Evolution and Ecology of Infectious Diseases

Syllabus for BIOL 4012 – 3 credits – Fall 2021

Class meetings: Tuesdays/Thursdays 11 AM -12:15 PM
Location: Maury 115 - class meetings will be held in person.

Instructor: Dr. Amanda Gibson, Assistant Professor (she/her)
amandagibson@virginia.edu; PLSB 114; coevolving.org
Office Hours: 3:30 to 4:30 pm on Thursdays, on Zoom:
https://virginia.zoom.us/j/92079002144?pwd=SjVDQjFWUHowUTJHZW9IUzNUTEV5Zz09

TA: Sophie Wong, 4th year in Biology and Environmental Science
sw5pe@virginia.edu
Office Hours: TBD, on Zoom:
https://virginia.zoom.us/j/94317561370?pwd=VlpuQ1JINm10T0hQdnE3S2lwMTdwQT09

Course site: Collab BIOL 4012: EEID
https://collab.its.virginia.edu/portal/site/b4dac7ad-f641-4ca9-9672-dffbc31343db
Please submit documents on Collab as Word (.docx) documents using the following file name system: LastNameFirstName_AssignmentName.docx. For assignments related to the semester project, please use the following naming system: LastNameFirstName_GroupName_AssignmentName.docx

Pre-requisites: BIOL 3020

Outline

1. About this course

Much of evolution is coevolution
~John N Thompson, 2005 pg. 3

Ecological disturbance causes diseases to emerge. Shake a tree, and things fall out.
~David Quammen, 2012, pg. 23

The skills needed to describe and recognize perturbations in the Homo sapiens *microecology are disappearing with the passing of the generations, leaving humanity, lulled into a complacency born of proud discoveries and medical triumphs, unprepared for the coming plague.*
~ Laurie Garrett, 1994, pg. 12

The SARS-CoV-2 outbreak has become the worst outbreak of an infectious disease that humans have experienced in our lifetimes, but it is not the first, and it will not be the last. The history of life on earth is a history of epidemics, like the Black Death, the Potato Famine, chytrid, rinderpest, smallpox, and stem rust. Even with our advances in antimicrobials, vaccinations, and public health, infectious diseases will plague our future as well. More than ever, the COVID-19 pandemic has made clear that parasites threaten our health, our economy, our civil societies, our food supply, and our fragile ecosystems. SARS-CoV-2 has laid bare our interconnectedness: we are linked not just by airplanes, supply lines, and the internet, but by the parasites that leap between individuals, populations, species, and communities.

This semester, we'll work to better understand parasites, and how to manage them by examining them not just as agents of destruction, but as members of ecological communities. Forty percent of species are parasitic, and that's likely a gross underestimate! Recent research has asked fascinating questions like: Why aren't all hosts resistant to parasites? Why do parasites harm their hosts? Does sex exist because of parasites? Do parasites maintain biodiversity in ecosystems? Can we use one parasite to save us from another? These questions recast parasites as vital members of complex, coevolving communities. Indeed, the relatively new field of disease ecology and evolution emphasizes that a holistic perspective on parasites gives us the tools we need for coexistence on this rich, diverse planet.

In this course, we'll dive into our current understanding of the evolution and ecology of parasitic interactions through primary literature, modeling, and experimental design. We'll cover the fundamentals of disease dynamics and the (co)evolution of host resistance and parasite virulence. We will apply these ideas to modern problems to make sense of how human interventions, like drugs, vaccinations, and habitat destruction, might change the spread and evolution of parasites. The topics we discuss have broad implications for public health, the sustainability of agricultural practices, and the conservation of biodiversity. Throughout, we will focus on generating and testing hypotheses, evaluating theoretical models with evidence, drawing parallels between diverse domains of life, and connecting evolutionary and ecological ideas to today's past, present, and future epidemics.

2. What you'll learn

During this course, you'll spend a lot of time trying to figure out what we know and how we know it. In other words, you'll be doing the work of a scientist! We have to engage in this process if we want to understand the world around us and make informed decisions. The ongoing pandemic has only accentuated the significance, and the challenges, of collecting and evaluating evidence – it saves lives.

