Evolution and Ecology of Infectious Diseases

Syllabus for BIOL 4559 – 3 credits – Fall 2020

Class meetings Tuesdays/Thursdays 11 AM -12:15 PM
Class meetings will be held online, synchronously.
Zoom links are posted on our Collab site
Please join **via your UVA account** so we can pre-assign break rooms

Instructor: Dr. Amanda Gibson, Assistant Professor
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Lab website: coevolving.org

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Course site: Collab BIOL 4559 : EEID
https://collab.its.virginia.edu/portal/site/c3e81b27-474d-43ea-9e14-d02503ccbe7a
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, attending and participating in class (25% of grade)*

Mini-quizzes (5% of grade): You will prepare for Tuesday class by reading the assigned background material and completing a mini-quiz on Collab before 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 Journal (10% of grade): You will prepare for Thursday class by reading a primary research article and posting three discussion questions to Piazza. You will keep a dated record of your discussion questions (your Discussion Journal) that you will turn in at the end of the semester. This journal will prepare you for an engaged class discussion by allowing you to reflect on the reading and build connections to previous concepts, and the questions will be used to spark class conversation. Please refer to the *Guide for Discussion Journals* for details.

Attendance and participation in class (10% of grade): 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 earn all attendance and participation points if you attend class and actively participate by responding to prompts, asking questions, and making substantive contributions to discussions. The online format gives you opportunities to participate in many ways – if you're not comfortable speaking in front of the whole group, you can post in the chat, speak in smaller break-out rooms, or stay a few minutes after class to follow-up. You lose points by missing more than two classes (you get two free absences) and showing limited to no active participation.

If you anticipate needing to miss class, please alert the instructors a week in advance. If internet access is the reason, then you may let us know that as late as the day of the class period. You are responsible for the material covered in every c regardless of whether you attend.

b) *Leading paper discussion (10% 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. In leading paper discussion, 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, identifying gaps that future work can address, and teaching your peers. Please refer to the *Guide to Leading Discussions* for details.

c) *Modeling activities (15% of grade)*

You will complete seven 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 9 am the following Friday. 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) **representing** complex biological processes as abstract models by breaking them down into their component parts; 3) **graphing** and **interpreting** data; and 4) **formulating** and **testing** 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. Four of the 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*. Two additional activities 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) *Exams (25% of grade)*

The purpose of the exams is to 1) prompt you to **actively review** and **synthesize** material from class as you prepare; 2) **solidify** learning through retrieval practice; and 3) **demonstrate** your ability to **think** critically, **identify** the important

elements of a problem, and **communicate** that to me through writing and figures. You will take two exams, a midterm on October 8 and a final on December 10. I design these exams such that you will succeed if you commit yourself to preparing and studying in advance. Two weeks before an exam, I will release a study guide of 15-20 questions. The exam will draw directly from these study questions. There will be six short essay questions of which you must complete five.

e) *Semester project (25% 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 Pre-Registered Report, a scientific publication that is written prior to conducting an experiment. In doing this project, you will go through the major steps of developing and publishing a scientific paper, 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 report. This project has multiple components due throughout the semester. You will complete some individually and others in groups of 4. Please refer to the *Guide to the Semester Project* for details.

4. How I'll determine your grade

250 points: Preparing for, attending and participating in class
- 100 points: attendance and participation in class
- 100 points: Discussion Journal (10 of 12 graded; lowest dropped)
- 50 points: mini pre-class quizzes (5 points each, 10 of 11 graded, lowest dropped)

100 points: Leading paper discussion
- 50 points: quality of presentation (group)
- 50 points: quality of discussion (individual)

150 points: Modeling activities
- 5 points: Experimental design activity
- 25 points: Epidemiological modeling 1
- 25 points: Epidemiological modeling 2
- 25 points: Epidemiological modeling 3
- 25 points: Epidemiological modeling 4
- 20 points: Monoculture Effect
- 25 points: Red Queen Game and Local Adaptation

250 points: Exams (two, 125 each)

250 points: Final project
- 30 points: Question and hypotheses (group)
- 30 points: Experimental design overview and graphic (individual)
- 30 points: Annotated bibliography (individual)
- 30 points: Submission for peer review (group)
- 35 points: Peer review (individual)
- 30 points: Poster (group)
- 35 points: Final pre-registered report (group)
- 30 points: Within-group peer evaluation (individual)

Extra credit opportunities

- 10 points: Attend Felipa Ferreira's virtual talk on September 18
- 10 points: Watch one of the following EvoEcoSeminars on Youtube: Otto, Wood, Schulenburg, Weigel, William Sutherland, Metcalf, Gordon, OR Read
- In each case, tell me what talk you watched and send three substantive discussion questions about the talk to confirm attendance

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

A+ 97-100%	B+ 87-89%	C+ 77-79%	D+ 67-69%	F 0-59%
A 93-96%	B 83-86%	C 73-76%	D 63-66%	
A- 90-92%	B- 80-82%	C- 70-72%	D- 60-62%	

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) *Online learning and technology*

This course will be taught entirely online. Microphones will be muted when the full group is meeting; you will be able to unmute yourself after volunteering on the chat and being invited to speak. This ensures that everyone has a chance to speak uninterrupted. I encourage you to have your video on when we meet as a full group, but this is not a requirement. It is important that you have your video on in breakout rooms, which are designed to facilitate collaboration and discussion. When possible, join class from a quiet, private space. Please communicate with me regarding obstacles you face with your learning environment.

