Term Information

Effective Term	Autumn 2018
Previous Value	*Summer 2012*

Course Change Information

What change is being proposed? (If more than one, what changes are being proposed?)

Change the course from a 2 credit to a 3 credit offering.

What is the rationale for the proposed change(s)?

A) Student feedback suggests the course material is dense and they would like more time to understand the content. A change to 3 credit hours gives the instructors an additional 40 minutes to explain complex content. This is reflected in the learning objectives which reflect higher levels of content understanding.

B) Immunology is a rapidly changing field, and additional time will allow the instructors to spend more time on newly emerging material

What are the programmatic implications of the proposed change(s)?

(e.g. program requirements to be added or removed, changes to be made in available resources, effect on other programs that use the course)?

None

Is approval of the requrest contingent upon the approval of other course or curricular program request? No

Is this a request to withdraw the course? No

General Information

Course Bulletin Listing/Subject Area	Microbiology
Fiscal Unit/Academic Org	Microbiology - D0350
College/Academic Group	Arts and Sciences
Level/Career	Graduate, Undergraduate
Course Number/Catalog	5122
Course Title	Immunology
Transcript Abbreviation	Immunology
Course Description	Cellular and molecular properties of the immune system.
Semester Credit Hours/Units	Fixed: 3
Previous Value	*Fixed: 2*

Offering Information

Length Of Course	14 Week, 12 Week, 8 Week, 7 Week, 6 Week
Flexibly Scheduled Course	Never
Does any section of this course have a distance education component?	No
Grading Basis	Letter Grade
Repeatable	No
Course Components	Lecture
Grade Roster Component	Lecture
Credit Available by Exam	No
Admission Condition Course	No
Off Campus	Never
Campus of Offering	Columbus

Prerequisites and Exclusions

Prerequisites/Corequisites	Prereq: 4000 or 4100.
Previous Value	*Prereq: 4000 (509) or 4100 (520).*
Exclusions	
Previous Value	Not open to students with credit for MicrBiol 522.01.
Electronically Enforced	No

Cross-Listings

Cross-Listings

Subject/CIP Code

Subject/CIP Code	26.0502
Subsidy Level	Doctoral Course
Intended Rank	Junior, Senior, Masters, Doctoral

Requirement/Elective Designation

The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

- Appreciate how several seminal immunological concepts were discovered.
- Describe the differences between innate and adaptive immune responses
- Explain how innate immunity recognizes and eliminates microbial pathogens.
- Explain the multiple functions of the complement system.
- Understand how innate immune response initiates and enhances the adaptive immune response.
- Compare the cellular and humoral branches of adaptive immunity.
- Describe the origin, maturation, and function of T-cells.
- Understand and compare antigen processing/presentation to different types of T cells.
- Describe the origin, maturation, and function of B-cells.
- Understand antibody generation and the genetic basis for antibody diversity.
- Describe different types of antibodies and their functions.
- Explain multiple types of vaccines and how they work.
- Understand the basis of allergic reactions.
- Compare and contrast the different types of hypersensitivity reactions.
- Describe the immunological concepts relevant transplantation.
- Communicate how the innate and adaptive immune systems synergize to eliminate bacteria, viruses, or parasites.
- Explain how stress influences immunity.

Previous Value

Content Topic List

- Innate immunity: complement cascade, pathogen recognition, reactive oxygen and nitrogen, antimicrobial peptides, neutrophils, macrophage, and macrophage activation
- Adaptive immunity-humoral response: B lymphocytes, antibody production and antibody diversity, and memory immunity
- Adaptive immunity-cell mediated response: thymus, T lymphocytes, major histocompatibility complex (MHC), T cell receptors, antigen presenting cells, apoptosis, and superantigens
- Signaling: signal transduction cascades, interleukins and interleukin receptors, chemokines and chemokine receptors, interferons and antivirals

Sought Concurrence No

Attachments

- 5122_current_2cr.pdf: Current (2cr) syllabus

  (Syllabus. Owner: Kwiek,Jesse John)
- 3 cr hr syllabus.pdf: Proposed (3cr) syllabus

  (Syllabus. Owner: Kwiek,Jesse John)
- Micro5122_transition.pdf: Cover Letter

  (Cover Letter. Owner: Kwiek,Jesse John)
- M5122LO_mappedtoMicroPO.pdf: CourseLO mapped to MicroPO

  (Other Supporting Documentation. Owner: Kwiek,Jesse John)

