

The Biology of Viruses

MMI / BIOCHEM 575 (2 CREDITS) - SPRING 2023

INSTRUCTORS: Professor Paul Friesen
Professor Andrew Mehle

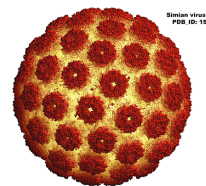


COURSE DESCRIPTION: “Biology of Viruses” (MMI/Biochem 575) is a 2-credit course that teaches upper-level students the molecular biology and biochemistry of viruses and virus infection. Students will learn the fundamentals of virus structure, virus multiplication, disease mechanisms, prevention and intervention of infection, and how viruses pose threats to human health through emergence and evolution. We will discuss selected examples of viruses that impact our world and everyday life. The course will focus on viruses pathogenic to animals but will NOT be a “bug (virus) per day” style of class. At the course’s conclusion, students will understand principles and themes in modern day virology, including virus pathogenesis, vaccination, anti-viral drugs, and gene therapy. Virology 575 is a high-rewards course that will benefit students interested in medicine, public health, biology, and graduate-level research. The course has an undergraduate honors option and is available for graduate credit (with university-mandated requirements).

MEETING TIME AND MODALITY:

LECTURES: Tuesday and Thursday, 1:00 PM – 1:50 PM
Room 1520, Microbial Sciences Building

Papilloma virus



In Spring 2023, this course will be offered in-person. An in-person discussion session will be held on Mondays, 4:00-5:30 PM. The session is highly recommended yet optional.

NOTE: Two 1-hour exams will be held outside of normal class hours on Tuesday evenings, 7:30 PM – 9:00 PM, CST (see Course Schedule, p. 8-10).

Printed lecture handouts will be provided for each class or they can be downloaded from the Canvas [575 Website](#) as Power Point or pdf files. The lectures will not be recorded. Taking careful classroom notes by using the lecture handouts and reviewing suggested materials (the textbook included) outside of class is essential. The lecture notes are not intended to substitute for the lecture presentations, nor will the notes include every detail discussed in the instructor’s lectures. Thus, students should attend class and the offered review sessions. ***Regular participation is necessary for student success.***

CREDIT HOURS: This class consists of two 50-min class periods each week throughout the semester and carries the expectation that students will work on course learning activities (recommended readings, assigned problem sets, exam preparation, and review sessions) for 2-3 hours outside of class for every lecture period. Additional information relevant to class periods and expectations for student work are described below.

LEARNING OUTCOMES: By semester’s end, students will have obtained knowledge to:

1. Recognize and list fundamental members of the predominant families of RNA and DNA viruses that affect animals (humans included) by causing viral diseases, including AIDS, cancer, flu, and COVID-19.
2. Describe and distinguish the basic concepts of virus particle structure and the biochemical mechanisms for entry and multiplication of diverse RNA and DNA viruses.

3. Recognize and apply the basic principles of virus transmission and viral pathogenicity, combined with the factors that contribute to virus emergence and evolution, to situations involving virus outbreaks that affect global health.
4. Identify and evaluate individual steps in a virus' replication cycle that can be effectively targeted by anti-viral drugs for pharmaceutical intervention of virus diseases.
5. Design effective strategies for i) prevention of infection through development of viral vaccines and ii) treatment of diverse human diseases by gene therapy through the design and administration of genetically engineered virus vectors.
6. For graduate students, describe and evaluate the scientific premise, hypotheses, and supportive data presented in a scientific talk or published report in the field of virology.

COURSE PREREQUISITES: Important for student progress is basic knowledge of many subjects in Biocore 301/302, Zoology 151/152, or MM&I 301. A solid background in cell biology, genetics, and biochemistry will be necessary since these principles will be emphasized throughout the course. Coursework in general biochemistry is **highly** recommended; some immunology will be helpful.

COURSE WEBSITE: Our Canvas website (<https://canvas.wisc.edu/courses/337508>) contains a wealth of information, including the course syllabus, the lectures (Power Point presentations), lecture handouts, problem sets, problem set answers, practice exams, and Study Guides. Additional information to facilitate student understanding is included. We **STRONGLY** encourage you to visit the website often, offer feedback, and start discussion groups if interested. The website is updated every class. Go to: [575 Website](#)

RECOMMENDED TEXTBOOK: *Principles of Virology*, 5th Edition, 2020. S.J. Flint, V.R. Racaniello, G.F. Rall, T. Hatziioannou, A.M. Skalka (eds). ASM Press. 2 volumes. ISBN 978-1683670322.

