

Graduate Curriculum: MS-A and PhD Programs

MS-A & PhD Credit Requirements

MS-A	PhD
30 credits total	72 credits total
24 credits at CSU	24 credits at CSU (30 credits can be applied from MS or DVM degree)
16 credits must be 500+	21 credits must be 500+ (beyond MS/DVM if applicable)
12 credits must be regular courses*	16 credits must be regular courses*
Of the total regular courses, 9 credits must be regular courses* with MIP prefix	Of the total regular courses, 13 credits must be regular courses* with MIP prefix
2 credits must be MIP700	4 credits must be MIP700

*Regular course work is defined as didactic courses other than topics (MIP700 or MIP796), or any course above X82 including: seminars (MIP792A), independent or group studies (MIP795 or MIP796), research credits (MIP698/MIP798), thesis/dissertation credits (MIP699/MIP799), and supervised college teaching (MIP784).

Course Number and Title	Offered	Credits
MIP700 - Topics in Microbiology, Immunology and Pathology	Fall and Spring	1
Discussion of research literature in core areas, a new topic e Must be taken once every year.	every semester.	
MIP792A - Graduate Student Seminar	Fall and Spring	1

Students present their research in this weekly seminar. Must be taken every semester and present every other year.

MIP654 - Research Policies and Regulations Spring 1 Research policies and regulations will be reviewed in the context of ethics theories and practical solutions will be discussed for realistic case studies on issues in the research environment. This course has a focus on Responsible Conduct of Research (RCR) and meets federal standards for providing trainees with formal ethics training. Face-to-face RCR training is required for trainees as part of their formal or informal training experience. CSU requires that all trainees (postdoctoral fellows, graduate students) funded by the NIH, NSF, USDA NIFA take an approved face-to-face training course.

General Electives

D.

MIP470 -Graduate Fellowship Proposal PreparationFall1Guidance for the process of preparing a proposal for submission to the National Science Foundation -
GRFP.1

MIP540 -Fundamentals of Biosafety and Biosecurity	y Spring	2
Practical applications of biosafety principles, in	cluding lab practices and	regulatory aspects of
research involving infectious microorganisms a	nd rDNA.	

MIP643 -Grant Writing for Microbiology/PathologyFall and Spring1The ability to effectively communicate scientific ideas, project goals and experimental
approaches is vital for graduate students (and all scientists). To assist in developing these skills,
students will receive a series of formal lectures/discussions on how to prepare an effective grant
proposal. Students will create a full NIH-R21 format research proposal based on their own
research project.

MIP666 -Writing Scientific ManuscriptsFall3Language is the key to publication, to funded grants, and to long and productive careers in
science. As a practicing scientist, ninety, perhaps ninety-nine, percent of those who will come to
know you, will come to know you only through your written words –your manuscripts, your grant
applications, your reviews, and your abstracts. If the words you write cannot carry the force of
your science, you might as well not bother. Science without the words is not truly science at all.

MIP710 –Research Teams MentoringSpring1This course teaches graduate students pursuing research-based master's or PhD degrees and
postdoctoral fellows pursuing original research skills and techniques to effectively mentor in a
research laboratory setting.1

Virology Electives

MIP533 -Epidemiology of Infectious DiseaseSpring3The epidemiologic bases of infectious and zoonotic diseases have a major impact on community
health. The course will focus principally on zoonotic, emerging, and vector-borne diseases that
are recognized on a national or global level. Instructors will be drawn from CSU as well as from
CDC and USDA laboratories in the Fort Collins area to provide students with cutting edge
theoretical as well as "real world" practical insight into the epidemiology of these diseases.

MIP543 -RNA BiologyFall odd years3From microbes to mammals, understanding the fundamentals of molecular biology is required for
a student's mastery of their biology. Training in the area of RNA biology, therefore, is
fundamental for the well-rounded student in the life sciences. This course will provide graduate
students and advanced undergraduates with an in-depth, cutting edge exposure to the subject of
RNA biology/post-transcriptional control.