I will automatically record our sessions and make those available; however, the interactive nature of the course means that the recording will not capture much of what we accomplish in class. I aim to be flexible with my attendance policy in order to accommodate problems you may encounter with internet access, including opportunities to review material and make up missed class meetings. I expect you to take all steps you can to ameliorate internet problems and to communicate with me about them so I can best accommodate you. Accommodations for missed classes due to internet connection problems will only be made if you communicate them to me via email on the day of the class.

d) *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) I have a sense of you as a person so I can write an effective, well-rounded letter – you can help me get a sense of you as a person by asking questions during and/or after class, participating in discussion, and arranging to meet with me outside of class.

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.

e) *Equity, inclusion and well-being*

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).

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 (http://www.virginia.edu/studenthealth/sdac/sdac.html) 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 9 am on Friday[1]
1	Tuesday	8/25	What is a parasite?	Mini-quiz 1: pre-class survey	Activity A: Experimental Design; Sign up for Primary Article presentations
	Thursday	8/27	Paper discussion - *led by instructors*	Borer et al. 2011, Lafferty and Kuris 2002; Discussion Journal 1	
2	Tuesday	9/1	Disease Modeling I: introduction	Otto and Day, pg. 1-39 Mini-quiz 2	Install R/RStudio and set up DSAIDE[2]
	Thursday	9/3	Paper discussion – *Group 1*	Allan et a. 2010 Discussion Journal 2	
3	Tuesday	9/8	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 9/15
	Thursday	9/10	Paper discussion – *Group 2*	Ezenwa and Jolles 2015 Discussion Journal 3	
4	Tuesday	9/15	Disease Modeling III: transmission	Wilson et al. 2017 Mini-quiz 4	Activity C: Epidemiological modeling II
	Thursday	9/17	Paper discussion – *Group 3*	Stephenson et al. 2017 Discussion Journal 4	
	Friday	9/18	**Extra credit:** 12-1 pm, Biology Department Virtual Seminar, Dr. Felipa Ferreira, Howard Hughes Medical Institute Associate at UT Southwestern - "*The Rhythmic Day of Malaria Parasites"*		
5	Tuesday	9/22	Disease Modeling IV: control	Fine and Heymann 2011 Mini-quiz 5	Activity D: Epidemiological modeling III; Question and hypotheses due
	Thursday	9/24	Paper discussion – *Group 4*	Bakker et al. 2019 Discussion Journal 5	
6	Monday	9/28	Study Guide for Exam I released		
	Tuesday	9/29	Parasites in communities I: multihost parasites	Quammen, Ch. 1 Mini-quiz 6	Activity E: Epidemiological modeling IV
	Thursday	10/1	Paper discussion – *Group 5*	Kay et al. 2019 Discussion Journal 6	
7	Monday	10/5	Review session		
	Tuesday	10/6	Parasites in communities II: specialist parasites		
	Thursday	10/8	**Mid-term**		

8	Tuesday	10/13	Evolution of Resistance I: evolutionary models	Thompson, pg 3-13,121-128 ; 133-143 Mini-quiz 7	Activity F: Coevolutionary card games I; Experimental Design Graphic due
	Thursday	10/15	Paper discussion – *Group 6*	Bonneaud et al. 2011 Discussion Journal 7	
9	Tuesday	10/20	Evolution of resistance II: why isn't everyone resistant?	Schmid-Hempel 2002 Mini-quiz 8	Annotated bibliography due
	Thursday	10/22	Paper discussion – *Group 7*	Koskella et al. 2012 Discussion Journal 8	
10	Tuesday	10/27	Coevolution I: the Red Queen	Lively 2010 Mini-quiz 9	
	Thursday	10/29	Paper discussion – *Group 8*	Morran et al. 2011 Discussion Journal 10	
11	Tuesday	11/3	Coevolution II: local adaptation and alternate models	*No reading – vote!*	Activity G: Coevolutionary card games II; Pre-registered reports due for initial review
	Thursday	11/5	Paper discussion – *Group 9*	Elde et al. 2009 Discussion Journal 10	
12	Tuesday	11/10	Evolution of virulence	Alizon et al. 2009 Mini-quiz 10	Vote on papers for next Thursday 11/19; Peer reviews due back to authors
	Thursday	11/12	Paper discussion – *Group 10*	Mackinnon and Read 2004 Discussion Journal 11	
13	Tuesday	11/17	Careers in Disease Biology	Brandell et al. 2020; McCarthy 2019; Mini-quiz 11	
	Thursday	11/19	Paper discussion – *communal effort*	TBD by popular vote Discussion Journal 12	
14	Tuesday	11/24	**Poster Session**		
	Monday	11/30	Study Guide for Exam II released		
	Friday	12/4	**Final pre-registered report and within-group peer evaluations due**		
	Monday	12/7	Review session		
	Thursday	12/10	Final Exam		