This **two-volume** textbook is ***highly recommended***, but not required. It is available for purchase, rent, or as an online eBook. Limited copies are also available at Steenbock Library Reserves Desk. It is an excellent reference for lecture concepts and principles, even though it covers more detail than will be discussed in class. Many figures used in the lecture presentations by the instructors are adapted from this book.

QUIZZES: Two or three quizzes (10 pts each) will be given (to be announced) to facilitate student learning. Each quiz will be open book and available for 48 hours to complete online.

EXAMS: All examinations must be taken in this course. The first two exams will be given during evening hours (Tuesdays) outside of class (see Schedule, p. 8-10). Make-up exams are discouraged and will be given **ONLY** under extraordinary circumstances. Missed exams will be allowed only if written notice of a conflict or illness is given to the instructor **24 hours prior** to the exam. There will be **NO** early final exams given in this course.

GRADING: A student's final grade in this upper-level course will be based on the following:

	<u>POINTS</u>	
1. Two one-hour exams (100 points each)	200	Total Points = 360
2. Final exam (50% comprehensive)	100	
3. Three online quizzes (10 pts each)	30	
4. Problem sets	30	

Points for all assignments/exams will be totaled at the end of the semester. The instructors will apply a curved grading scheme to ensure an equitable distribution of grades. Usually, the grade distribution provides an “A” for point totals in the top 25% of the class, an “AB” for the next 10%, a “B” for the next 25%, a “BC” for the next 10%, “C” for the next 25%, and the remainder a “D” or “F”. The instructors reserve the right to make minor adjustments to accommodate the above distribution. A grading curve will be shown after each exam, but such curves will only serve as guidelines for students to assess their performance on that exam. The exam curves do not set boundaries for final grades, which includes all points.

EXAM REGRADING POLICY: If you have questions concerning a grade on an exam, see your TA promptly. If you desire to have the exam regraded, you must return it to a TA or the instructor within **one week** of taking the exam. Your graded exam must be accompanied by a written description of the perceived problem, which is to be stapled to the front page of the exam. In such cases, the entire exam will be regraded.

GRADUATE CREDIT: Graduate students enrolled in this course must fulfill special university-mandated requirements in addition to the standard course assignments. Grad students should see Dr. Mehle or Dr. Friesen for the syllabus addendum containing details relevant to receiving graduate credit. Included will be required attendance at the Molecular Virology Seminar Series (designated Biochem 910) – these seminars are held Thursdays from 12:10–1:00 PM, immediately prior to this class. The Biochem 910 seminar schedule for Spring 2023 will be made available. Graduate and honors students are **NOT** required to enroll in Biochem 910, but rather attend the seminars only.

UNDERGRADUATE HONORS OPTION: For honors credit, *undergraduates must contact Dr. Mehle first to receive the syllabus addendum for the honors option.* He will explain (in writing) the actions needed for students to fulfill these requirements. Honors students will also be required to attend the Molecular Virology Seminar Series (see above).

PROBLEM SETS: Five problem sets will be assigned (6 points each). Printed copies will be provided in class and electronic copies can be downloaded from the [575 Website](#). The problem sets are designed to facilitate student understanding. The instructors will evaluate, but not correct them. Credit will be given only to fully completed assignments. The instructors will discuss the answers at discussion sessions. An answer key will be posted on the 575 Website after the due date. Problem sets must be completed by each individual student and turned in on the indicated due date. Although students are encouraged to work in groups, identical group answers are NOT ACCEPTABLE. The use of online services that complete assignments on a student's behalf is not permitted.

DISCUSSION SESSIONS & OFFICE HOURS: There are NO required discussion sessions for this upper-level course. However, your TAs and instructors will lead a 90-min class discussion on **Mondays** 4:00-5:30 PM in Room B105, Bock Laboratories (1525 Linden Drive) to answer questions about lecture material and the problem sets. **Student attendance is highly beneficial.** In addition, each instructor will take office appointments should you desire to meet individually to discuss class material. Please note that your TAs are Ph.D. students, whose thesis research involves microbiology. They are experts, who are willing to help you succeed in this course. It is recommended that students consult the TAs and the instructors to help learn the material in this course.

