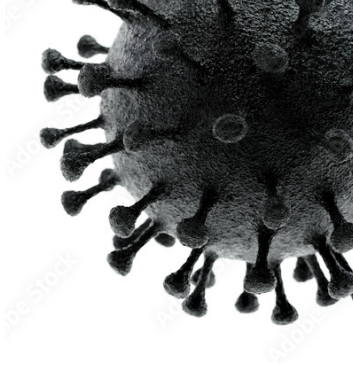

How Viruses Rule The Planet

Course instructor
Dr. Nichola Hill (she/her)
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Course name and credits
BIOL 376 Virology, 3 credits

Meeting day(s) and time
Tuesdays & Thursday 9:30-10:45am. In-person, University Hall Y01-1350 TEAL

Office hours
Tuesday 2:00-5:00pm, or by appointment

Prerequisites
BIOL 210/212 (Genetics) and BIOL 252/254 (Cell Biology)

Course description
What makes viruses so successful at ruling the planet? This is the key question that we will investigate during this course. Viruses are everywhere and are the most abundant inhabitants of the biosphere. We will examine how viruses adapt in the face of change, including dynamic environments and in response to host defences such as immunity and the microbiome. This course provides a foundation for virology with a focus on medically-important viruses. We will explore the following concepts: virus classification, the infectious cycle, viral genomes and coding strategies, virus structure and function, host responses to infection, and virus transmission. Classes will emphasize hands-on, experiential learning, and active discussion. Instead of traditional wet lab sessions, we will put knowledge into practice with dry lab sessions including a primer on tools used for viral discovery, as well as develop applied skills in outbreak investigation and epidemiology. By taking this course, you will advance your skills and understanding of virology, molecular biology, bioinformatics, emerging infectious disease and global health.

Rationale for taking this course
This course meets the demand by undergraduate students to learn about the emerging fields of infectious disease, virus evolution, bioinformatics and molecular virology. Students will gain knowledge and skills to prepare them for careers in medicine, industry or academic research labs.

Course objectives

Upon successful completion of this course, students will be able to:

- Contrast differences in virus architecture and classification
- Describe and review the elements of the viral replication cycle
- Diagram transmission and replication for medically important viruses
- Distinguish characteristics of normal cells and virus-infected cells
- Explain and apply methods used in research and diagnosis of viral diseases
- Describe vaccine strategies and mechanisms of antiviral drugs
- Explore control strategies of viruses to improve public health

Mimiviruses are some of the largest and most recently discovered viruses (link).

Textbooks, podcasts, etc

There is no required textbook. However, to help consolidate your learning, I recommend: 'Principles of Virology' (2020), 5th Edition by Flint, Racaniello, Rall, Hatziioannou and Skalka. A single digital copy is available to borrow from the Healey Library. If you borrow this, please be mindful of returning the e-book in a timely manner so all class members have a chance to access it.

We will also use a variety of sources including scientific papers, podcasts and YouTube videos that are free and available online. Links will be provided to all material used in class. The COVID-19 pandemic has meant that the internet is overflowing with virology content. This is mostly good. For example, Virology Live by Vincent Racaniello is an excellent online virology class that I highly recommend to supplement your learning. I strongly suggest reading widely and 'digging' into the literature or online media to supplement content covered in class. The more, the better!

Course materials

All course materials and slides will be posted on Blackboard after each class to facilitate electronic access and revision of material. All quizzes are due on Fridays by 11:59PM midnight. All other assignments are due on Sundays by 11:59PM midnight. Here is the link to Blackboard: https://umb.umassonline.net.

Weekly schedule:

Week	Topic	In-class activities	Suggested readings
1 *Sep 6 & 8*	• What are *viruses*? • Why are they so *successful*? • Why do some viruses make you *sick*?	• Icebreakers & welcome to the virosphere • Viruses: help vs harm to human/animal health • Pathogenicity: determined by host response • Susceptibility vs resistance	• Reading: What is a pathogen? A question that begs the point (link) • Reading: Viruses can help as well as harm us (link)

