ASV Graduate Curriculum Guidelines

ASV Graduate Curriculum Guidelines Committee - Contributing Authors:

Melissa Maginnis, PhD, Co-chair, ASV Education and Career Development Committee
Associate Professor, Department of Molecular and Biomedical Sciences, Graduate School of Biomedical Science and Engineering
The University of Maine

Lauren O'Donnell, PhD, Co-chair, ASV Education and Career Development Committee
Associate Professor, School of Pharmacy, Graduate School of Pharmaceutical Sciences
Duquesne University

David B Kushner, PhD, Professor, Department of Biology
Dickinson College

John S. L. Parker, DVM, PhD, ASV Councilor for Veterinary Virology, Associate Professor, Baker Institute for Animal Health, College of Veterinary Medicine
Cornell University

Suchetana Mukhopadhyay, PhD, Professor, Department of Biology
Indiana University

Dylan M Johnson, PhD, Postdoctoral Fellow, Galveston National Laboratory, Department of Microbiology & Immunology
The University of Texas Medical Branch

Pranav Danthi, PhD, Professor, Department of Biology
Indiana University

Chelsey C Spriggs, PhD, Assistant Professor, Department of Cell and Developmental Biology, University of Michigan Medical School

Daniel A Morales, PhD Student, Department of Biological Sciences
Florida International University

Context for the Guidelines

The purpose of the ASV Graduate Curriculum Guidelines is to serve as an accessible and comprehensive entry point for instructors designing a graduate course in virology. The guidelines are designed to lay a foundation for graduate students to pursue more advanced topics related to virology in their graduate education. In order to develop a diverse, equitable, and inclusive scientific workforce, it is important to create an inclusive curriculum with broad representation in course materials such as diverse authors of primary research articles or guest lecturers. As instructors develop a graduate virology course, it is important to consider the needs and resources of the program as well as the educational background that students bring to each iteration of the class. Instructors may wish to modify the guidelines based on the following considerations:

- *Survey of prior coursework*: Students enter graduate school from a variety of university settings, majors, and research experiences and opportunities. Undergraduate virology courses are not available at all institutes of higher education, and a survey of 135 ASV trainees revealed that only 25% of them had taken an undergraduate virology class prior to graduate school. ASV trainees also report certain topics to be most helpful for their virology education, including cellular and molecular biology, biochemistry, immunology, genetics, and microbiology. Instructors could consider surveying their students to determine the subjects and processes that may require additional training or support.
- *Concept-focused vs. virus-family focused format:* Graduate virology courses are often structured around key virology concepts (*e.g.*, entry, replication) or around virus families. The guidelines describe a format based on virology concepts, although a blend of formats (*e.g.,* key concepts with particular viruses as examples) is feasible.
- *Alignment with institutional expertise*: If an institute has a particular research focus, it is worthwhile to incorporate those themes into a virology course to leverage expertise in the institute while still focusing on foundational material.
- *Emphasis on current virology methods and techniques*: In addition to foundational concepts in virology, a deep understanding of modern techniques can prepare students to engage and participate in virology research. Some institutions may have the infrastructure to support hands-on virology laboratory research experiences, yet where lacking, a bioinformatics-based research project could serve as a beneficial alternative. Incorporation of recent primary literature through journal-club style classes also provides students with an opportunity to learn newer methods and to develop a critical eye for the literature.

Learning goals

The goal of a graduate virology course is to gain in-depth knowledge of molecular virology, viral pathogenesis, virus-host interactions, and viral host defenses. The course should guide students towards a deep understanding of key concepts in virology and enable them to apply their understanding to explain complex virologic processes. Additionally, students should be able to critically read peer-reviewed literature in the field of virology, define and understand current questions in virology, describe appropriate technologies to address relevant questions, and effectively communicate scientific findings to broad audiences. While the strategies to deliver the

content will differ by institution and instructor, potential approaches include a combination of: analysis and discussion of primary literature, presentation of published or independent research findings, writing a virology-based grant proposal, and engaging in discussions regarding scientific publications, ethics in research, and scientific reporting. It would also be beneficial for students to explore potential careers in virology and utilize the classroom space as an opportunity to practice professionalism. The learning objectives below are designed for a comprehensive graduate curriculum that focuses on the learning *process* to develop higher-order thinking skills, *content* to build awareness of foundational material and experimental approaches critical to virology, and *skill-building* for professional development of graduate students in the field of virology.