Comments

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Kwiek,Jesse John	11/07/2017 09:28 AM	Submitted for Approval
Approved	Kwiek,Jesse John	11/07/2017 11:18 AM	Unit Approval
Approved	Haddad,Deborah Moore	11/07/2017 11:30 AM	College Approval
Pending Approval	Nolen,Dawn Vankeerbergen,Bernadette Chantal Oldroyd,Shelby Quinn Hanlin,Deborah Kay Jenkins,Mary Ellen Bigler	11/07/2017 11:30 AM	ASCCAO Approval

THE OHIO STATE UNIVERSITY

Department of Microbiology

105 Biological Sciences Building
484 W. 12th Ave.
Columbus, OH 43210

614-292-2301 Phone

microbiology.osu.edu

7 November 2017

RE: Microbiology 5122

Dear Colleagues,

The Department of Microbiology requests to change Microbiology 5122: Immunology from a 2-credit course to a 3-credit course. Functionally, the course will transition from two 60 minute meetings per week to two 80 minute meetings per week. This change is predicated on A) student feedback, both during office hours and from SEIs, which consistently state that the course material is dense, and B) the dynamic nature of the field (immunology), which requires additional information to be added each year. Specific examples of topics that will be expanded is included at the end of this letter. This transition to a 3- credit course also helps Microbiology Majors to progress through our curriculum more rapidly; specifically, students are required to take 9 hours of electives, which is usually satisfied with by 3-electives. Currently, students who choose to take Micro 5122 often have 8 hours of electives and thus have to take a fourth course to make up the extra elective hour.

To facilitate your evaluation of this proposal, I have attached both the current (2 cr.) and proposed (3 cr.) Microbiology 5122 syllabi; major changes to the proposed syllabus are highlighted yellow. I also include a map of the course learning objectives to the Microbiology BS Program Learning Goals.

I thank you for your consideration.
Regards,

Jesse J. Kwiek
Associate Professor
Vice Chair for Teaching & Undergraduate Affairs
Department of Microbiology
Ohio State University
476 Biological Sciences Building
484 West 12th Avenue
Columbus, OH 43210
kwiek.2@osu.edu
Phone: 614-292-3256
Fax: 614-292-8120

From the current instructor:

The major challenges in learning immunology:

1. Students, while trying to master the new immunology vocabulary and details, lose the big picture.
2. Students struggle to make connections between different processes taking place in the immune system. Students tend to compartmentalize the processes and fail to see the interconnectedness of different branches of the system, such as innate branch influencing the adaptive resonse (eg, the PRRof DC engaged will affect which polarizing cytokine is produced by DC thereby affecting which subset of T helper will be produced), TH1 subset of cell mediated immunity will affect activity of macrophages from innate immunity, or TFH and TH2 will affect humoral response WRT which type of antibodies will be produced.
3. Students fail to visualize the functioning of the immune system. Therefore, dynamics of immune system in Time and Space is critical: talk about flow of lymph, circulation of lymphocytes in blood and lymph and organs of maturation, how they migrate from blood to lymph nodes etc. How effector cells are delivered to the site of infection from the site of generation, use of chemokine receptors, adhesion molecules etc.

The following topics will be expanded when the class transitions to 3 credits:

- Cells and organs of the Immune system: Lymphatic system
  - Include Lymphatic system and circulation of lymphocytes between lymph and blood.
  - Develop timeline: for example, mature T lymphocytes are released from thymus into the blood-T lymphocytes circulate in blood for approximately 30 minutes and then migrate into a lymph node-T cells make this journey 2-3 times in 24 hrs.
  - New research findings in the field: Second thymus: how new T cell repertoire is not needed in absence of thymus since most T cells are self-renewing and long lived in the periphery as opposed to B cells; thymus involution and replacing thymocytes with fat.

- Innate Immunity
  - Expand on Innate Immune Receptors PRR (TLR, NLR, RLR)
  - Expand Concept of Signal Transduction and signaling cascades: elaborate on how the signals through PRR are transduced to activation of transcription factors and which type of genes are affected; resulting outcomes
  - Application based discussion: Multiple myeloma is a cancer of antibody producing plasma cells..what goes wrong in signal transduction?
  - Establish connections: Cytokines and their role wrt topics being discussed
  - Detailed discussion on phagocytic mechanisms of destruction of a captured microbe: compare and contrast phagocytic mechanisms of neutrophil and macrophages, expand on endocytic pathway
  - Include latest information in the field on different types of Dendritic cells and their location and functions (compare immature vs. mature DCs, Follicular DC and tissue DC)
  - Application of Immunology: Complement discussion in the context of disorders

