the groups discussed in lecture. We will also look at preserved specimens and slides. The Lab Notebook assignment is designed to help you engage with lab material, and will be graded by your instructor at the end of the quarter. Please adhere to the following guidelines in lab:

- No food or drink, including gum
- Always wear close-toed shoes
- Put any sharp waste (scalpel blades, broken glass) in the sharps container
- Handle preserved specimens and shells carefully
- Rinse tools before and after use
- Rinse your hands well with water only to remove lotions or soaps before touching live animals
- Handle all animals gently
- Keep live animals in water and avoid temperature, oxygen, and light shock
- Don't feed the animals unless you are instructed to
- Don't let animals dry out
- Never place dead animals in the garbage – put them in the bags provided
- Put preserved animals back in the correct jar
- Don't mix instruments used with live and dead animals
- If you are unsure of what to do, ask before you act

## Participation

Science education research has demonstrated that students who take an active role in their learning learn more and retain that knowledge longer; therefore, it is in your best interest to prepare for and actively participate in class meetings – including small group activities and whole-class discussions. This is a relatively easy way to earn points toward your final grade.

***One thing that may help you participate in class is bringing questions you have written out ahead of time.*** I will sometimes use a random name generator to call on students at random.

Your participation grade will be determined by how often you contribute in class, as well as the quality of those contributions. 10 points (of 10) = student goes beyond required reading, bringing in outside examples and knowledge beyond the scope of the course or connecting concepts across lectures, 8 points = regular participation, usually well thought-out, useful contributions; 6 points = regular participation, sometimes useful, sometimes not; 4 points = occasional participation that is generally useful; 2 points = occasional participation, but generally non-substantive, adding little new information; 0 points = rarely contributed. I can provide feedback on your participation at any point in the semester, at your request.

### **Attendance Policy**

Attendance is the best way to ensure you absorb the material and perform well on tests and assignments, but it will not be recorded. Absence from lab is to be absolutely avoided if at all possible, because you'll miss out on the opportunity to see demonstrations and slides that are designed to help you know the parasites well.

### **Guest Lectures**

We will have visitors lecture on various topics. You are expected to show extra respect to our invited speakers by arriving early, if possible, for these presentations, remaining engaged throughout the class period, and asking thoughtful questions at the end. There will be at least one question on each exam about the material presented by these speakers.

### **E-mail**

Any e-mail sent to me will receive a response within 48 hours. Detailed questions should be addressed to me in person – either after class or during office hours.

### **Late Assignments**

Late assignments will not be accepted and will receive a grade of 0%. If you anticipate having trouble meeting one of the deadlines set out in this syllabus, please discuss with me beforehand.

### **Incomplete (I)**

From UW's Faculty Resource on Grading: "An *Incomplete* is given only when the student has been in attendance and has done satisfactory work until within two weeks of the end of the quarter and has furnished proof satisfactory to the instructor that the work cannot be completed because of illness or other circumstances beyond the student's control... To obtain credit for the course, an undergraduate student must convert an *Incomplete* into a passing grade no later than the last day of the next quarter... An *Incomplete* grade not made up by the end of the next quarter is converted to the grade of 0.0 by the Office of the University Registrar... An *Incomplete* grade does not count for registered hours nor in computation of grade-point averages."

### **Classroom Climate**

Diverse backgrounds, embodiments, and experiences are essential to the critical thinking endeavor at the heart of higher education. I expect you to follow the UW Student Conduct Code in your interactions with your colleagues and me in this course by respecting the many social and cultural differences among us, which may include, but are not limited to: age, cultural background, disability, ethnicity, family status, gender identity and presentation, citizenship and immigration status, national origin, race, religious and political beliefs, sex, sexual orientation, socioeconomic status, and veteran status. Please talk with me right away if you experience disrespect in this class, and I will work to address it. DCinfo@uw.edu is a resource for students with classroom climate concerns.

### Access and Accommodations for Persons with Disabilities

It is crucial that all students in this class have access to the full range of learning experiences. At the University of Washington, it is policy and practice to create inclusive and accessible learning environments consistent with federal and state law. Full participation in this course requires the following types of engagement:

<b>Course component</b>	<b>Requirement</b>
Lecture	the ability to attend 3 hour-long lectures per week with up to 30 other students; the ability to complete two written and timed exams; the ability to compose a 10-page research paper; the ability to give an oral presentation before the class
Lab	the ability to participate in weekly 3-hour lab sessions that include dissections, use of microscopes, and observing the behavior of live animals; the ability to participate in group discussions; the ability to stand and sit for extended periods of time, engage in repetitive motion activities, and manipulate lab equipment

If you anticipate or experience barriers to your learning or full participation in this course based on a physical, learning, or mental health disability, please immediately contact the instructor to discuss possible accommodation(s). A more complete description of the disability policy of the College of the Environment can be found here:

<https://environment.uw.edu/intranet/academics/teaching/disability-accommodation/>. If you have, or think you have, a temporary or permanent disability that impacts your participation in any course, please also contact Disability Resources for Students (DRS) at: 206-543-8924 V / 206-543-8925 TDD / [uwdss@uw.edu](mailto:uwdss@uw.edu) e-mail / <http://www.uw.edu/students/drs>.