2 *Sep 13 & 15*	• What *makes* up a virion? • What are the *functions* of the virion?	• Virus structure and function • Capsid architecture & geometry • Compare & contrast your 3D virus in small groups • Enveloped vs non-enveloped viruses (& why soap works to destroy virions) • Viral packaging: fitting it all in	• Video: COVID-19 nucleocapsid protein from Dance Your PhD (link)
3 *Sep 20 & 22*	• How are viruses *classified*? • How are viruses *discovered*?	• Viral discovery through the ages: microscopy to metagenomics • Baltimore classification & the central dogma • Tracking changes in virus taxonomy	• Reading: Giant viruses, big surprises (link)
4 *Sep 27 & 29*	• How do viruses *replicate*? • How do we *trick* viruses into replicating outside the body?	• The replication cycle • Binding to host receptors to assembly and budding • In vitro methods: culturing viruses in cells and organoids	• Video: Influenza invading host cells (link) • Reading: How Zika virus infects the brain (link)
5 *Oct 4 & 6*	• How do virus code their *genetic* information? • How are viruses *engineered* for scientific discovery?	• Viral genomes are compact • Coding strategies are diverse i.e., multiple subgenomic mRNAs, leaky scanning, ribosomal frameshifting	• Video: Making of viral vectors and COVID-19 vaccines (link)
6 *Oct 11 & 13*	• *How* do viruses *evolve*? • *Why* do viruses *evolve*? • Are there *limits* to virus evolution?	• Mechanisms of viral evolution • Mutations, recombination, reassortment & acquiring genes from the host cell • Neutral and non-neutral selection in viruses	• Reading: How evolution 'landscapes' help predict viruses (link)
7 *Oct 18 & 20*	• What is a *virome*? • What can viruses *teach* us about *evolution*?	• Viruses as a community: all together now • Discussion: viromes & hosts as a unit of selection. The Holobiont concept (link)	• Reading: Diversity and evolution of animal viromes (link)
8 *Oct 25 & 27*	• How do *hosts respond* to infection?	• Productive vs non-productive infection • Cell death, persistent infection, latent infection	• Video: Cytotoxic T cell in action (link)

	• What are host *barriers* to infection?	• Barriers: mechanical, skin, mucosal, interferons, immunity • Innate vs adaptive immunity	• Video: Targeting infected cells for immune defence (link)
9 *Nov 1 & 3*	• How do viruses cause *cancer*? • What *preventions* exist for virus-induced cancers?	• Cancer causing mechanisms of viruses: interference with cell activities, accidental gene activation, damage to immune defences • Virus induced cancers in humans and animals	• Reading: Cancer: the next preventable pandemic (link)
10 *Nov 8 & 10*	• How do viruses *spread* between hosts? • Why do viruses have high *pandemic* potential?	• Direct vs indirect transmission pathways • Role of environmental transmission • Host-virus interactions: stable, evolving, dead-end, resistance	• Reading: Is viral zoonotic risk the same across taxonomic orders? (link)
11 *Nov 15 & 17*	• Your turn! • Class presentations	• Each group pitches 'next-experiment' proposals • Peer feedback by all class members	
12 *Nov 22 & 24*	• Thanksgiving (Indigenous Day of Mourning) recess		
13 *Nov 29 & Dec 1*	• How do we *control* viruses? • How do we know if control is *successful*?	• Control vs eradication strategies in action • Public health strategies: masks, physical distancing, quarantine, contact tracing • Biomedical strategies: convalescent plasma, vaccines, anti-viral drugs	• Video: The physics of a sneeze (link) • Reading: Respiratory virus shedding in exhaled breath (link) • Reading: Deadly viruses that vanish (link)
14 *Dec 6 & 8*	• How do we *measure* disease in *populations*? • What is *epidemiology*?	• Roots of epidemiology: John Snow & cholera outbreaks • Course of infection: acute phase, a/symptomatic phase, clearance vs death • Measuring disease frequency vs disease distribution • Prevalence vs incidence	• Reading: Simulating epidemics from the Ebola outbreak (link)

15 *Dec 13*	• How are *outbreaks* investigated? • How are outbreaks *controlled*?	• Collecting case history • Sample collection & lab testing • Diagnostics: rapid vs lab testing • qPCR and sequencing • Forming a diagnosis and recommendations	• Reading: Steps of an outbreak investigation – CDC (link)