Upon completion of a graduate virology course, students should be able to demonstrate the following skills and knowledge:

Process

1. Synthesize basic concepts in virology to coherently describe complex virologic processes.
2. Apply knowledge of virologic principles to primary literature to gain a deep understanding of discovery-based science.
3. Critically read and critique primary literature in the field of virology.
4. Explain current topics and new advances in the field of virology.

Content

1. Describe the principles of virus structure and viral genomes.
2. Explain the replication strategies of multiple viruses from attachment to exit.
3. Explain how virus-host cell interactions lead to infection and viral pathogenesis.
4. Explain how the host innate and adaptive immune system defends against viral infection.
5. Describe how viruses successfully evade the host innate and adaptive immune system to establish infections.

Skill-Building

1. Effectively communicate virology-research based findings in a group setting to both scientific and lay audiences.
2. Identify new insights by gathering information from the virology literature, formulating new hypotheses, and developing effective, feasible strategies to test new virology research questions.
3. Discuss ethical and responsible conduct in virology research.

Content

The overarching goal for content delivery is to focus on foundational material and broad virologic concepts, with examples of specific virus families and integration of eukaryotic and non-eukaryotic, plant, animal, and human viruses throughout, including but not limited to the following topics*:

1. Virus Structure
2. Viral Attachment and Entry
3. Virus Trafficking and Uncoating
4. Viral Replication
5. Virus Assembly
6. Viral Egress/Exit
7. Viral Pathogenesis
8. Innate and Adaptive Immune Response to Viral Infection
9. Evasion of the Immune Response by Viruses
10. Viruses, Transformation, and Cancer
11. Antiviral Treatments
12. Vaccines
13. Viral Emergence and Evolution
14. Classic and Modern Technologies to Study Viruses

**Due to time constraints, to teach these topics, instructors may choose to focus on an example of: an enveloped or non-enveloped virus, +/- strand RNA viruses, dsRNA viruses, retroviruses, and/or dsDNA viruses or the viruses most relevant to their institutional research.*

Approaches to Content Delivery for Developmental Learning Process and Skill-building

The content delivery should be designed to focus on knowledge building, critical-thinking skills, and skill-building exercises for oral and written communication and practicing professionalism. Graduate virology classes could differ across institutions based on resources, local expertise, class sizes, and prior background and preparation of students. Some examples of content delivery include:

1. Lecture-based active learning to teach key concepts to students from broad educational backgrounds
2. Journal club-style courses
3. Blended lecture-based active learning and paper-discussion course
4. Emphasizing methods/techniques with a focus on cutting-edge techniques
5. Incorporation of classic virology papers to illustrate the research that developed textbook-based knowledge
6. Primary-literature articles to reinforce and gain a depth in knowledge in key concepts
7. Classroom-based discussions on primary literature articles and/or virology techniques
    a. Consider instructor-curated article lists to reinforce concepts and utilize examples for teaching opportunities
    b. Consider an approach of discussing a series of papers to demonstrate how techniques have advanced and improved over time to illustrate concepts such as reverse genetics or advances in whole genome or single cell sequencing
8. Possible incorporation of computation exercises or bioinformatics-based projects
9. Classroom-based discussions on ethical topics in virology as a mechanism to discuss responsible conduct of research (RCR; *i.e.*, CCR5 CRISPR babies, virology gain of function experiments, rigor and reproducibility)

10. Possible incorporation of pre-print BioRxiv articles for students to perform a mock-manuscript review and discussion as a critical-thinking exercise. As an extension, consider following a BioRxiv paper from deposition to publication and analyzing public reviewer comments (*i.e.*, eLife).
11. Oral presentation of published or independent research findings
12. Activities to practice written communication skills such as a manuscript summary and review or a mock mini-grant proposal
13. Individual or group projects focused on integration of literature resources to develop hypotheses and experimental strategies to address key questions in virology

Source

Parker, R. Mol Cell. 2012 May 25; 46(4): 10.1016/j.molcel.2012.05.003.