After completing this course, you should be able to:

1) **formulate** testable hypotheses and **design** experimental tests to **differentiate** between hypotheses
2) **build** theoretical models and **evaluate** their utility and limitations by **identifying** and **assessing** their inputs and outputs
3) **read**, **synthesize** and **discuss** primary literature, **interpret** figures and data, and **critique** scientific evidence
4) **communicate** scientifically through written, oral, and graphical formats
5) **explain** forces that can operate on host and parasite populations to drive disease spread and evolutionary change and **generalize** these concepts across diverse taxa and scientific fields
6) **connect** and **apply** foundational concepts to **predict** the outcome of disease management strategies

3. How you'll know you're learning

I intend for you to succeed in this course. The following activities and assessments are designed to provide guidance and regular evaluation of your progress in meeting the course objectives above.

a) *Preparing for and engaging in class (25% of grade)*

Mini-quizzes (5%): You will prepare for Tuesday class by reading the assigned background material and completing a mini-quiz on Collab by midnight the day before the class. These quizzes will help direct your thinking towards key concepts and identify difficult points to focus on in class.

Discussion Questions (10%): You will prepare for Thursday class by reading a primary research article and posting two discussion questions to Piazza. Your first question will highlight a conceptual, methodological, or analytical element of the article that you'd like to understand better. We will have some time during class to discuss these "Foundation" questions. Your second question will propose an avenue for future work – if you were the authors of this article, what question would you ask next? You will use these "Next Step" questions in your Discussion Groups to design a follow-up experiment. This practice will prepare you to engage in class discussion and move from simply comprehending papers to using them as springboards for scientific advancement. Please refer to the *Guide for Discussion Questions and Reading Scientific Papers* for details.

Class engagement (10%): In-class participation is where the work happens in this course. We will use class time to dig into topics through discussion and to practice applying concepts and using skills like scientific reasoning and modeling. There is not a textbook and I will spend little time on pure lecture. Thus you will need to be present to succeed in this course. You will have plenty of opportunities to participate – if you're not comfortable speaking in front of the whole group, you can speak in smaller discussion groups, actively engage with classroom activities, or stay a few minutes after class to follow-up with me and classmates. Your grade will be based on your engagement in classroom activities. You will earn full credit if you make a good-faith effort to complete classroom activities, which tells me that you're present in class and engaged. You will also complete two self-evaluations of your engagement during the semester.

You can miss up to two classes during the semester without penalty. You do not need to check in with me about missing up to two classes. You will lose engagement points for missing more than two classes. If you would like to discuss an anticipated absence, beyond your two freebies, please alert me at least a week in advance of the class. You are responsible for the material covered in every class regardless of whether you attend.

b) *Leading paper discussion (20% of grade)*

Every Thursday, we will spend at least 45 minutes of class time discussing a primary research article. Ten of the 12 discussion periods will be led by a group of four students, the day's Discussion Leaders. As Discussion Leader, you will learn to read a scientific article and engage in the scientific process by deeply examining the research, connecting it to the broader scientific literature, teaching your peers, and identifying gaps that future work can address. Your grade will be based on your presentation of the article, your responses to your classmates' Foundation questions, and the quality of your Next Step proposal submitted after your class discussion. Please refer to the *Guide to Leading Discussions* for details.

c) *Modeling activities (20% of grade)*

You will complete six individual modeling assignments throughout the class. Typically, we will start these in class on a Tuesday and you will complete them outside of class, turning them in by midnight Friday of that week. The purpose of these activities is to 1) **reinforce** and **practice** the concepts we cover in class by engaging with them via hands-on simulation; 2) **represent** complex biological processes as abstract models by breaking them down into their component parts; 3) **graph** and **interpret** data; and 4) **formulate** and **test** hypotheses.

Our first modeling activity will ask you to model an experiment, as learning to design experimental tests of scientific hypotheses is an objective of this course and a major focus of your final project. The next four modeling activities will use the R package DSAIDE (*Dynamical Systems Approach to Infectious Disease Epidemiology*) to engage with the basics of epidemiological modeling through simulation. You can read more about the package in Handel (2017) *PLoS Computational Biology*. Our final activity will simulate host-parasite coevolution using playing cards, building off of the Red Queen Game that you may have done in

BIOL 2200. You can read more about the basic game in Gibson et al. (2015) *Evolution: Education and Outreach*.

d) *Semester project (35% of grade)*

Two objectives of this course are to learn to think scientifically, by formulating hypotheses and designing experimental tests, and to communicate scientific ideas through written, oral and graphic modes. You will work towards these learning objectives by developing and writing a grant proposal, a scientific document that is written to propose a scientific project, usually for evaluation by a funding body. In doing this project, you will go through the major steps of developing a scientific project, including: identifying major knowledge gaps in the existing literature, giving and responding to peer review, and communicating your ideas in the form of a scientific poster and a written grant. This project has multiple components due throughout the semester. You will complete some individually and others in groups of four. Please refer to the *Guide to the Semester Project* for details.