Competencies

This course delivers foundational competencies that will equip the next generation of scientists to succeed in virology and more broadly, across scientific disciplines. This course emphasizes basic tools and principles that can be applied to any scientific discipline, including:

- Gain familiarity with how science constantly evolves as new discoveries occur
- Practice writing scientific reports including aims, methods, results and conclusions
- Critique research applicable to the biological sciences
- Identifying areas of uncertainty and limitations of a study
- Effective oral delivery of scientific information to fellow students and the public
- Develop and propose your own experiment to test a biological principal/observation

The human immunodeficiency virus (HIV) being surrounded and attacked by antibodies. The antibodies bind to the surface proteins of HIV and prevent the virus from entering the host cell. What color are the antibodies? What color are the surface proteins? Bonus if you can identify the HIV genome! (link)

Expectations

Attendance: It is expected that you attend all sessions. If you must miss a session, alert the course instructor in advance by email. Legitimate emergencies or excused absences negotiated beforehand will be considered on a case-by-case basis but may require make-up work. Assignments are expected to be submitted on or before the due dates set out in the syllabus. Assignments submitted after the submission date without the explicit prior approval of the course instructor will be graded down, 10% for each day late. Repeated absences, even if previously announced, may adversely affect the in-class participation portion of the final grade. We will follow the class attendance policy of UMB. For more details of this policy, please check: https://www.umb.edu/registrar/policies/attendance.

Campus closing/cancellation of class: We will follow the lead of UMass Boston with regard to observing holidays or days of reflection/commitment/action (ie. Indigenous People's Day). Please check the academic calendar: https://www.umb.edu/registrar/registration/academic_calendar. If the University is closed, class will not be held. If campus is open, class will be held as scheduled.

COVID-19 and pivot to online classes: In the event classes go remote due to the current Covid-19 pandemic, you should expect to participate in class from a computer terminal, using Zoom, during the hours that class was scheduled. Instructions for logging on and participating will be emailed to you in advance. Therefore, you should keep the class hours as scheduled even if campus is closed, until and unless receiving notice that a distance-based class will not be held.

Laptops: Please bring a laptop/tablet and charger to each class. This will be important to participate in activities that require internet access. Chromebooks are available to borrow for 24 hours from the Library Circulation Desk (https://www.umb.edu/it/labs/laptops) or for the entire semester. Ensure that you checkout your laptop loan prior to attending class. If you have any issues gaining access to a laptop please contact the course instructor as soon as possible.

Cell phone etiquette: If you bring a phone to class, please be considerate of others by turning it off and storing out of sight when class is in session.

Mutual tolerance and respect: In all interactions and communications in this class, please demonstrate mutual respect and tolerance for each other and for any course guests and members of the community with whom we come into contact. "Never allow anyone to be humiliated in your presence" is a quote by Elie Wiesel that sums up our classroom culture. Wiesel was a professor at Boston University, an activist and Holocaust survivor.

Student feedback

Your feedback regarding the course material, lectures, or other issues during the course is welcome and actively encouraged to make the learning environment collegial, pleasant, worthwhile, and productive. In an effort to receive useful feedback, you may be asked to complete a mid-course evaluation. If you feel there are areas of the course that could be improved upon, please also feel free to inform the instructor and be constructive in your comments. Please make an appointment with the instructor during the week, or feel free to provide feedback after the class session.

Dolphins get pox viruses too! Infection with cetacean pox virus results in skin lesions, earning the virus the moniker 'tattoo skin disease'. It's suggested that environmental stressors, including exposure to contaminants might trigger pox virus in dolphins (link).

Major assignment descriptions

Weekly quizzes (25% of final grade): Quizzes of 5-10 multiple choice questions will be distributed on a weekly basis. Frequent, low-pressure testing is known to improve learning outcomes. The quizzes are designed to test concepts learned in class and help you identify gaps in your own understanding for follow-up. The top scoring grades from 10 quizzes will count towards the final grade. Quizzes are online, and due Friday nights, submitted via Blackboard by 11:59 PM.