- Lymphocyte Receptors
  - Use electrophoresis experiment based discussion for elucidation of gamma-globulin fraction of serum
  - Include details on immunoglobulin fold: structure and receptors containing these folds
  - More explanation and how it is used in research: Antibody isotype, idiotype, allotypes,
  - Antibody structure as it relates to function: hinge region, number of Ig folds in Heavy chain of diff isotypes, glycosylation of Abs and its role (believed to increase its solubility…..rate at which Abs are cleared from serum. Current knowledge is that CHO attached to CH2 keeps two chains away and provides space for complement to bind)
  - Use experimental approach: discuss pepsin, papain treatments to understand parts of antibody structure 150 kd, Fc 50 Kd, Fab 45 Kd each (Fab= antigen binding fragment, Fc= crystallized fragment)
  - Expand with details: Interaction between Ag and Ab, bonds involved, why it is important to generate high affinity antibody, Affinity vs avidity
  - Establish connections: Hapten, antibodies to hapten carrier conjugate, its use in vaccines etc

- Generation of lymphocyte diversity
  - Recombination of VDJ with RSS
  - Nobel prize winning experiments: design and how conclusions were reached
  - Establish connection between this topic and immunoglobulin fold structure in Ig. How junctional diversity affects CDR3 and how VDJ affects other CDRs; how this affects binding to antigen
  - More emphasis on genetics involved: what is dictated at DNA level, what is affected by RNA splicing location etc.
  - Enzymes involved: RAG regulation
  - Expand of immunoglobulin diversity: genetic processes involved
  - Establish connections: how this process is connected to autoimmune disorder

- MHC genetics
  - Experimental approach-based discussions: expts in mice to show self MHC restriction
  - Visuals: to discuss allotypes, haplotypes
  - Application: how transplant rejection/acceptance is integrated with this topic

- Lymphocyte Development and Maturation
  - Application: D'George's syndrome because of lack of thymus and other diseases,
  - Resulting outcomes: Self Tolerance vs Autoimmunity
  - Current development in the field: include discussions on current hypotheses. Discuss the views of different schools of thoughts. Eg. three models to explain how DP T cells become SP, How CD4 vs CD8 is selected
  - Current models to explain paradox of positive and negative signaling: special proteasome of thymic cortex vs affinity of binding….two models
  - More discussion on different stages of DN and what changes occur to T cells in these stages
  - Importance of this process as it relates to autoimmune diseases, self MHC restriction (transplant immunity), central tolerance by clonal deletion vs, peripheral tolerance (compare and contrast)

- T and B cell mediated Immunity: Humoral and Cell-mediated
  - Must include: Immunology in time and Space. in order to establish connections among different immune processes and establish a timeline of an immune response
  - Dynamics of integrated adaptive response: Timeline and movement of lymphocytes and effector responses
  - Circulation of lymphocytes: how they migrate in lymph nodes …adhesins, selectins, HEV, chemokines etc. How they migrate in infected tissue
  - More emphasis on chemokine receptor expression/suppression (CCR7, CXC5) and how it affects the movement of naïve, effector and memory lymphocytes
  - Movement of B lymphocytes (naïve, activated, proliferating and differentiating) within the different sections of lymph node, during humoral response. Eg. activated B cells become IgM secreting plasma cells in medulla. A few B cells move to follicles to form germinal centers, where affinity maturation and class switching takes place. How is this movement regulated through chemokine receptors?
  - T dependent vs independent response: add more depth, how this is important to consider while designing vaccines
  - Adjuvants
  - Different subsets of B cells: B1, B2 etc and their functions
  - Include the most current information: long vs short-lived plasma cells, vs Memory B cells
  - Memory B cells: what is the most current understanding of scientists
  - Most current info: Ever evolving Subsets of T cells, their origin, formation and functions
  - Memory T cells: TCM vs TEM,
  - T reg cells: induced vs, Natural. Transcription factors, formation, functions, connection to autoimmunity

- More discussions based on experimental approach

- More discussions based on application/translation of concepts: eg. Immunotherapy (CAR T cells)

- More encouragement for active learning by enforcing group work/discussion in the classroom.