### Roles and Responsibilities

- *Student*: inform the instructor no later than the first week of the quarter of any accommodation(s) you will or may potentially require.
- *Instructor and TA*: maintain strict confidentiality of any student's disability and accommodation(s); help all students meet the learning objectives of this course.

### Accommodations for Religious Observances

Students who expect to miss class or assignments as a consequence of their religious observance will be provided with a reasonable alternative opportunity to fulfill their academic responsibilities. Absence from class for religious reasons does not relieve students from responsibility for the course work required during the period of absence. It is the responsibility of the student to provide the instructor with advance notice of the dates of religious holidays on which they will be absent. Students who are absent will be offered an opportunity to make up the work, without penalty, within a reasonable time, as long as the student has made prior arrangements. Pre-arranged absences for religious observances will not be counted against class participation.

## FISH 406: Parasite Ecology

### Schedule of Lectures and Labs

You are expected to have read these materials (from the textbook or course website) *before* each lecture. You are also expected to have read each lab overview before lab (available on the course website). This schedule is subject to change. R&J = Foundations of Parasitology, Roberts and Janovy. K&H = Karban and Huntzinger's How to Do Ecology: A Concise Handbook, pdfs of chapters available on Canvas. Combes = Combes' Parasitism: The Ecology and Evolution of Intimate Interactions (required ONLY for graduate students). TWiP = "This Week in Parasitism" podcast, available at: <http://www.microbeworld.org/podcasts/this-week-in-parasitism/archives>. OR = optional reading, available on the course website. PR = Parasite Rex, Carl Zimmer.

Date	Lecture	Required reading and other assignments ( <u>grad-level assignments indicated with underline</u> )	Multimedia ( <i>optional but recommended</i> )
Wednesday, 26 Sep	<b>Lecture 1 – This wormy world:</b> Review syllabus, introduction to parasite ecology, parasitology lingo	<input type="checkbox"/> R&J Chapters 1 & 2 <input type="checkbox"/> Bush <i>et al.</i> 1997 <input type="checkbox"/> <u>Combes Chapter 1</u>	TWiP 1: Introduction to parasitism TWiP 2: General parasitism RadioLab: Parasites (in Season 6) OR 1 – Parasite filters OR 2 – Parasitologists at cocktail parties OR 3 – Parasitological museum PR Prologue and Chapter 1
Friday, 28 Sep	<b>Lecture 2 – Adaptations to parasitism and Introduction to the trematodes</b>	<input type="checkbox"/> R&J Chapters 13 & 15 <input type="checkbox"/> Lafferty and Morris 2006 <input type="checkbox"/> <u>Combes Chapter 2</u>	TWiP 27: Trematodes OR 4 – Cercarial dermatitis Why Captain Higgins is my favorite parasitic flatworm: <a href="http://theoatmeal.com/comics/captain_higgins">http://theoatmeal.com/comics/captain_higgins</a>
Monday,	<b>Lecture 3 – The trematodes</b>	<input type="checkbox"/> R&J Chapters 17 & 18	

<b>1 Oct</b>		<input type="checkbox"/> <u>Combes Chapter 3</u>	
<b>Tuesday, 2 Oct</b>	<b>Lab #1: The deep end</b> (This year, I'll kick off our labs by throwing you into the deep end of the parasitology pool. In our first lab, you will get to see live schistosome adults in mice, hatch their eggs into miracidia, and view slides and preserved specimens of schistosomes)	<input type="checkbox"/> Lab Notebook Guidelines (in this syllabus) <input type="checkbox"/> Lab #1: Overview	
<b>Wednesday, 3 Oct</b>	<b>Lecture 4 – Schistosomes 1</b>	<input type="checkbox"/> R&J Chapter 16 <input type="checkbox"/> Watch Shelly Xie's video: <a href="https://www.youtube.com/watch?v=lo1cRLdqKq4">https://www.youtube.com/watch?v=lo1cRLdqKq4</a> <input type="checkbox"/> <u>Combes Chapter 4</u>	TWiP 26: The schistosomes Shelly Xie's TED Talk – Impacting medicine through art: <a href="https://www.youtube.com/watch?v=Ri5i5Mhj_do">https://www.youtube.com/watch?v=Ri5i5Mhj_do</a>
<b>Friday, 5 Oct</b>	<b>Lecture 5 – Schistosomes 2</b>	<input type="checkbox"/> <u>Combes Chapter 5</u>	PR Chapter 2
<b>Monday, 8 Oct</b>	<b>Lecture 6 – Monogeneans</b>	<input type="checkbox"/> R&J Chapter 19	
<b>Tuesday, 9 Oct</b>	<b>Lab #2: The shallow end</b> (Now that you've done a deep dive into the schistosomes, let's take a broader view: we'll check out a diversity of parasites from marine and freshwater fishes, covering monogenes, trematodes, cestodes, nematodes, acanthocephalans, and crustaceans)	<input type="checkbox"/> Lab #2: Overview <input type="checkbox"/> K&H Chapter 1	
<b>Wednesday, 10 Oct</b>	<b>Lecture 7 – Cestodes 1</b>	<input type="checkbox"/> R&J Chapter 20 <input type="checkbox"/> <u>Combes Chapter 6</u>	TWiP 6: Tapeworms, the long and short of it TWiP 7: Tapeworms are fantastic!
<b>Friday, 12 Oct</b>	<b>Lecture 8 – Cestodes 2</b>	<input type="checkbox"/> R&J Chapter 21 <input type="checkbox"/> <u>Combes Chapter 7</u>	"The Vicious Worm" advocacy tool: <a href="http://www.theviciousworm.org">www.theviciousworm.org</a> and intro paper (Johansen et al. 2014) OR 5 – Neurocysticercosis
<b>Monday, 15 Oct</b>	<b>Lecture 9 – Introduction to the nematodes</b>	<input type="checkbox"/> R&J Chapter 22 <input type="checkbox"/> <u>Combes Chapter 9</u>	PR Chapter 3
<b>Tuesday,</b>	<b>Lab #3: Trematodes 2 + cestodes</b> (shed and dissect	<input type="checkbox"/> Lab #3: Overview	