MIP581A5 -Advanced Virology I - Fundamentals/New Insights Spring even years 1 The study of virology at the molecular and cellular level has been fundamental to our knowledge of structural biology, mechanisms of nucleic acid and protein biosynthesis, regulation of gene expression, and the host-pathogen molecular arms race. These will be topics of the lectures. Emphasis in the course will be on vertebrate animal viruses (insect viruses will be covered in later modules).

<u>MIP581A6 -Advanced Virology II- Mechanisms of Viral Disease Spring even years</u> 1 This course will focus on the mechanisms by which viruses cause disease. Students should have an understanding of virus structure/replication, entry, spread, and viral evolution from Module I (or similar coursework) to lay the groundwork for subsequent presentations on particular mechanisms of disease and systemic effects of viral infection. Particular emphasis will be placed on current knowledge and unifying concepts regarding virus interactions with the host at the molecular, cellular, and whole animal levels.

MIP581A7 -Advanced Virology III -Discovery Tools & Control Spring even years 1 This course will focus on the mechanisms by which viruses cause disease. Students should have an understanding of virus structure/replication, entry, spread, viral evolution and immunopathogenesis from Advanced Virology I and II (or similar coursework) to lay the groundwork for subsequent presentations on particular mechanisms of disease and systemic effects of viral infection. This course will focus on arthropod-borne viruses including alphaviruses, flavivirues and bunyaviruses and mechanisms of disease in the vertebrate host. It will address mosquito biology, innate immunity in the mosquito vector and emerging technologies for discovery and control

MIP680A4 -Fundamentals of Infectious Disease Immunity Spring odd years 1 This course will introduce students who are researching or interested in immune responses to infectious agents to the basic knowledge in host/pathogen interactions, activation and escalation of the immune response during infections, innate and adaptive immune mechanisms, and vaccine development and production.

 MIP680A5 – Immunity to Viruses
 Spring odd years
 1

 This course will introduce graduate students and advanced undergraduate students who are researching or interested in immune responses to viruses, how viruses evade the host response and cause disease, and how the immune response can contribute to pathology.

Bacteriology Electives

MIP550 -Microbial and Molecular Genetics LaboratorySpring4This course is an introduction to various *in vivo* genetic and *in vitro* molecular techniques used in
prokaryotic gene analysis and studying gene regulation. Genetic and molecular techniques will
be performed in class by the students using instructor-derived protocols.

 MIP573A-Intro to Mechanisms of Bacterial Pathogenesis
 Fall odd years
 1

 The first module in a series of three modules designed to conceptualize and integrate the complex cellular and molecular processes that occur when bacteria infect a host and cause disease. Classic and contemporary examples will be used to provide introductory concepts for a broad range of pathogens to define diverse mechanisms of pathogenesis in molecular and genetic terms.

 MIP573B -Bacterial Pathogenesis Mechanisms & Lifestyle
 Fall odd years
 1

 The second module in a series of three modules designed to conceptualize and integrate the complex cellular and molecular processes that occur when bacteria infect the host and cause disease. This module will further explore bacterial strategies of survival in the host in the context of diverse pathogens

<u>MIP573C</u> -Bacterial Pathogenesis –Evading Host Defenses Fall odd years 1 The third module in a series of three modules designed to conceptualize and integrate the complex cellular and molecular processes that occur when bacteria infect the host and cause disease. This module will further explore bacterial strategies of survival in the host in the context of obtaining nutrition from the host and avoiding the innate immune response. MIP680A4 -Fundamentals of Infectious Disease Immunity Spring odd years 1 This course will introduce students who are researching or interested in immune responses to infectious agents to the basic knowledge in host/pathogen interactions, activation and escalation of the immune response during infections, innate and adaptive immune mechanisms, and vaccine development and production.

 MIP680A6 -Immunity to Bacteria and Parasites
 Spring odd years
 1

 This course will introduce students who are researching or interested in immune responses to bacteria and parasites, and how these pathogens evade the immune response.
 1

MIP681A5 -Introduction to Advanced Microbial Physiology Fall even years 1 This course provides a condensed series of topics to establish a foundation in the biochemistry and physiology of microbes, and the background required to pursue the more in-depth and literature-based materials of subsequent modules. Topics include the structure/function of the prokaryotic cell, bioenergetics, central and intermediary metabolism, membrane function, macromolecule biogenesis, and regulation of physiology/metabolism.