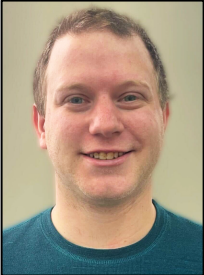
ACADEMIC INTEGRITY: By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. Such action includes but is not limited to failure on the assignment or course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review. For more information, refer to <https://conduct.students.wisc.edu/academic-integrity/>.

**INSTRUCTORS:**

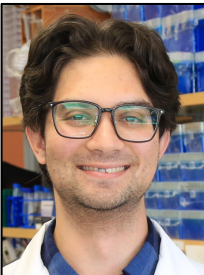
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GUEST INSTRUCTORS:

Kristen Bernard, Professor and Chair –
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Room 4270c, Veterinary Medicine Bldg. 2015 Linden Drive
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Dr. Bernard is the Chair of Pathobiological Sciences at UW-Madison, a previous President of the American Society for Virology, and a world's expert in emerging viral diseases, RNA viruses included.

MATERIALS ON RESERVE: Various course-related materials will be placed on reserve at Steenbock Library (Babcock and Observatory Drive) These resources include the recommended textbook and other useful reading materials (see below).

- 1) 5th Edition, 2020. S.J. Flint, V.R. Racaniello, G.F. Rall, T. Hatzioannou, A.M. Skalka (eds). ASM Press. 2 volumes. ISBN 978-1683670322.
- 2) Basic Virology, 3rd Edition. 2008. E.K. Wagner, M.J. Hewlett, D.C. Bloom, D. Camerini (eds). Blackwell Publishing. ISBN 978-1-4051-4715-6.
- 3) Fundamentals of Molecular Virology, 1st Edition, 2007. N.H. Acheson, John Wiley & Sons. ISBN 0-471-35151-2

OTHER USEFUL MATERIALS:

Principles of Molecular Virology, 2015. Cann, Alan J. Elsevier Science & Technology. ProQuest Ebook Central, available online and downloadable via UW Library portal – <https://search.library.wisc.edu/catalog/9913082637602121>

Description: An online text that can be downloaded via the UW Library. Provides an additional presentation of many of the topics we will cover.

Basic Virology, 3rd Edition. 2008. E.K. Wagner, M.J. Hewlett, D.C. Bloom, D. Camerini (eds). Blackwell Publishing. ISBN 978-1-4051-4715-6.

Description: an older version, but this book is an excellent reference for materials covered in class. It will also provide more details than we offer in class. Some of the figures used in lecture are adapted from this textbook. **On reserve at Steenbock Library.**

Fundamentals of Molecular Virology, 1st Edition, 2007. N.H. Acheson, John Wiley & Sons. ISBN 0-471-35151-2.

Description: this is rather dated, but a great review of virus replication and individual virus families. **On reserve at Steenbock Library.**

Introduction to Modern Virology, 7th Edition, 2016. N. Dimmock, A. Easton, K. Leppard (eds). Blackwell Publishing.

Description: Interesting alternative to Flint's *Principles of Virology*. **The library only has a digital copy of the 7th edition, available here – <https://search.library.wisc.edu/catalog/9912334536202121>

Fields Virology, 6th Edition, 2013 D.M. Knipe, P.M. Howley et al. (eds).

*Description: This is **the** reference text of virology. It goes into much more detail than class or the recommended textbook. Provides supplemental and advanced reading for interested students. A new 7th edition was released in 2020, splitting the original monster text into several smaller volumes. It was released as a physical book and an ebook, but the library does not have it yet.*

WEBSITES: There are numerous websites for virology and virus-caused diseases. Many of these sites have links to additional sites. Do some exploring. You will find material to supplement the lectures and peak your interest in special topics.

[This Week in Virology \(TWIV\)](#) Vincent Racaniello, a virology professor at Columbia and an author of our textbook, has pioneered science outreach with his podcasts called **TWIV** about virology and related microbiology topics. His website and podcasts provide up-to-date stories of recent events and issues in virology. [The Virology 101](#) section offers a good primer on different aspects of virology. The lecture videos and handouts from his course at Columbia are [online](#) and cover much of the 575's material and follow our same textbook used in MMI/Biochem 575.

<https://viralzone.expasy.org> This website is a great resource for understanding viral families and taxonomy, replication strategies, and general molecular virology. It has extensive figures that also aid learning (some of which are included in the lecture PPT slides).