4. How I'll determine your grade

250 points: Preparing for and engaging in class
- 100 points: in-class engagement
- 100 points: Discussion Questions (10 of 12 graded; lowest dropped)
- 50 points: mini pre-class quizzes (5 points each, 10 of 13 graded, lowest dropped)

200 points: Leading paper discussion
- 50 points: quality of presentation overall (group)
- 50 points: quality of your individual portion of presentation (individual)
- 15 points: in-class Q+A (group, but individual contribution considered)
- 80 points: Next Step proposal (individual)
- 5 point: Within-group peer evaluation (individual)

200 points: Modeling activities
- 10 points: Experimental design activity
- 40 points: Epidemiological modeling 1
- 40 points: Epidemiological modeling 2
- 40 points: Epidemiological modeling 3
- 40 points: Epidemiological modeling 4
- 30 points: Coevolutionary Card Games

350 points: Final project
- 40 points: Question and hypotheses (group)
- 55 points: Experimental design overview and graphic (individual)
- 55 points: Literature matrix (individual)
- 20 points: Submission for peer review (group)
- 60 points: Peer review (individual)
- 50 points: Poster (group)
- 65 points: Final pre-registered report (group)
- 5 points: Within-group peer evaluation (individual)

Final course grades will be assigned according to the following thresholds:

A+ 98%	B+ 87%	C+ 77%	D+ 67%	F 0%
A 95%	B 83%	C 73%	D 63%	
A- 90%	B- 80%	C- 70%	D- 60%	

5. A few course policies

a) *Academic integrity*

Scientific progress requires that we first acknowledge and make sense of the knowledge generated by others. Only then can we identify gaps in our understanding and identify the path forward. Therefore, in this course, it is of the utmost importance that you give credit to ideas, facts, words, phrases, images, etc. that you use. Plagiarism and related acts actively impede your learning and the progress of science, so they will not be tolerated. I trust every student to fully comply with all provisions of the UVA honor system (https://honor.virginia.edu/).

b) *Late work policy*

This course is designed such that pre-work forms the foundation for what we do in class. Thus, this pre-work is not beneficial to you as a learner if it is done late. Up to 10% of points per day will be deducted for late assignments.

c) *Office hours*

Office hours will be held virtually, because this seems to make it much easier for you to attend. Office hours means that each week, I set aside one hour for you to pop by my "virtual office." You can use this time to ask questions about course material and assignments, listen to questions other students have, and interact with me and your peers. I encourage you to take advantage of this opportunity. Even if you do not have a specific question, I am happy to use this time to get to know you and get your feedback on the course. Please note in *Section 5e* below that attendance at office hours is a pre-requisite for obtaining a letter of recommendation from me. I do keep a record of students that attend office hours.

d) *Technology*

This class will be taught entirely in person, unless otherwise mandated by the university. We will do computer work most classes, however. Working on our computers saves paper and gives us access to some amazing platforms, like DSAIDE. If computer access is an issue for you, please communicate with me so we can figure out an appropriate accommodation.

Technology in the classroom can improve your ability to engage and learn course material *if* it is used exclusively for educational purposes during class. Computer use will be unavoidable during certain class times. Outside of these times, I ask you to limit your computer use in class to course-related activities. Computers invite multi-tasking (i.e. off-task use, like social media). When you multi-task with technology in class, you don't learn as well (Carrier et al. 2015). What's worse, you hurt your peers' learning too - students don't learn as well when their classmates visit sites that aren't related to course material (Hall et al. 2020; Sana et al. 2013; Ravizza et al. 2016). I encourage you to consider taking notes by hand if

possible. We tend to transcribe verbatim when we take notes on our computer, producing a shallow record of the material, while writing by hand requires more active processing of information. Thus, for this course, which focuses on engagement with concepts rather than memorization, hand-written notes will be more valuable upon review than computer notes (Mueller et al. 2014; Luo et al. 2018). Finally, phones must be silenced and put away during class, unless specifically advised otherwise. They cause distraction and reduce learning and engagement (Mendoza et al. 2018; Felisoni et al. 2018). Dontre et al. (2020) provides a recent comprehensive review of the experimental work on the distracting effect of technology in academics.