<u>MIP681A6 -Advanced Microbial Physiology Experimentation</u> Fall even years 1 This course addresses state-of-the-art experimentation techniques and emerging concepts in the study of bacterial physiology and metabolism.

MIP681A7 -Microbial Physiology –Translational DiscoverFall even years1This course will explore how the metabolism and physiology of bacteria can be exploited for drug discovery, diagnostic development and tools important for biotechnology. Subject material addresses both historical and state-of-the-art concepts in translational discovery.

Vector Biology Electives

MIP535 -Vector Collection and Identification MethodsFall odd years1The purpose of this course is to provide students with a comprehensive foundational training in
the morphological identification of one group of medically-important arthropods: mosquitoes.
Using a teaching collection as reference material, students will learn the basic morphology of
insects and how to use a dichotomous key for identification. Students will participate in field
trips during the first few weeks of the semester to collect adult and larval mosquitoes, which they
will then properly mount, label, and identify to turn for a grade at the conclusion of the 8 weeks.
Molecular techniques to identify cryptic species will also be introduced.

 MIP580A5 - Introduction to Biology of Disease Vectors
 Spring even years
 1

 This course will introduce students to the basic knowledge in vector biology, epidemiology, physiology, genetics, genomics, vector/pathogen/host interactions, and old and new strategies in vector control and control of vector-borne diseases.
 1

 MIP580A6 -Biology of Arbovirus Vectors/Genetics
 Spring even years
 1

 This course will provide advanced knowledge of vector biology associated with arbovirus transmission, epidemiology, vector/arbovirus/host interactions, and diseases. It will also integrate concepts of vector genetic manipulation techniques and genetic control strategies into this knowledge base

MIP580A7 -Biology of Parasite/Bacteria VectorsSpring even years1This course provides advanced knowledge in vector biology, epidemiology, physiology, genetics

vector/pathogen/host interactions pertaining specifically to vectors of eukaryotic and bacterial pathogens.

Molecular and Genomic Approaches Electives

MIP543 -RNA Biology	Fall odd years	3
From microbes to mammals, understanding the fundamentals	s of molecular biology i	s required for
a student's mastery of their biology. Training in the area of R	NA biology, therefore,	is
fundamental for the well-rounded student in the life sciences	. This course will provi	de graduate
students and advanced undergraduates with an in-depth, cutti	ng edge exposure to the	e subject of
RNA biology/post-transcriptional control.		
MIP545 -Microbial Metagenomics/Genomics Data Analysis	Fall	2
Microbiomes, microbes and their genetic material present in risk to disease in humans, animals and plants. Metagenomics survey methods and shotgun metagenomics, use high through provide insight towards composition and potential function o hands on experience in using bioinformatics and statistical to the resulting large datasets.	a host/environment, are , including 16S rRNA c uput sequencing techno f microbiomes. This co ols necessary to proces	e linked to community logy to urse provides s and analyze
MIP565 -Next Generation Sequencing Platform/Libraries	Fall	1
This course is designed to give comprehensive training in the	e design and execution of	of next
generation sequencing experiments. Some wet-lab experience	e and basic understand	ing of nucleic
acids is required, but students from non-life science disciplin	es are welcome	-
	F 11	2
MIP5/0 -Functional Genomics	<u>Fall</u>	<u>5</u>
genomic and proteomic tools rapidly reveal a wealth of infor	mation contained in the	se genomes
This course combines lectures and laboratory exercises to co	ver state-of-the-art func	tional
genomic tools at the advanced undergraduate and beginning	graduate levels. Topics	include web-
based bioinformatics tools; gene and homology searches; wh	ole genome comparisor	ns; principles
of DNA microarrays; principles of proteomics; applications a	and visualization of nex	t generation
sequencing; in vivo technologies for assessing gene expression	on.	
Immunology Floatiyos		
Immunology Electives		
MIP525 -Flow Cytometry for Immunology	Fall	1
This course provides students with the basic tools to underst	and and interpret flow	cytometry
principles. Additionally it covers background of flow cytom	etry, experimental desig	gn and
applications, and briefly explains cell sorting.		
	F 11	2
MIP651 -Immunobiology This course will examine what is known and/or thought show	<u>Fall</u> thosy humoral and call	3
components of the host's immune system interact in multiple	ways with "non-self"	uiai environmental
contacts to cause a variety of immune responses and diseases		
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MIP730 -Principles of Flow Cytometry and Cell Sorting	Spring	1
This course explores the background of flow cytometry, fluo	rescent molecules, expe	erimental
design, Flow Cytometry data Analysis, applications, and prin	ciples of cell sorting.	
MIP542 - Pillars of Immunology	Fall odd years	1
This course will explore the fundamental discoveries in imm	unology through review	v of pillar
publications that shape our current understanding of modern	immunology.	r