Microbiology 5122: Immunobiology

The Ohio State University
Autumn 2017

Lectures:
Monday and Wednesday, 4:10pm to 5:05pm.
Jennings Hall Rm 40

Recommended books
"Immunology" 7th Edition
by Male, Brostoff, Roth and Roitt
Publisher: Mosby/Elsevier
ISBN13: 976-0-323-03399-2
OR
Kuby "Immunology" 7th Edition
By Owen, Punt, Stranford
Publisher: Freeman
ISBN13: 978-14292-1919-8

Extra (free) Resource:
Janeway *et al.,* Immunobiology, 5th Edition (circa 2001)
http://www.ncbi.nlm.nih.gov/books/NBK10757/
Many topics outdated, but core concepts are usually correct.

Course instructors: Dr. Abhay Satoskar
Email: Abhay.Satoskar@osumc.edu
Phone: 614-366-3417
Office: 129 Hamilton Hall
Office Hours: By appointment

Dr. Madhura Pradhan
Email: pradhan.2@osu.edu
Phone: 614-292-1196
Office: 372 Biological Sciences Building
Office Hours: Tue, Thurs 2:00-4:00pm. I may also be available after the lecture and by appointment to answer your questions.

Lecture Schedule
Autumn 2017
MW 4:10-5:05 pm, Jennings Hall Rm 040

NOTE: THE FOLLOWING SCHEDULE IS SUBJECT TO CHANGE.

Date	Topic (instructor)	Corresponding Book Chapter (reading not required)	
		Roitt	Kuby
08-23 (W)	Introduction to immune system (ARS)	1	1
08-28 (M)	Cells and organs of the immune system (ARS)	2	2
08-30 (W)	Innate immunity-1 (ARS)	6	5
09-04 (M)	**Labor Day (No Class)**		
09-06 (W)	Innate immunity-2 (ARS)	6	5
09-11 (M)	Complement (ARS)	4	6
09-13 (W)	Introduction to Adaptive Immunity (MP)	3,8	13
09-18 (M)	**Exam 1**		
09-20 (W)	Receptors of Adaptive immunity and Signaling (MP)	7	3,4
09-25 (M)	Generation of lymphocyte receptor diversity (MP)	5	7
09-27 (W)	Generation of Immunoglobulin diversity (MP)	5	7
10-02 (M)	MHC structure and genetics (MP)	3,8	8
10-04 (W)	Transplantation and rejection reaction (AS)	21	16
10-9 (M)	**Exam 2**		
10-11 (W)	Lymphocyte development (MP)	3,8	9,10
10-16(M)	Lymphocyte maturation (MP)	3,8	10,12
10-18 (W)	Immunological Tolerance (PB)	19	16
10-23 (M)	Autoimmunity (SO)	20	16
10-25 (W)	Activation and Effector responses of B cells (MP)	3,8	12,13

10-30 (M)	Activation and Effector responses of T cells (MP)	3,8	8,11
11-01 (W)	Vaccination (SO)	24, 25	15
11-06 (M)	**Exam 3**		
11-08 (W)	Regulation of Immune responses (ARS)	11	14
11-13 (M)	Immunity to bacteria and fungi (ARS)	14	17
11-15 (W)	Immunity to protozoa and viruses (ARS)	15,13	17
11-20 (M)	Mucosal Immunology (PB)	various	various
11-22 (W)	**Thanksgiving Break- No Class**		
11-27 (M)	Hypersensitivity reactions (ARS)	24, 25	15
11-29 (W)	Immunity to cancers (ARS)	22	19
12-04 (M)	Primary Immunodeficiency (SO)	16	18
12-06 (W)	Stress and the Immune Response (MB)	various	various

12-14 (Thursday) FINAL EXAM (4PM-5:45PM) in Jennings Rm 40

Microbiology 5122 Learning Outcomes

Successful students will be able to…

1. Appreciate how several seminal immunological concepts were discovered.
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15. Describe the immunological concepts relevant transplantation.
16. Communicate how the innate and adaptive immune systems synergize to eliminate bacteria, viruses, or parasites.
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Guidelines for Final Grade

Points Available:

Lecture Exam I	70 points
Lecture Exam II	70 points
Lecture Exam III	80 points
Final Exam	80 points
TOTAL POINTS	**300 points**

*Please see Attendance Policy in this syllabus

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Lecture attendance
Attendance in lecture is highly recommended. You are responsible for *all the material covered in lecture*.