7. What you'll be reading

Week	Day	Date	Pre-class reading	Media Links[3]
1	Tuesday	8/25		
	Thursday	8/27	1) Borer, Elizabeth T., et al. "Bridging taxonomic and disciplinary divides in infectious disease." *EcoHealth* 8.3 (2011): 261-267.* 2) 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	9/1	Otto, Sarah P., and Troy Day. *A biologist's guide to mathematical modeling in ecology and evolution*. Princeton University Press, 2011. *Pages (1-39)*	
	Thursday	9/3	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	9/8	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	9/10	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"
4	Tuesday	9/15	Wilson, Anthony James, et al. "What is a vector?." *Philosophical Transactions of the Royal Society B: Biological Sciences* 372.1719 (2017): 20160085.*	
	Thursday	9/17	Stephenson, Jessica F., et al. "Host heterogeneity affects both parasite transmission to and fitness on subsequent hosts." *Philosophical Transactions of the Royal Society B: Biological Sciences* 372.1719 (2017): 20160093.	
5	Tuesday	9/22	Fine, Paul, Ken Eames, and David L. Heymann. ""Herd immunity": a rough guide." *Clinical infectious diseases* 52.7 (2011): 911-916.	
	Thursday	9/24	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	9/29	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	10/1	Kay, Sharon WC, et al. "Reciprocal abundance shifts of the intertidal sea stars, *Evasterias troschelii* and *Pisaster ochraceus*, following sea star wasting disease." *Proceedings of the Royal Society B* 286.1901 (2019).	Pynn for Hakai Magazine "The Unexpected Winners from Sea Star Wasting Disease"
7	Tuesday	10/6	*No reading this week* – study for that midterm!	
	Thursday	10/8		
8	Tuesday	10/13	Thompson, John N. *Relentless evolution*. University of Chicago Press, 2013. *Pages (pg 3-13,121-128 ; 133-143)* **Available Online through UVA**	
	Thursday	10/15	Bonneaud, Camille, et al. "Rapid evolution of disease resistance is accompanied by functional changes in gene expression in a wild bird." *Proceedings of the National Academy of Sciences* 108.19 (2011): 7866-7871.	
9	Tuesday	10/20	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	10/22	Koskella, Britt, et al. "The costs of evolving resistance in heterogeneous parasite environments." *Proceedings of the Royal Society B: Biological Sciences* 279.1735 (2012): 1896-1903.*	
10	Tuesday	10/27	Lively, Curtis M. "Antagonistic coevolution and sex." *Evolution: Education and Outreach* 3.1 (2010): 19-25.	
	Thursday	10/29	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"
11	Tuesday	11/3	*No reading* – it's election day!	
	Thursday	11/5	Elde, Nels C., et al. "Protein kinase R reveals an evolutionary model for defeating viral mimicry." *Nature* 457.7228 (2009): 485-489.	
12	Tuesday	11/10	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	11/12	Mackinnon, Margaret J., and Andrew F. Read. "Immunity promotes virulence evolution in a malaria model." *PLoS Biol* 2.9 (2004): e230.	Mackenzie, New Scientist "Malaria vaccines could make the disease worse"
13	Tuesday	11/17	1) Brandell, Ellen E., et al. "The rise of disease ecology." *bioRxiv* (2020). https://doi.org/10.1101/2020.07.16.207100	

			2) McCarthy, Matt. “The scary shortage of infectious disease doctors.” *The New York Times*. April 9 2019. https://www.nytimes.com/2019/04/09/opinion/doctors-drug-resistant-infections.html OR through UVA	
	Thursday	11/19	We will vote on which paper(s) we will read. See options below	

[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 first. We will mainly use DSAIDE’s graphical user interface, but those interesting in the underlying R code can work with that easily.
[3]I am linking to media pieces that you may find provide helpful summaries or additional insight, 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 in the original paper.
*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!

Options for papers to read on 11/19

Your suggestions are welcome too!

- 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.
- Faria, Nuno R., et al. "The early spread and epidemic ignition of HIV-1 in human populations." *Science* 346.6205 (2014): 56-61.
- 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.
- Worobey, Michael, Guan-Zhu Han, and Andrew Rambaut. "Genesis and pathogenesis of the 1918 pandemic H1N1 influenza A virus." *Proceedings of the National Academy of Sciences* 111.22 (2014): 8107-8112.
- Zhu, Youyong, et al. "Genetic diversity and disease control in rice." *Nature* 406.6797 (2000): 718-722.