MIP680A4 -Fundamentals of Infectious Disease Immunity	Spring odd years	1
This course will introduce students who are researching or i	nterested in immune res	ponses to
infectious agents to the basic knowledge in host/pathogen in	teractions, activation an	nd escalation
of the immune response during infections, innate and adapti	ve immune mechanisms	s, and vaccine
development and production.		
MIP680A5 –Immunity to Viruses	Spring odd years	1
This course will introduce graduate students and advanced u	indergraduate students v	who are
researching or interested in immune responses to viruses, ho	w viruses evade the hos	st response
and cause disease, and how the immune response can contri	bute to pathology.	-
MIP680A6 -Immunity to Bacteria and Parasites	Spring odd years	1
I his course will introduce students who are researching or i besterie and paresites, and how these pathogens avade the ir	nterested in immune res	ponses to
bacteria and parasites, and now these pathogens evade the n	innune response.	
Pathology Electives		
MIP675 - Advanced Bioanalytic Pathology	Spring odd years	2
Students will learn basic concepts needed to interpret c	linical laboratory data	from
domestic small animals. This course is typically taken by st	udents in the DVM prog	gram.
MIP765 - Comparative Neuropathology	Spring even vears	2
The position of diagnostic neuropathology as a specialty is of	listinguished by the fact	$\frac{2}{1}$ that it
recruits from postgraduate trainees and possibly from other	specialties. In general, y	veterinarians
do not get exposed to in-depth diagnostic neuropathology du	uring core training or ge	neral surgical
training. Training in diagnostic neuropathology should be re-	egarded as higher specia	lty training.
Whatever the provenance of those who register for this cour	rse may be, the registere	d students will
needs two sets of knowledge/skills to enjoy and excel in this	s course: either basic his	stopathology
or basic clinical neuroscience. This course will equip studen	nts with terminology, ba	isic concepts
of pathologic processes in both of the central and peripheral familier with morphology of neurologic diseases at the gross	nervous system and ena	able you to be
fammar with morphology of neurologic diseases at the gros	s, instologic and utrasti	uctural levels.
MIP766 -Cytopathology	Fall and Spring	1
This one credit course will focus on improving a student's b	asic cytology skills. Cas	ses submitted
to Clinical Pathology by the Veterinary Teaching Hospital v	vill be reviewed on a we	ekly basis.
Students who have completed the Clinical Pathology section	n of Junior Practicum (V	′M786),
veterinary interns, and veterinary residents will be eligible to	o take the course.	
MIP767 Advanced General Pathology	Fall	3
Detailed study of general pathology and associated disease	directed towards first a	<u>J</u> und second
vear graduate and post-professional students. This courses	serves, in part, as prepar	ation for
ACVP board exams.	····, ···, ··· [···; ··· [···]	
MIP768 - Advanced Clinical Pathology	Spring	2
Detailed study of clinical pathology (cytology, hematology	, and biochemistry) for	post-
professional students in CVMBS residency and/or graduate	e degree granting progra	ms. This
course serves, in part, as preparation for ACVP board exan	18.	
MIP778 -Pathobiology of Laboratory Animals	Fall odd vears	3
Laboratory Animal pathology is a subspecialty of veterinar	y pathology focusing or	n diagnosis
and characterization of naturally acquiring and induced die	anged in animal models	for humon