<b>16 Oct</b>	<i>Batillaria attramentaria</i> snails from coastal Washington, view slides, discussion and assignment of focal parasite/disease for term project)	<input type="checkbox"/> Forward and Chapter 1 of "What's Worked?" Working Group 2004	
<b>Wednesday, 17 Oct</b>	<b>Special Guest Lecture:</b> TBD	<input type="checkbox"/> <u>Combes Chapter 8</u>	
<b>Friday, 19 Oct</b>	<b>Lecture 10 – Nematodes 1</b>	<input type="checkbox"/> R&J Chapter 26 <input type="checkbox"/> R&J Chapters 27, 25 <input type="checkbox"/> <u>Combes Chapter 10</u>	TWiP 21: The giant intestinal worm, <i>Ascaris lumbricoides</i> TWiP 20: The whipworm, <i>Trichuris trichiura</i> TWiP 22: Hookworm TWiP 29: Neglected tropical diseases with Peter Hotez TWiP 71: Happy trails to you OR 6 – Whipworm
<b>Monday, 22 Oct</b>	<b>Lecture 11 – Nematodes 2</b>	<input type="checkbox"/> R&J Chapters 23, 24, & 28 <input type="checkbox"/> <u>Combes Chapter 11</u>	TWiP 19: <i>Enterobius vermicularis</i> , the pinworm TWiP 23: <i>Strongyloides stercoralis</i> , a most unusual parasite TWiP 3: <i>Trichinella spiralis</i> TWiP 4: <i>Trichinella</i> life cycle TWiP 5: The nurse cell TWiP 70: Invasion of the swamp eels OR 7 – Pinworm OR 8 – <i>Trichinella spiralis</i> OR 9 – Raccoon roundworm
<b>Tuesday, 23 Oct</b>	<b>Lab #4: Nematodes</b> (discussion of Al Jazeera's "How to Slay a Dragon", dissection of pickled <i>Ascaris lumbricoides</i> , dissect live cockroaches and ID their pinworms, view slides of nematodes)	<input type="checkbox"/> Lab #4: Overview <input type="checkbox"/> K&H Chapter 2 <input type="checkbox"/> "How to Slay a Dragon", Al Jazeera: <a href="http://www.cartercenter.org/news/features/h/guinea">http://www.cartercenter.org/news/features/h/guinea</a>	

		<a href="#">_worm/guinea-worm-health-heroes.html</a>	
<b>Wednesday, 24 Oct</b>	<b>Lecture 12 – Nematodes 3</b>	<input type="checkbox"/> R&J Chapter 30 <input type="checkbox"/> Siddall 2013 <input type="checkbox"/> Cleveland <i>et al.</i> 2017 <input type="checkbox"/> <a href="#">Combes Chapter 12</a>	TWiP 37: Dracunculiasis PR Chapter 4
<b>Friday, 26 Oct</b>	<b>Lecture 13 – Nematodes 4</b>	<input type="checkbox"/> R&J Chapter 29 <input type="checkbox"/> <a href="#">Combes Chapter 13</a>	TWiP 24: <i>Onchocerca volvulus</i> , a vector-borne, filarial nematode TWiP 40: Doctor, there's a worm in my eye! TWiP 25: <i>Wuchereria bancrofti</i>
<b>Monday, 29 Oct</b>	<b>EXAM 1</b>		
<b>Tuesday, 30 Oct</b>	<b>Lab #5:</b> Pitch your term paper ideas for peer commentary; discussion of the costs and benefits of eradication; scientific writing bootcamp	<input type="checkbox"/> Morrison <i>et al.</i> 2007 <input type="checkbox"/> Edwards and Leung 2009	
<b>Wednesday, 31 Oct</b>	<b>Lecture 14 – Introduction to the arthropods</b>	<input type="checkbox"/> R&J Chapter 33 <input type="checkbox"/> <a href="#">Combes Chapter 14</a>	TWiP 41: Flying and crawling beasts TWiP 28: Medical entomology with Robert W. Gwadz
<b>Friday, 2 Nov</b>	<b>Lecture 15 – Arthropods 1</b>	<input type="checkbox"/> R&J Chapter 41 (intro, <i>Ixodes</i> spp., <i>Dermacentor</i> spp., family Argasidae, family Demodicidae, family Trombiculidae, family Sarcoptidae, family Pyroglyphidae) <input type="checkbox"/> <a href="#">Combes Chapter 15</a>	PR Chapter 5
<b>Monday, 5 Nov</b>	<b>Lecture 16 – Arthropods 2</b>	<input type="checkbox"/> R&J Chapters 36 (all),	RadioLab: The Most Horrible Seaside Vacation