e) *Reference letter writing policy*

I would be happy to consider writing a letter of recommendation for you if you meet the following criteria: 1) You have completed one full semester in a course of mine. I do not have enough information to write a strong letter for you otherwise. 2) You earned an A or higher in the class. 3) You attended office hours or otherwise met with me at least two times *during* the semester. This helps me to write an effective, well-rounded letter by giving me sense of you as a person. It also helps if you ask questions during and/or after class and engage in discussion.

Please email me to request a letter at least three weeks before the deadline and include an explanation of why you need the letter, details of when and how I should submit it, your CV/resume, an unofficial transcript, a copy of any cover letters or personal statements you'll submit if available (these really help me to write a better letter), and any details of what you would like me to highlight in your letter.

It is rewarding for me to write letters in support of students that perform well in my class, and while I appreciate thank you notes, I do not need any more compensation than that.

f) *Equity, inclusion and well-being*

Please communicate with me regarding your preferred pronouns. I appreciate being corrected if I get it wrong.

As a member of the UVA academic village, I am committed to maintaining an equitable, just, and safe community in my classroom and on grounds. I will not tolerate discrimination or harassment and I expect the same of you. We must hold one another to this standard. You can find resources through the Office for Diversity, Equity and Inclusion (https://vpdiversity.virginia.edu/) and the Office for Equal Opportunity and Civil Rights (https://www.virginia.edu/eop). Please communicate with me regarding obstacles you face in your learning environment.

I welcome you to meet with me to discuss any barriers you anticipate to your learning so that we can work together to arrange accommodations. The Student Disability Access Center (https://www.studenthealth.virginia.edu/sdac) helps students develop plans for managing learning barriers related to disabilities, including learning disabilities or chronic diseases. Please communicate with me if you have been working with the Center so that I can implement these plans.

Many of us are feeling anxious, overwhelmed or alone right now. UVA has people who can help. You can speak with a counselor through CAPS, the Student Health Center's Counselling and Psychological Services, at 434-243-5150 (https://www.studenthealth.virginia.edu/caps). Madison House's anonymous HELP line is also available 24/7: 434-295-TALK (http://www.helplineuva.com/). If you or someone you know feels unsafe, please seek help via these resources: https://justreportit.virginia.edu/sexual-and-gender-based-harassment-violence.

Credit to Ian Becker for assembling these resources.

Undocu+: Students of all immigration statuses are welcomed and valued in this classroom, including undocumented students, students from mixed-status families, and students with Temporary Protected Status. I aim to create a learning environment that respects and affirms the diversity of your experiences and perspectives. If your status is impacting your ability to learn and perform in the course, please come see me to discuss what I can do to accommodate you. I pledge to keep your status confidential unless required by judicial warrant.