and characterization of naturally-occurring and induced diseases in animal models for human disease. MIP778 is the primary post-graduate didactic exposure to pathobiology of laboratory

animals offered at CSU. This course will provide an overview of unique biology, spontaneous and induced diseases, and animal model use in the most common laboratory animal species. Clinical, diagnostic, and pathologic features of diseases will be emphasized.

 MIP779 - Laboratory Animal Pathology Rotation
 Spring even years
 1

 Using case material compiled from submissions to the Laboratory Animal Resources necropsy
 1
 service, the VTH Diagnostic services, the Armed Forces Institute of Pathology, and other resources, students will analyze selected slides demonstrating histologic pathology in laboratory animals and provide a diagnosis and a brief summary of the pathogenesis. **Courses offered by other CSU Departments**

 BC563 - Molecular Genetics
 Fall
 4

 Mechanisms of replication, transcription, processing, translation, and packaging of genetic

 material, emphasizing original literature and methods. <u>BC565 - Molecular Regulation of Cell Function</u> Spring 4 Molecular regulation of cell organization, membrane formation, organelle biogenesis, cell communication, shape and motility, growth, aging, and death. BIOM525 -Cell and Tissue Engineering Spring even years 3 Cell and tissue engineering concepts and techniques with emphasis on cellular response, cell adhesion kinetics, and tissue engineering design. 500 -Mammalian Physiology IFall4Cell physiology of nerve, skeletal, cardiac and smooth muscle with an emphasis on how cellular BMS500 - Mammalian Physiology I functions integrate into systems behavior. BMS501 - Mammalian Physiology II Spring Respiratory, renal, digestive, endocrine, metabolic, and reproductive function. Spring 3 ERHS510 -Cancer Biology Cancer biology, from epidemiology and classification, through the molecular basis of the phenotypes to detection and treatment. <u>ERHS535 - R Programming Research</u> Fall 3 In-depth instruction on data collection, data management, programming, and visualization, using data examples relevant to academic research. Taught using the statistical programming language R, but the principles will be translatable to other programming languages (e.g., Python, Matlab, SAS). Conducting reproducible research in R and how to construct custom functions and bundle these in a shareable R package. ERHS611 - Cancer GeneticsFall2Role of genetic background in determining individual susceptibility to cancer.

 GRAD544 -Ethical Conduct in Research
 Fall and Spring
 1

 Principles and practice of ethical conduct of research.
 GRAD550 -STEM Communication
 Fall and Spring
 1

 Review and practice of key communication principles for Science, Technology, Engineering,
 Image: Communication principles for Science, Technology, Engineering,

 and Mathematics (STEM) professionals. NSCI575/GRAD575 -Ethical Issues with Big Data Spring 1 Examines big data research through an applied interdisciplinary approach to ethical issues surrounding collection, use, reporting, and preservation of big data. Incorporates a wide range of transferable skills training, so students are well equipped to engage and lead data-centric research within or outside academia. DSCI510 -Linux as a Computational Platform Fall 1 Use of the Linux operating system for computational work using command-line tools; basic Linux commands, running and managing jobs, installing software. DSCI511 -Genomics Data Analysis in Python Fall Analyzing complex data sets using Python.

DSCI512 -RNA-Seq Data Analysis	Fall	1
Hands-on experience with tools for analysis of next ger	neration sequencing	data.
STAR511 -Design and Data Analysis for Researchers I	Fall	4
Statistical methods for experimenters/researchers emphasizing design and analysis of		
experiments using R software.		-
STAR512 -Design and Data Analysis for Researchers II	Spring	4
Statistical methods for experimenters and researchers e	mphasizing design a	and analysis of
experiments		

More curriculum details and MIP course syllabi are available by request from <u>cvmbs-</u><u>mip_microbio@mail.colostate.edu</u>