		37 (all), 38 (all)	( <a href="http://www.radiolab.org/story/169882-typhoid-mary/">http://www.radiolab.org/story/169882-typhoid-mary/</a> )
<b>Tuesday, 6 Nov</b>	<b>Lab #6: Arthropods</b> ( <i>Demodex folliculorum</i> demonstration, arthropod slides)	<input type="checkbox"/> Lab #6: Overview <input type="checkbox"/> K&H Chapter 6 <input type="checkbox"/> Submit first draft of your term paper for peer review by a classmate <input type="checkbox"/> Collect a classmate's first draft for peer review	
<b>Wednesday, 7 Nov</b>	<b>Lecture 17 – Arthropods 3</b>	<input type="checkbox"/> R&J Chapter 39 (subfamily Phlebotominae, family Culicidae, family Simuliidae, family Tabanidae, family Glossinidae, family Muscidae, subfamily Cuterebrinae) <input type="checkbox"/> <u>Combes Chapter 16</u>	
<b>Friday, 9 Nov</b>	<b>NO CLASS</b> – Chelsea will be at the <b>Western Society of Naturalists (WSN) Meeting</b> in Tacoma to talk about nematode parasites in Puget Sound! Interested in joining? See Chelsea – it's a fun meeting and SAFS has funding to support student participation, if you have some research you'd like to present. More details here: <a href="http://www.wsn-online.org">www.wsn-online.org</a> .		
<b>Monday, 12 Nov</b>	<b>VETERAN'S DAY – NO CLASS</b>		
<b>Tuesday, 13 Nov</b>	<b>Lab #7: Protozoa (amoebae, flagellates)</b> (dissect termites to find their gut flagellates, view protozoa slides)	<input type="checkbox"/> Lab #7: Overview <input type="checkbox"/> Submit your peer review <input type="checkbox"/> Collect your classmate'	

		peer review of your draft	
<b>Wednesday, 14 Nov</b>	<b>Lecture 18 – Acanthocephalans and a final few metazoan parasites</b>	<input type="checkbox"/> R&J Chapter 32 <input type="checkbox"/> Sato et al. 2012 <input type="checkbox"/> <u>Combes Chapter 17</u>	TWiP 39: I encyst, said the amoeba TWiP 17: <i>Entamoeba histolytica</i> TWiP 73: I'm nibbling my way back to you
<b>Friday, 16 Nov</b>	<b>Lecture 19 – Introduction to the protozoa and Protozoa 1</b>	<input type="checkbox"/> R&J Chapter 4 (p. 43–44, p. 50–53) <input type="checkbox"/> R&J Chapters 5 (p. 61–62, p. 64–85), 6 ( <i>Giardia</i> ), 7 (p. 107–115) <input type="checkbox"/> <u>Combes Chapter 18</u>	TWiP 38: How to <i>Trichomonas</i> TWiP 16: <i>Giardia</i> TWiP 15: Tryp the light fantastic TWiP 14: <i>Leishmania</i> OR 10 – <i>Trichomonas vaginalis</i> OR 11 – <i>Giardia</i> OR 12 – Leishmaniasis PR Chapter 6
<b>Monday, 19 Nov</b>	<b>Lecture 20 – Protozoa 2</b>	<input type="checkbox"/> <u>Combes Chapter 19</u>	TWiP 18: <i>Cryptosporidium</i> TWiP 57: An outbreak of cyclosporiasis OR 13 – <i>Cryptosporidium</i> TWiP 12: <i>Toxoplasma gondii</i> TWiP 13: Toxoplasmosis TWiP 60: Urine a game of cat and mouse OR 14 – <i>Toxoplasma</i>
<b>Tuesday, 20 Nov</b>	<b>Lab #8: Protozoa (hemoflagellates, apicomplexans)</b> (view protozoa slides)		
<b>Wednesday, 21 Nov</b>	<b>Lecture 21 – Protozoa 3</b>	<input type="checkbox"/> R&J Chapter 8 (all) and 9 (p. 147–162) <input type="checkbox"/> Lafferty 2006 <input type="checkbox"/> Submit second draft for professor's comments	TWiP 9: Mala aria TWiP 10: <i>Plasmodium</i> life cycle TWiP 11: One times three million TWiP 63: <i>Plasmodium</i> of the apes TWiP 68: Malaria rising PR Chapter 7
<b>Friday, 23 Nov</b>	<b>THANKSGIVING – NO CLASS</b>		
<b>Monday, 26</b>	<b>Lecture 22 – Abridged bacteria and viruses</b>		