<http://www.virology.wisc.edu/> This website is authored by the Institute for Molecular Virology here at U.W.-Madison. Go to the link "Virus World" for great for images and movies of different viruses – it is very popular for teaching virology courses. You can also link to a list of virology seminars happening on campus.

<http://www.promedmail.org> This website is the global electronic reporting system for virus outbreaks, including emerging infectious diseases and toxins. You'll know exactly when and where, coronaviruses, Ebola and Zika hit hard again.

DIVERSITY AND INCLUSION:

Institutional statement on diversity:

"Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals.

The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world."

Go to: <https://diversity.wisc.edu/> .

THE USE OF COURSE LECTURES:

Lecture materials and recordings for this course are protected intellectual property of UW-Madison. Students enrolled in this course may use the materials and recordings for their personal participation in class. Students may also take notes solely for their personal use. If a lecture is not already recorded, students are not authorized to record the lectures without permission unless the student is considered by the UW to be a qualified student with a disability requiring accommodation [Regent Policy Document 4-1]. Students may not copy or have lecture materials, problem sets, and recordings outside of class, including posting on internet sites or selling to commercial entities. Students are also prohibited from providing

or selling their personal notes to anyone else or being paid for taking notes by any person or commercial firm without the instructor's express written permission. Unauthorized use of these copyrighted lecture materials and recordings constitutes copyright infringement and may be addressed under the university's policies, UWS Chapters 14 and 17, that govern student academic and non-academic misconduct.

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES:

The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform the course instructors of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. The instructors will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA. (See: McBurney Disability Resource Center)

UW-MADISON CLASSROOM HEALTH GUIDELINES - COVID-19

Dated: September, 2022

For the most recent campus-wide COVID recommendations, go to:

<https://covidresponse.wisc.edu/>

Vaccinations: COVID-19 vaccination and all boosters are highly recommended for all UW-Madison students, faculty, and staff. Vaccines, boosters, and COVID-19 testing are readily available to all UW students upon request.

Masks: Effective March 12, 2022, masks may be worn but are no longer required inside university buildings. Masks are required when visiting COVID-19 test sites and other clinical spaces on campus, including University Health Services. You should wear a mask for 10 days following a positive COVID-19 test and for 10 days following an exposure to someone with COVID-19.

Class activities: Students should continually monitor themselves for COVID-19 symptoms and get tested for the virus if they have symptoms or have been in close contact with someone with COVID-19. Students should reach out to their instructors as soon as possible if they become ill or need to isolate or quarantine, in order to make alternate plans for how to proceed with their courses. Students are strongly encouraged to communicate with their instructor concerning their illness and the anticipated extent of their absence from the course. Your instructors will work with students to provide alternative ways to complete the course work.

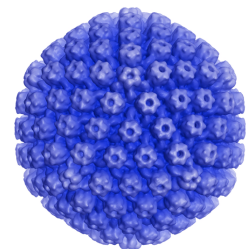
Please protect yourself, your classmates, and your instructors.

COURSE SCHEDULE:***Part 1. What are viruses and how do they multiply?***

In this first part of “Biology of Viruses”, we will develop the thesis that all viruses adopt a common strategy that must be followed to exist as what we define as “viruses.” We will show that viruses have specific life cycles, express their genetic information (genomes) in a regulated fashion, and assemble highly specialized particles to pass on their genome to the next susceptible host. You will see that although the multiplication tactics used by some virus families are very different, they all have common themes.

2023

<u>Lecture #</u>	<u>Date</u>	<u>TOPIC</u>	<u>Instructor</u>	<u>Reading</u>
1	Jan. 24 (Tues)	Introduction, Definition of a Virus	Friesen	see Lecture Notes
2	Jan. 26 (Thurs)	Genomes and Classification	Friesen	
3	Jan. 31 (Tues)	Virus Structure and Methodology	Friesen	
4	Feb. 2 (Thurs)	DNA Viruses I: Gene expression	Friesen	
5	Feb. 7 (Tues)	DNA Viruses II: Genome replication	Friesen	
6	Feb. 9 (Thurs)	Replication of Retroviruses	Friesen	
7	Feb. 14 (Tues)	Replication of RNA Viruses (+ strand)	Mehle	
8	Feb. 16 (Thurs)	Replication of RNA Viruses (– strand)	Mehle	
9	Feb. 21 (Tues)	Virus Attachment, Entry, Uncoating	Mehle	
10	Feb. 23 (Thurs)	Assembly, Maturation, Exit	Mehle	
	TBA	Review for Exam 1		
	Feb. 28	Exam 1 (30% of grade) – evening exam period (Tues, 7:30 PM – 9:00 PM)		