Credit to undocUVA

6. What you'll be doing

Readings detailed in full in section 7

Week	Day	Date	In-class	Assignments due by midnight before class day	Assignments due by 12 am on Friday[1]
1	Tuesday	8/24	What is a parasite?	Quammen 2012 Mini-quiz 1: pre-class survey	Activity A: Experimental Design; Sign up for Primary Article presentations
	Thursday	8/26	Paper discussion - *led by instructors*	Lafferty and Kuris 2002; Discussion Journal 1	
2	Tuesday	8/31	Disease Modeling I: introduction	Otto and Day, pg. 1-39 Mini-quiz 2	Install R/RStudio[2]
	Thursday	9/2	Paper discussion – *Group 1*	Allan et al. 2010 Discussion Journal 2	
3	Tuesday	9/7	Disease Modeling II: SIR + R_0	Keeling and Rohani, pg. 1-11,15-21, 26-28; Mini-quiz 3	Activity B: Epidemiological modeling I; Form groups for final projects (four people); Install NetLogo for 9/14
	Thursday	9/9	Paper discussion – *Group 2*	Ezenwa and Jolles 2015 Discussion Journal 3	
4	Tuesday	9/14	Disease Modeling III: transmission	Antonovics 2017 Mini-quiz 4	Activity C: Epidemiological modeling II
	Thursday	9/16	Paper discussion – *Group 3*	Stephenson et al. 2018 Discussion Journal 4	
5	Tuesday	9/21	Disease Modeling IV: control	Ashby and Best 2021 Mini-quiz 5	Activity D: Epidemiological modeling III; Question and hypotheses due
	Thursday	9/23	Paper discussion – *Group 4*	Bakker et al. 2019 Discussion Journal 5	
	Tuesday	9/28	Parasites in communities I: population regulation	Wood and Johnson 2015 Mini-quiz 6	Activity E: Epidemiological modeling IV
	Thursday	9/30	**Synthesis session**		
	Tuesday	10/5	Parasites in communities II: community assembly	Alexander 2010 Mini-quiz 7	
	Thursday	10/7	Paper discussion – *Group 5*	Parker et al. 2015 Nature Discussion Journal 6	
8	Tuesday	10/12	**Reading Day, no class!**		Experimental Design Graphic due
	Thursday	10/14	Biological Control with Dr. Fabiane Mundim	Lim et al. 2012 Discussion Journal 7	

9	Tuesday	10/19	Evolution of Resistance I: what is resistance?	Rigby et al. 2002 Mini-quiz 8	
	Thursday	10/21	Paper discussion – *Group 6*	Stroeymeyt et al. 2018 Discussion Journal 8	
10	Tuesday	10/26	Evolution of resistance II: why isn't everyone resistant?	Schmid-Hempel 2002 Mini-quiz 9	
	Thursday	10/28	Paper discussion – *Group 7*	Duffy et al 2012 Discussion Journal 9	
11	Tuesday	11/2	Coevolution I: the Red Queen	Lively 2010 Mini-quiz 10	Literature matrix due
	Thursday	11/4	Paper discussion – *Group 8*	Morran et al. 2011 Discussion Journal 10	
12	Tuesday	11/9	Coevolution II: adapting locally	Brockhurst et al. 2014 Mini-quiz 11	Activity F: Coevolutionary card games; Grant proposal due for initial review
	Thursday	11/11	Paper discussion – *Group 9*	Batstone et al 2020 Discussion Journal 11	
13	Tuesday	11/16	Parasite perspective I: evolution of virulence	Alizon et al. 2009 Mini-quiz 12	
	Thursday	11/18	Paper discussion – *Group 10*	**Miller and Metcalf *in rev*** Discussion Journal 12	
14	Tuesday	11/23	Parasite perspective II: Within-host evolution	Lythgoe et al. 2017 Mini-quiz 13	Peer reviews due back to authors on **Tuesday 11/23**
	Thursday	11/25	**Happy Thanksgiving!**		
15	Tuesday	11/30	Careers in Disease Biology	Walensky et al. 2020 (this is *Rochelle Walensky*, current director of the CDC); Piazza Post	Submit final poster file (PDF or JPG) for printing by me
	Thursday	12/2	**Synthesis Session**		
16	Tuesday	12/7	**Poster Session**		
	Monday	12/13	**Final paper due**		