<b>Nov</b>			
<b>Tuesday, 27 Nov</b>	<b>Lab #9: Diagnose your dog</b> (bring your own dog poop! If you don't have easy access to dog poop, don't worry – we'll have some highly parasitized poop on hand [generously donated by a local shelter]; if we get lucky, we might also have some whale poop!)	<input type="checkbox"/> Lab #8: Overview <input type="checkbox"/> If you'd like, bring your own dog poop! No cat poop allowed (sorry cat people).	
<b>Wednesday, 28 Nov</b>	<b>Special Guest Lecture:</b> TBD	<input type="checkbox"/> I will return your second drafts with my comments today <input type="checkbox"/> <u>Combes Reflections</u>	
<b>Friday, 30 Nov</b>	<b>Lecture 23 – Parasites: who cares?</b>	<input type="checkbox"/> Kuris et al. 2008 <input type="checkbox"/> Wood and Johnson 2015 <input type="checkbox"/> Carlson et al. 2017	
<b>Monday, 3 Dec</b>	<b>Lecture 24 – Nature's services, nature's disservices</b>	<input type="checkbox"/> Keesing <i>et al.</i> 2010 <input type="checkbox"/> Wood <i>et al.</i> 2017	
<b>Tuesday, 4 Dec</b>	<b>Lab #10: Elevator pitch presentations</b>	<input type="checkbox"/> Come ready to present your elevator pitch <input type="checkbox"/> Bring your lab notebook to be submitted for a grade	
<b>Wednesday, 5 Dec</b>	<b>Lecture 25 – The "parasitologist's dilemma":</b> What will become of our wormy world? (15 minutes will be set aside for completion of course evaluations – and if >90% of students complete evals, there will be a 5-point bonus question on the final!)	<input type="checkbox"/> Bring a device to class so you can fill out online course evals <input type="checkbox"/> <u>Combes Conclusion</u>	PR Chapter 8 + Epilogue
<b>Friday, 7 Dec</b>	<b>EXAM 2</b>		
<b>Thursday, 13 Dec</b>	<b>Final term paper due</b>	<input type="checkbox"/> Final term papers due	

## Required Readings Available on Canvas

Bush AO, KD Lafferty, JM Lotz, and AW Shostak. 1997. Parasitology meets ecology on its own terms: Margolis *et al.* revisited. *Journal of Parasitology* **83**: 575–583.

Carlson CJ, Burgio KR, Dougherty ER, Phillips AJ, Bueno VM, Clements CF, et al. 2017. Parasite biodiversity faces extinction and redistribution in a changing climate. *Science Advances* **3**: e1602422.

Cleveland CA, Eberhard ML, Thompson AT, Smith SJ, Zirimwabagabo H, Bringolf R, and Yabsley MJ. 2017. Possible role of fish as transport hosts for *Dracunculus* spp. larvae. *Emerging Infectious Diseases* **23**: 1590–1592.

Edwards PK and B Leung. 2009. Re-evaluating eradication of nuisance species: Invasion of the tunicate, *Ciona intestinalis*. *Frontiers in Ecology and the Environment* **7**: 326–332.

Keesing F, Belden L, Daszak P, Dobson A, Harvell CD, Holt RD, et al. 2010. Impacts of biodiversity on the emergence and transmission of infectious diseases. *Nature* **468**: 647–652.

Kuris AM, Hechinger RF, Shaw JC, Whitney KL, Aguirre-Macedo L, Boch CA, et al. 2008. Ecosystem energetic implications of parasite and free-living biomass in three estuaries. *Nature* **454**: 515–518.

Lafferty KD. 2006. Can the common brain parasite, *Toxoplasma gondii*, influence human culture? *Proceedings of the Royal Society B* **273**: 2749–2755.

Lafferty KD and Morris. 1996. Altered behavior of parasitized killifish increases susceptibility to predation by bird final hosts. *Ecology* **77**: 1390–1397.

Morrison SA, N Macdonald, Kelvin Walker, Lynn Lozier, and M Rebecca Shaw. 2007. Facing the dilemma at eradication's end: Uncertainty of absence and the Lazarus Effect. *Frontiers in Ecology and the Environment* **5**: 271–276.

Sato T, Egusa T, Fukushima K, Oda T, Ohte N, Tokuchi N, et al. 2012. Nematomorph parasites indirectly alter the food web and ecosystem function of streams through behavioural manipulation of their cricket hosts. *Ecology Letters* **15**: 786–793.

Siddall, M. 2013. An extinction to celebrate. *The New Yorker*.  
<http://www.newyorker.com/tech/elements/an-extinction-to-celebrate>.

WHO "What's Worked?" Working Group. 2004. What's Worked? Accounting for Success in Global Health. Center for Global Development and PRN Global Health Policy Research Network.