Virtual lab reports (25% of final grade): Virtual labs provide a forum for hands-on application of the concepts learned in the course to real or simulated research. These labs do not involve conventional wet lab or bench science and require a computer to complete. A total of 3 lab reports will be submitted throughout the semester, and should be formatted with a Title, Introduction, Methods, Results and Discussion section, and include references to the primary literature. Tips for how to write a scientific report (link). Lab reports are due Sunday nights, submitted via Blackboard by 11:59 PM.

Next-experiment project (25% of final grade: 15% written proposal, 10% class presentation): Students work in pairs/groups to identify a virology paper and design the next experiment that follows on from the study. The proposal will draw on skills learned throughout the course including: critique of primary literature, developing a research hypothesis, and applying current methods to a real-world problem. Students will pitch their experiment to the class for feedback during Week 11. Written proposals are due the following Sunday night, submitted via Blackboard by 11:59 PM. Each student is responsible for submitting their own the work.

Final exam (15% of final grade): This take-home, open book exam will test a range of topics covered over the entire course. The examination is mostly short answer format, with the reasoning that students do more careful deliberative thinking than multiple choice offered in the weekly quizzes. The exam will cover current concepts and methods in virology and interpretation of data. The exam will be scheduled during the final exam period.

Class participation (10% of final grade): Much of the material covered in the course will be presented through lectures, hands-on case studies, and other in-class activities. It is important that you actively and positively participate in all activities. Full credit for class participation will be earned if you attend class, actively participate in discussions, engage and offer feedback to peers and are not distracted by phones, texting, web-surfing, emailing or other non-class-related activities.

Accommodations

UMass Boston is committed to creating learning environments that are inclusive and accessible. If you have a personal circumstance that will impact your learning and performance in this class, please let me know as soon as possible, so we can discuss the best ways to meet your needs and the requirements of the course. If you have a documented disability, or would like guidance about navigating support services, contact the Ross Center for Disability Services by email (ross.center@umb.edu), phone (617-287-7430), or in person (Campus Center, UL Room 211). To receive accommodations, students must be registered with the Ross Center and must request accommodations each semester that they are in attendance at UMass Boston. For more information visit: www.rosscenter.umb.edu. Please note that the Ross Center will provide a letter for your instructor with information about your accommodation only and not about your specific disability.

Academic integrity and student code of conduct

Education at UMass Boston is sustained by academic integrity. Academic integrity requires that all members of the campus community are honest, trustworthy, responsible, respectful, and fair in

academic work at the university. As part of being educated here, students learn, exercise, increase, and uphold academic integrity. Academic integrity is essential within all classrooms, in the many spaces where academic work is carried out by all members of the UMass Boston community, and in our local and global communities where the value of this education fulfills its role as a public good. Students are expected to adhere to the Student Code of Conduct, including policies about academic integrity, delineated in the University of Massachusetts Boston Graduate Studies Bulletin, Undergraduate Catalog, and relevant program student handbook(s), linked at www.umb.edu/academics/academic_integrity.

UMass Boston is a vibrant, multi-cultural, and inclusive institution committed to ensuring that all members of our diverse campus community are able to thrive and succeed. The university provides a wide variety of resources to support students' overall success. As we continue to deal with the evolving impacts of the COVID-19 pandemic, these resources are more important than ever.

- Are you in emotional distress? Call 617.287.5690 to speak with a licensed clinician 24/7 who can offer support, crisis recommendations, and assistance with finding resources.
- Have a campus question or issue? Use Here4U in the UMass Boston app or via www.umb.edu/here4U.
- Want advice in navigating a university or life situation? Contact the Dean of Students Office at www.umb.edu/deanofstudents.
- Want to connect with housing and food insecurity support, student life groups and events, or recreation activities? Visit www.umb.edu/life.
- Want to access resources specifically for immigrant-origin, DACA, TPS, and undocumented students? Visit www.umb.edu/immigrant.
- Looking for additional identity-based community support? Find more resources at www.umb.edu/identity-support
- Want to make the most of your academic experience? Visit www.umb.edu/academics/vpass/academic_support.
- Unable to attend class on a specific date or participate in an exam or class requirement due to a religious observance? Fill out the excused absence form (requires 2-weeks' notice) to request religious accommodation at www.umb.edu/religiousabsence.

Hey, thanks for reading to the bottom of the syllabus! Please enjoy (and think about) this illustration below that summarizes how viruses and microbes rule the planet (link).