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Microbiology 5122: Immunobiology
The Ohio State University
Autumn 2017
3 credit hours

Lectures:
80 minutes lecture, twice a week
Tuesday and Thursday, 3:00pm to 4:20pm.
Jennings Hall Rm 40

Recommended books
"Immunology" 7th Edition
by Male, Brostoff, Roth and Roitt
Publisher: Mosby/Elsevier
ISBN13: 976-0-323-03399-2
OR
Kuby "Immunology" 7th Edition
By Owen, Punt, Stranford
Publisher: Freeman
ISBN13: 978-14292-1919-8

Extra (free) Resource:
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12-06 (W)	Stress and the Immune Response (MB)	various	various

12-14 (Thursday) FINAL EXAM (4PM-5:45PM) in Jennings Rm 40

Microbiology 5122 Learning Outcomes

Successful students will be able to…

1. Appreciate how several seminal immunological concepts were discovered.
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Required Prerequisites for the Major

Learning Goals

Semester Course Number		Course Title	Semester hrs	1	2	3	4	5
BIOL 1113		Biological Sciences: Energy Transfer and Development	4	B			B	
BIOL 1114		Biological Sciences: Form, Function, Diversity, and Ecology	4	B			B	
MATH Requirement 1	MATH 1151	Calculus 1 (5 Hrs)	5	B				
	or							
	MATH 1156	Calculus for Biol. Sciences (5 Hrs)						
MATH Requirement 2	MATH 1152	Calculus 2 (5 Hrs)	3 - 5	B				
	or							
	MATH 1157	Math. Modeling for Biol. Sciences (5 Hrs)						
	or							
	STATS 1450	Intro. to the Practice of Statistics (3 Hrs)						
	or							
	STATS 2480	Statistics for the Life Sciences (3 Hrs)						
CHEM 1210		General Chemistry 1	5	B				
CHEM 1220		General Chemistry 2	5	B				
CHEM 2510		Organic Chemistry 1	4	B	B			
CHEM 2520		Organic Chemistry 2	4	B	B			
CHEM 2540		Organic Chemistry Lab 1	2	B	B		B	
PHYS 1200		Mechanics, Thermal Physics, Waves	5	B			B	
PHYS 1201		E&M, Optics, Modern Physics	5	B			B	
		Total Hrs.	**46 - 48**					

Goal: B: Beginning; I, Intermediate; A, Advanced

Required Core for the Major

Learning Goals

Semester Course Number		Course Title	Semester hrs	1	2	3	4	5
MICRBIOL 4100		General Microbiology	5	I	I	I	I	I
MICRBIOL 4110		Pathogenesis and Immunobiology	3	A	A	A		
MICRBIOL 4120		Microbial Physiology and Diversity	3	A	A	A		
MICRBIOL 4130		Microbial Genetics	3	A	A	I	I	
MICRBIOL 4140		Molecular Microbiology Laboratory	3	I	I	I	A	A
BIOCHEM 4511		Biochemistry	4	I	A			I
		Total Hrs.	**21**					

Goal: B: Beginning; I, Intermediate; A, Advanced

Electives: Total Required 9 hrs
Group 1: 3-9 hrs

Learning Goals

Semester Course Number		Course Title	Semester hrs	1	2	3	4	5
MICRBIOL 4150		Immunobiology Laboratory	3	I	I	A	A	A
MICRBIOL 4193		Individual Studies	1-3					
MICRBIOL 4194		Group Studies	1-3					
MICRBIOL 4591S		DNA Finger Printing Workshops in Columbus PS	1				A	A
MICRBIOL 4797		Study at a Foreign Institution	1-19					
MICRBIOL 4798		Study Tour Domestic	1-19					
MICRBIOL 4998		Undergrad Research in Microbiology	1-5				A	A
MICRBIOL 4998H		Honors Research	1-5				A	A
MICRBIOL 4999		Undergrad Research in Microbiology-Thesis	1-5				A	A
MICRBIOL 4999H		Honors Research-Thesis	1-5				A	A
MICRBIOL 5122		Immunology	**3**			A		
MICRBIOL 5129		Cellular and Molecular Biology of Pathogenic Eukaryotes	3		A	A		
MICRBIOL 5147		Eukaryotic Pathogens	3		A	A	A	
MICRBIOL 5149		Introductory Virology	3		A	A		
MICRBIOL 5150		Microbial Ecology	3	A	A	A		
MICRBIOL 5155		Environmental Microbiology	3	A	A	A		
MICRBIOL 5161H		Bioinformatics and Molecular Microbiology	3	A	A	A		A
MICRBIOL 5169H		Microbial Evolution	3			A		
MICRBIOL 5170		Microbes and Evolution	3			A		
MICRBIOL 5536		Food Microbiology Lecture	3		A	I		A