Wood CL and Johnson PTJ. 2015. A world without parasites: exploring the hidden ecology of infection. *Frontiers in Ecology and the Environment* **13**: 425–434.

Wood CL, McInturff AM, Young HS, Kim DH, and Lafferty KD. 2017. Human infectious disease burdens decrease with urbanization but not with biodiversity. *Philosophical Transactions of the Royal Society B* **372**: 20160122.

## Lab Notebook Guidelines\*

*\*Adapted from Kuris, Whitney, and McKenzie Parasitology Lab Exercises, UC Santa Barbara*

You are required to keep a lab notebook for this course. The notebook is worth 10% of your final grade. Lab notebooks will be collected on Tuesday, 4 December to be graded. Your lab notebook grade will be broken down as follows:

	Criterion	# points (of 10)
Completion	Handed in on time	2
Content	Data (host, site of infection, etc.)	2
	Methods	1
	Sketches (anatomy, labeling)	2
	Scale (magnification or measurement)	1
	Detail (life cycle, pathology, etc.)	2

If more than one lab is missing from your notebook, the 10 completion points will be forfeited. If one lab is missing, 4 points will be deducted.

**Materials:** I suggest that you do your drawings and notes on good quality printer paper and keep the notebook in a three-ring binder. Composition books are also acceptable. No spiral notebooks or lined loose-leaf paper please – both tend to fall apart before the end of the semester. Colored pencils are useful for labeling host and parasite anatomy and will be available in the lab for you to use.

**Contents:** Your notebook should emphasize the living organisms and dissections from the lab. A major part of this lab course is the study of fresh material, and we are fortunate to have access to these animals. A good record of your observations will be useful to you for studying and review and for any future research that you may do in parasitology or ecology. A table of contents must be included in your notebook.

**Drawings:** Artistic ability is not necessary to produce workable specimen drawings and don't worry, you will not be graded on the quality of your artwork. However, you will need to develop your observation skills. Even the smallest protozoan parasites have morphological and anatomical details that facilitate their identification. Find a specimen that shows the details described by your instructor, adjust the focus and illumination for optimal viewing, and observe the specimen carefully before you draw.

**Drawings should be large enough to accommodate anatomical detail and clear labeling.** Try sketching lightly in pencil and then trace over the lines that you want to keep for your finished drawing.

**Drawings should include the following details:**

1. Host identity (genus and species or lowest taxonomic level)
2. Host collection data (location and date of collection)
3. Host parameters (age, sex, size)
4. Dissection description (what parts of the host were examined?)
5. Parasite identity (genus and species)
6. Number of parasites found (for each parasite species found)
7. Site of infection (organ or tissue)
8. Scale bar or magnification (always use metric units)
9. Labeled parasite anatomy (notes and annotations are always useful)
10. Life cycle stage

**The following observations are also recommended:**

1. Pathology – describe any damage to host tissue or alteration of host morphology
2. Attachment – is the parasite attached or encapsulated?
3. Behavior – Describe any movement observed. Does the parasite respond to light, touch, or other stimulus? Do they abandon the host when disturbed?

The more detail that you include in your notes and drawings, the more useful your lab notebook will be to you.

## Term Paper Guidelines

The World Organization for Animal Health (OIE) is the international authority responsible for wildlife and livestock disease, and was the driving force in the eradication of rinderpest. According to OIE's website (<http://www.oie.int/about-us/our-missions/>), its responsibilities include:

- Ensuring transparency in the global animal disease situation
- Collecting, analyzing, and disseminating veterinary scientific information
- Encouraging international solidarity in the control of animal diseases
- Safeguarding world trade by publishing health standards for international trade in animals and animal products
- Improving the legal framework and resources of national veterinary services
- Promoting animal welfare through a science-based approach

In this assignment, you will write a **report advising the OIE on your recommendations for addressing the global burden of one primarily aquatic parasite** (i.e., do you recommend eradication, elimination, control, or even augmentation? Why and how?). Each student will be assigned a different parasite. Focal parasites will be discussed and decided upon in lab. Questions you might consider in your report include:

- Where (geographically speaking) do infections with this parasite primarily occur?
- Is eradication desirable (i.e., are there potential collateral impacts of eradication)?
- Is eradication possible? If not, is elimination possible for some regions? If not, is control possible?
- What has been tried already? Were those attempts successful? Why or why not?
- What obstacles stand in the way of eradication / elimination / control?
- Are there creative ecological solutions for eradication / elimination / control?
- What experiments would be needed to test your solution's efficacy?
- Would your solution work in the environmental and economic context in which your parasite primarily occurs?
- More challenging: Is parasite augmentation a desirable strategy? Why or why not? Make your case using data.

It is not necessary to address every question, but these should give you a starting point for thinking critically about what recommendations you might make to the OIE. Your arguments should be supported by references to the primary literature and should be

primarily ecological or veterinary in nature. Your references should follow the style guidelines on the final page of this document.