7. What you'll be reading

Week	Day	Date	Pre-class reading	Media Links[3]
1	Tuesday	8/24	Quammen, David. *Spillover: animal infections and the next human pandemic*. WW Norton & Company, 2012. *Chapter 1*	2012 interview on Scientific American, and 2020 interview
	Thursday	8/26	Lafferty, Kevin D., and Armand M. Kuris. "Trophic strategies, animal diversity and body size." *Trends in Ecology & Evolution* 17.11 (2002): 507-513.	
2	Tuesday	8/31	Otto, Sarah P., and Troy Day. *A biologist's guide to mathematical modeling in ecology and evolution*. Princeton University Press, 2011. *Pages (1-39)*. **Available online on UVA Virgo**	
	Thursday	9/2	Allan, Brian F., et al. "Invasive honeysuckle eradication reduces tick-borne disease risk by altering host dynamics." *Proceedings of the National Academy of Sciences* 107.43 (2010): 18523-18527.	Ed Yong for Discover Magazine "Invasive shrub increases risk of human disease (via ticks, deer and bacteria)"
3	Tuesday	9/7	Keeling, Matt J., and Pejman Rohani. *Modeling infectious diseases in humans and animals*. Princeton University Press, 2011. *Pages (1-11,15-21, 26-28)*	
	Thursday	9/9	Ezenwa, Vanessa O., and Anna E. Jolles. "Opposite effects of anthelmintic treatment on microbial infection at individual versus population scales." *Science* 347.6218 (2015): 175-177.	TWiP Podcast "Living in a Wormy World" and Eureka Alert! "Deworming programs in animal, human populatoins may have unwanted impacts"; recent relate paper in PNAS: Ezenwa et al. 2021
4	Tuesday	9/14	*Antonovics, Janis. "Transmission dynamics: critical questions and challenges." *Philosophical Transactions of the Royal Society B: Biological Sciences* 372.1719 (2017) 20160087.*	
	Thursday	9/16	Stephenson, Jessica F., et al. "Transmission risk predicts avoidance of infected conspecifics in Trinidadian guppies." *Journal of Animal Ecology* 2018.87 (2018): 1525-1533.	#StoryBehindThePaper by Jessica Stephenson
5	Tuesday	9/21	Ashby, Ben, and Alex Best. ""Primer: Herd Immunity." *Current Biology* 31 (2021): R161-R185	
	Thursday	9/23	*Bakker, Kevin M., et al. "Fluorescent biomarkers demonstrate prospects for spreadable vaccines to control disease transmission in wild bats." *Nature ecology & evolution* 3.12 (2019): 1697-1704.*	Madeline Bodin for Discover Magazine "Deadly animal diseases can jump to humans. Is vaccinating wildlife the answer?"; Jim Erickson for Futurity "Glowing bats show contagious vaccines can fight rabies"

6	Tuesday	9/28	Wood, Chelsea L and Pieter TJ Johnson. “A world without parasites: exploring the hiddn ecology of infection” *Frontiers in Ecology*. 13.8 (2015): 425-434.	Podcasts featuring Chelsea Wood on this topic: Tumble with Carl Zimmer and Save the parasites on Shortwave
	Thursday	9/30	*No reading – prepare for our synthesis session!*	
7	Tuesday	10/5	Alexander, Helen M. “Disease in natural plant populations, communities, and ecosystems: Insights into ecological and evolutionary processes.” *Plant Disease*. 94.5 (2010): 492-503.	
	Thursday	10/7	Parker, Ingrid M., et al. “Phylogenetic structure and host abundance drive disease pressure in communities.” *Nature*. 520 (2015): 542.	Highlight by Science Daily; Ingrid Parker featured on “People Behind the Science Podcast”
8	Tuesday	10/12	*Ironically no reading – it’s a reading day!*	
	Thursday	10/14	Lim, Tae-Hyun, et al. “Use of bacteriophage for biological control of *Salmonella* Enteritidis infection in chicken” *Research in Veterinary Science*. 93 (2012): 1173-1178	
9	Tuesday	10/19	Rigby, Mark C., “Why should parasite resistance be costly?” *TRENDS in Parasitology*. 18.3 (2002): 116-120	
	Thursday	10/21	Stroeymeyt, Nathalie, et al. “Social network plasticity decreases disease transmission in a eusocial insect.” *Science*. 362 (2018): 941-945.	Scientific American article/audio; UnDark highlight, with cool video
10	Tuesday	10/26	Schmid-Hempel, Paul. "Variation in immune defence as a question of evolutionary ecology." *Proceedings of the Royal Society B* 270.1513 (2003): 357-366.	
	Thursday	10/28	Duffy, Meghan A., et al. "Ecological context influences epidemic size and parasite-driven evolution." *Science*. 335.6076 (2012): 1636-1638.	Nice video on Duffy’s lab and *Daphnia*; How to Science podcast with Duffy; Duffy at the March for Science
11	Tuesday	11/2	Lively, Curtis M. "Antagonistic coevolution and sex." *Evolution: Education and Outreach* 3.1 (2010): 19-25.	
	Thursday	11/4	Morran, Levi T., et al. "Running with the Red Queen: host-parasite coevolution selects for biparental sex." *Science* 333.6039 (2011): 216-218.	Jon Hamilton for NPR “Have sex to stay one evolutionary step ahead”; Carl Zimmer for the Loom “Why is there sex? To fight the parasite army”
12	Tuesday	11/9	Brockhurst, Michael A., et al. “Running with the Red Queen: the role of biotic conflicts in evolution.” *Proceedings of the Royal Society B*. 281.1797 (2014): 20141382.	
	Thursday	11/11	Batstone, Rebecca T., et al. “Experimental evolution makes microbes more cooperative with their local host genotype.” *Science*. 370.6515 (2020): 476-478.	Nice explanation by The Molecular Ecologist