MICRBIOL 5546		Food Microbiology Laboratory	3		A	I	A	A
MICRBIOL 6020*		Microbial Physiology and Biochemistry	3	A	A	A	A	
MICRBIOL 6080*		Advanced Microbial Genetics	3		A		A	
MICRBIOL 7010*		Cellular and Molecular Immunology	3			A	A	
MICRBIOL 7020*		Physiology Meets Pathogenesis	2	A	A	A	A	
MICRBIOL 7023*		Molecular Immunology: Lecture	3			A	A	
MICRBIOL 7050*		Fermentation Biotechnology	3	A			A	A
MICRBIOL 7060*		Advanced Topics in Molecular Microbiology	2		A		A	
MICRBIOL 7536*		Advanced Food Microbiology	3		A	I	A	A
MICRBIOL 7724*		Molecular Pathogenesis	3		A	A	A	
MICRBIOL 7889*		Host-Pathogen Interactions: Research Seminar	1			A	A	
MICRBIOL 7899*		Microbiology Colloquium	1					
		Total Hrs.	**3-9**					

*Indicated graduate-level course. Requires special permission to enroll.

Goal: B: Beginning; I, Intermediate; A, Advanced

Electives: Total Required 9 hrs
Group 2: 0-6 hrs

Learning Goals

Semester Course Number		Course Title	Semester Hrs.	1	2	3	4	5
MICRBIOL 3300		The Biology of Pollution	2	B				I
BIOCHEM 5621		Intro Biological Chemistry Laboratory	4	I			I	
MOLGEN 4500		General Genetics	3		I			
MOLGEN 4606		Molecular Genetics I	4		I			
MVIMG 5000		Evolution of Emerging Viruses	2			A		
PLPATH 5010		Phytobacteriology	2		I	A		
PLPATH 5020		Introduction to Plant Virology	2		I	A		
PLPATH 5040		Science of Fungi: Mycology Lecture	3	I	I	A		
ANSCI 6090*		Anaerobic Microbiology	3		A			
ENR 5263		Biology of Soil Ecosystems	3	I	A			
ENR 5266		Field Soil Investigations	3	I			A	
		Total Hrs.	**0-6**					
		Total Hrs. for the Major	**30**					

*Indicated graduate-level course. Requires special permission to enroll.

Goal: B: Beginning; I, Intermediate; A, Advanced

Program Learning Goals (B, beginning; I, Intermediate; A, Advanced)

1. Students acquire the ability to interrelate and apply the fundamental concepts of chemistry, physics and mathematics to the functions of living cells.
2. Students understand the chemical properties of biological molecules and how these molecules function in the molecular mechanisms underlying physiological processes in microbial cells.
3. Students understand evolutionary processes, the diversity of microorganisms, and how microorganisms impact their environment, including their roles in human health and disease.
4. Students acquire the ability to design experiments to test hypotheses, perform analyses, interpret and analyze data, and present scientific information in written and oral formats.
5. Students acquire the ability to appraise scientific data presented in the popular press for accuracy and scientific merit and understand issues and ethical conflicts associated with applications of biotechnology.

Micrbiol 5122 learning Goals (Mapped to Program Learning Goals)

Successful students will be able to…
Appreciate how several seminal immunological concepts were discovered. (**PLG3I)**
Describe the differences between innate and adaptive immune responses. (**PLG3I)**
Explain how innate immunity recognizes and eliminates microbial pathogens. (**PLG3I)**
Explain the multiple functions of the complement system. (**PLG3I)**
Understand how innate immune response initiates and enhances the adaptive immune response. (**PLG3A)**
Compare the cellular and humoral branches of adaptive immunity. (**PLG3A)**
Describe the origin, maturation, and function of T-cells. (**PLG3A)**
Understand and compare antigen processing/presentation to different types of T cells. (**PLG3A)**
Describe the origin, maturation, and function of B-cells. (**PLG3A)**
Understand antibody generation and the genetic basis for antibody diversity. (**PLG3A)**
Describe different types of antibodies and their functions. (**PLG3A)**
Explain multiple types of vaccines and how they work. (**PLG3A)**
Understand the basis of allergic reactions. (**PLG3A)**
Compare and contrast the different types of hypersensitivity reactions. (**PLG3A)**
Describe the immunological concepts relevant transplantation. (**PLG3A)**
Communicate how the innate and adaptive immune systems synergize to eliminate bacteria, viruses, or parasites. (**PLG3A)**
Explain how stress influences immunity. (**PLG3A)**