The purpose of this assignment is: (1) to get you to think critically about the ecology and management of parasites, (2) to get you intimately familiar with at least one important parasite, (3) to have you practice generating hypotheses and designing experiments to explore the ecology of parasite transmission, and (4) to hone your scientific writing skills. The best papers will be featured on my website (with your permission, of course).

### **Paper requirements:**

- 12-point, Times New Roman font, double-spaced with 1" margins
- At least 10 pages long (including references)
- At least 20 references to primary literature
- No references to sources other than the scientific literature (i.e., no Wikipedia, no encyclopedias, no textbooks) – a handful of websites (< 3) is okay if warranted
- Number your pages
- References formatted according to Reference Formatting Guidelines (end of this document)

### **Parasites/diseases (not an exhaustive list – feel free to seek out alternatives!):**

- Sea star-associated densovirus
- Abalone withering syndrome
- MSX in oysters
- Oyster herpesvirus
- Oyster nocardiosis
- *Euhaplorchis californiensis*
- Nematomorphs
- White band disease
- *Porites* trematodiasis
- *Batrachochytrium dendrobatidis*
- Ranavirus
- *Ribeiroia ondatrae*
- *Anisakis* or *Pseudoterranova*
- Phocine distemper virus
- *Philometra* sp. filarial nematodes
- *Giardia*
- *Toxoplasma gondii*
- *Fasciola gigantica*
- *Schistosoma japonicum*
- *Diphyllobothrium latum*
- Myxozoan infection / whirling disease
- Ichthyophoniasis
- Viral hemorrhagic septicemia
- Viral erythrocytic necrosis
- Infectious haemopoietic necrosis virus

## Elevator Pitch Guidelines

Once you have crafted your plan for managing an important parasitic disease, you've got to convince people to put it into practice. Imagine that you are in a library on campus and you step into the elevator. Behind you, a man enters – and it's Bill Gates. He's at UW to give a speech to the School of Public Health. The Gates Foundation has generously funded human disease control projects throughout the developing world. You have the length of an elevator ride to convince Mr. Gates that your wildlife disease project is a worthy investment – that it addresses a major need, that it will work, and that it is cost-effective.

The purpose of this assignment is: (1) to get you comfortable with speaking about science to a variety of audiences, (2) to introduce some of the principles of excellent science communication, and (3) to have you practice boiling down complex scientific ideas.

### **Pitch requirements:**

- No more than 5 minutes long – you'll be stopped at 5 minutes on the dot
- This can be a more colloquial talk than you might give for a scientific audience. For inspiration, see the 3-minute TED talks:  
[https://www.ted.com/playlists/81/ted\\_in\\_3\\_minutes](https://www.ted.com/playlists/81/ted_in_3_minutes)
- If you want to use a visual aid, it must be something that you might reasonably carry with you into an elevator, with no prior expectation of meeting Bill Gates.

## Term Paper Grading Rubric

Category	Exceeds expectations (5)	Meets expectations (4)	Nearly meets expectations (3)	Does not meet expectations (2)	Incomplete (0-1)
Title page, including abstract/executive summary	Includes title and author's name. Abstract/executive summary is concise and accurately reflects the content of the paper. Paper matches or exceeds minimum number of pages.	Includes title and author's name. Abstract/executive summary is relatively concise and reflects the content of the paper, with some omissions or misrepresentations. Paper matches or exceeds minimum number of pages.	Includes title and author's name. Abstract/executive summary is wordy OR only partially represents the content of the paper. Paper too short.	Includes title and author's name. Abstract/executive summary is wordy AND only partially represents the content of the paper. Paper too short.	Any of the components (title, author's name, abstract/executive summary) are missing.
Introduction	The introduction successfully "funnels" by providing a broad context and narrowing in to the purpose of the paper.	The introduction provides appropriate background context but does not "funnel".	The introduction states the main topic but does not provide appropriate background context.	There is no clear introduction or main topic and no background context.	Absent
Thesis statement	Clearly and concisely states the paper's purpose in a single sentence, which is engaging and thought provoking.	Clearly states the paper's purpose in a single sentence.	States the paper's purpose in a single sentence.	Incomplete and/or unfocused.	Absent
Body	Each paragraph has topic sentences and thoughtful supporting detail sentences that develop the main idea.	Each paragraph has topic sentences and sufficient supporting detail sentences that develop the main idea.	Most paragraphs lack supporting detail sentences. Some topic sentences missing.	Paragraphs wander, failing to support the main idea. Some topic sentences missing.	n/a
Content	Paper makes a convincing argument, well supported by primary research.	Paper makes a somewhat convincing argument, partially supported by primary research.	Paper makes an unconvincing argument with little support from primary research.	No clear argument emerges or no support from primary research is provided.	n/a
Creativity	Entirely novel ecological solutions are proposed for eradication/elimination/control.	Somewhat novel ecological solutions are proposed for eradication/elimination/control.	Existing ecological solutions are proposed for eradication/elimination/control.	No solutions are proposed for eradication/elimination/control.	n/a
Organization – structural development of the idea	Writer demonstrates logical and subtle sequencing of ideas through well-developed paragraphs; transitions are used to enhance organization.	Paragraph development present but not perfected.	Logical organization; organization of ideas not fully developed.	No evidence of structure or organization.	n/a
Conclusion	The conclusion is engaging and restates the thesis.	The conclusion restates the thesis.	The conclusion does not adequately restate the thesis.	Incomplete and/or unfocused.	Absent
Mechanics	No errors in punctuation, capitalization, spelling, sentence structure, or word usage.	Almost no errors in punctuation, capitalization, spelling, sentence structure, or word usage.	Many errors in punctuation, capitalization, spelling, sentence structure, or word usage.	Numerous and distracting errors in punctuation, capitalization, spelling, sentence structure, or word usage.	n/a
References	All references are cited in the correct format with no errors. All sources are legitimate.	Some references are cited in the correct format. All sources are legitimate.	Few references are cited in the correct format. Some illegitimate sources (e.g., websites).	No references are cited in the correct format. Reference list contains illegitimate sources.	Absent