13	Tuesday	11/16	Alizon, Samuel, et al. "Virulence evolution and the trade-off hypothesis: history, current state of affairs and the future." *Journal of evolutionary biology* 22.2 (2009): 245-259.	
	Thursday	11/18	*Miller, Ian F. and C. Jessica E. Metcalf. "Assessing the risk of vaccine-driven evolution in SARS-CoV-2. *medRxiv* preprint (2021). *This is preprint, meaning that it has not yet been peer-reviewed.* What does this mean?	Ian also wrote an article projecting COVID-19 healthcare burdens in summer 2020
14	Tuesday	11/23	Lythgoe, Katrina A., et al. "Short-sighted virus evolution and a germline hypothesis for chronic viral infections." *TRENDS in Microbiology*. 25.5 (2017): 336-348.	
	Thursday	11/25	*No reading – Happy Thanksgiving!*	
15	Tuesday	11/30	Walensky, Rochelle P. "Where is the ID in COVID-19?" *Annals of Internal Medicine*. 173.7 (2020): 587-589.	We need more ID doctors
	Thursday	12/2	*No reading – Poster Session!*	
16	Tuesday	12/7	*No reading – prepare for our synthesis session!*	

[1]Subject to change
[2]R is a programming language that's very commonly used in biology and other fields for statistics, data manipulation, data visualization, and simulations. RStudio is an "integrated development environment" for R – basically RStudio uses R, creating a seamless and organized platform for using the language. RStudio is not necessary for our purposes, but I recommend it. The DSAIDE ("Dynamical Systems Approaches to Infectious Disease Epidemiology/Ecology/Evolution" package is an R package for studying infectious disease dynamics. DSAIDE is introduced here, https://cran.r-project.org/web/packages/DSAIDE/vignettes/DSAIDE.html with links for installing R and RStudio under "prerequisites". We will mainly use DSAIDE's graphical user interface via this link (https://shiny.ovpr.uga.edu/DSAIDE/) so **you do not need to install DSAIDE**, but those interesting in the underlying R code can do so easily by installing DSAIDE.
[3]I link to media pieces that you may find helpful or interesting but I do not necessarily condone any spin a media piece takes on the primary research article. I encourage you to consider how the science is presented by the media and whether it is backed up by the data.
*Paper includes an author who is based at or at one time trained at UVA. There may be more that I don't know of!

Papers I love but couldn't squeeze in

- Colwell, Rita R., et al. "Reduction of cholera in Bangladeshi villages by simple filtration." *Proceedings of the National Academy of Sciences* 100.3 (2003): 1051-1055.
- Graham, Andrea L. "Ecological rules governing helminth–microparasite coinfection." *Proceedings of the National Academy of Sciences* 105.2 (2008): 566-570.
- Halstead, Neal T., et al. "Agrochemicals increase risk of human schistosomiasis by supporting higher densities of intermediate hosts." *Nature communications* 9.1 (2018): 1-10.
- Huijben, Silvie, et al. "Aggressive chemotherapy and the selection of drug resistant pathogens." *PLoS Pathog* 9.9 (2013): e1003578.
- Medlock, Jan, and Alison P. Galvani. "Optimizing influenza vaccine distribution." *Science* 325.5948 (2009): 1705-1708.
- Nazni, Wasi A., et al. "Establishment of Wolbachia strain wAlbB in Malaysian populations of Aedes aegypti for dengue control." *Current Biology* 29.24 (2019): 4241-4248.

- Smith, Neal Griffith. "The advantage of being parasitized." *Nature* 219.5155 (1968): 690-694.
- Zhu, Youyong, et al. "Genetic diversity and disease control in rice." *Nature* 406.6797 (2000): 718-722.