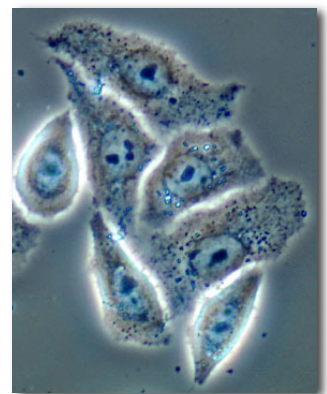
Herpes Simplex Virus capsid

Part 2. Viral Pathogenesis – Anti-viral Strategies

In this section, we will examine the complexity of host-virus relationships. Viruses have effects on the host that can range from benign to lethal. We will discuss mechanisms of virus-induced disease (pathogenesis). We will study the mechanisms by which animals respond to virus attack and how some viruses escape the host's anti-viral defenses by evolving clever mechanisms, including the establishment of persistent or latent infections by some of the most "successful" viruses. Lastly, we will begin discussions of the treatment and prevention of viral disease by using anti-viral drugs and vaccines.

<u>Lecture #</u>	<u>Date</u>	<u>TOPIC</u>	<u>Instructor</u>	<u>Reading</u>
11	Feb. 28 (Tues)	Intro to Viral Pathogenesis: Multiplication in the Host	Friesen	see Lecture Notes
12	Mar. 2 (Thurs)	Apoptosis and Evasion by Viruses	Friesen	
13	Mar. 7 (Tues)	Role of Viruses in Cancer I	Friesen	
14	Mar. 9 (Thurs)	Role of Viruses in Cancer II	Friesen	
SPRING BREAK (March 11 – March 19)			No classes	
15	Mar. 21 (Tues)	Virus Persistence and Latency	Friesen	
16	Mar. 23 (Thurs)	HIV & AIDS – I	Friesen	
17	Mar. 28 (Tues)	HIV & AIDS – II	Friesen	
18	Mar. 30 (Thurs)	Anti-viral Drug Strategies	Friesen	
19	Apr. 4 (Tues)	Host Defenses to Viral Infection: Innate Immunity	Mehle	
20	Apr. 6 (Thurs)	Host Defenses to Viral Infection: Adaptive Immunity	Mehle	
	TBA	Review for Exam 2		
	Apr. 11	Exam 2 (30% of grade) evening exam period (Tues, 7:30 PM – 9:00 PM)		

HeLa cells (cancer)



Part 3. Prevention and Emerging Viral Threats

In this last section, we will discuss vaccines and their strategy to prevent infection. Importantly, we will focus the real-time health issue of emerging viruses, some old (bird and swine flu) and some new (West Nile and SARS-CoV-2). We will discuss their potential to threaten humankind. Finally, we will turn our attention to beneficial uses of viruses. We will discuss modern approaches in medicine that exploit viruses and their properties in vaccine production and human gene therapy as examples. The bottom line is that viruses have taught us an enormous amount about biology, disease, and human defenses against pathogens.

<u>Lecture #</u>	<u>Date</u>	<u>TOPIC</u>	<u>Instructor</u>	<u>Reading</u>
21	Apr. 11 (Tues)	Immune Evasion Strategies: How Viruses Fight Back	Mehle	see Lecture Notes
22	Apr. 13 (Thurs)	Viral Vaccines	Teaching Assistant	
23	Apr. 18 (Tues)	Influenza virus: Birds, swine, and humans	Mehle	
24	Apr. 20 (Thurs)	Emerging viruses: West Nile, SARS, Hantavirus	K. Bernard - Guest Professor	
25	Apr. 25 (Tues)	Hemorrhagic Fever Viruses Ebola, Marburg, Lassa	Teaching Assistant	
26	Apr. 27 (Thurs)	Hepatitis B and C Viruses	Mehle	
27	May 2 (Tues)	SARS-CoV-2 and COVID-19	Mehle	
28	May 4 (Thurs)	Virus Vectors & Gene Therapy	Friesen	
	TBA	REVIEW for final exam		
	May 9 (Tues)	FINAL EXAM (30% of grade) 2:25 PM – 4:45 PM - Room TBA		

Nodavirus