## Elevator Pitch Grading Rubric

Category	Exceeds expectations (5)	Meets expectations (4)	Nearly meets expectations (3)	Does not meet expectations (2)	Incomplete (0–1)
Content	The information included is accurate and completely addresses each component of the assigned topic.	The information included adequately addresses each component of the assigned topic.	The information included inadequately addresses the assigned topic. The information included is sometimes inaccurate.	The information included does not address the assigned topic.	There is no evidence of accurate content information.
Delivery	The presenter effectively and creatively delivers the information while staying on topic. The presenter appears relaxed and self-confident. Body language, voice modulation, and eye contact are effectively used.	The presenter adequately delivers the information while staying on topic. The presenter appears relaxed and self-confident. Body language, voice modulation, and eye contact are mostly appropriate.	The presenter delivers the information but does not stay on topic. The presenter appears tense or nervous. Body language, voice modulation, and eye contact are inappropriate or lacking.	The presenter omits important information and does not stay on topic. The presenter appears tense or nervous. Body language, voice modulation, and eye contact are inappropriate or lacking.	The presenter does not effectively deliver the necessary information.
Organization	The presentation content has been organized using a logical sequence. The presentation is engaging and effective.	The presentation content has been mostly organized using a logical sequence, but some flaws exist. The presentation is adequate.	The presentation content has been organized using a somewhat logical sequence. The presentation is sometimes confusing.	The presentation content is disorganized, unclear, or confusing. The presentation is not adequate.	The presentation does not include evidence of organization.
Preparation	Presentation indicates detailed preparation.	Presentation indicates adequate preparation.	Presentation indicates minimal preparation.	Presentation indicates a lack of preparation.	Presentation shows no evidence of preparation.

## Reference Formatting Guidelines\*

\*Adapted from Rutgers University Libraries Research Guide

### **In-text references**

For references with one author: (First author's last name Date), e.g., (Abrams 1987)

For references with two authors: (First author's last name and Second author's last name Date),  
e.g., (Abrams and Menge 1987)

For references with three or more authors: (First author's last name *et al.* Date), e.g., (Abrams *et al.* 1987)

### **Journal article: one author**

Last name First initial Second initial. Date. Title. *Journal Title* **volume number**: page range.

*Example*: Abrams PA. 1987. The functional responses of adaptive consumers of two resources. *Theoretical Population Biology* **32**: 262–288.

### **Journal article: two or more authors**

Last name First initial Second initial, First initial Second initial Last name, and First initial Second initial Last name. Date. Title. *Journal Title* **volume number**: page range.

*Example*: Hjalten J, K Danell, and P Lundberg. 1993. Herbivore avoidance by association: Vole and hare utilization of woody plants. *Oikos* **68**: 125–131.

### **Chapter in a book**

Last name, First initial Second initial, First initial Second initial Last name, and First initial Second initial Last name. Date. Chapter title. Pages *in* First initial Second initial Last name and First initial Second initial Last name, editors. Book Title. City of publication, State of publication, Country of publication: Publisher name.

*Example*: Abrams PA, BA Menge, and GG Mittelbach. 1995. The role of indirect effects in food webs. Pages 371–395 *in* G. Polis and K. O. Winemiller, editors. Food Webs: Integration of Patterns and Dynamics. New York, NY, USA: Chapman and Hall.

### **Book**

Last name, First initial Second initial, First initial Second initial Last name, and First initial Second initial Last name. Date. Book Title. City of publication, State of publication, Country of publication: Publisher name.

*Example*: Drake JA, F DiCastri, and RH Groves. 1989. Biological Invasions: A Global Perspective. New York, NY, USA: Wiley.

### **Government document**

Last name First initial Second initial, First initial Second initial Last name, and First initial Second initial Last name, editors. Date. Document title. Report number. City of publication, State of publication, Country of publication: Government agency, Agency division.

*Example*: Maschinski J, HD Hammond, and L Holter, editors. Southwestern rare and endangered plants: Proceedings of the second conference. General Technical Report RM-GTR-283. Fort Collins, CO, USA: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.