Fall 9-1-2021

BIOB 410.01: Immunology

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Immunology (BIOB 410) Syllabus: Fall 2021

Class Meeting Time and Location: 9:00 – 9:50 am; MWF FOR 305

Prof: Dr. Scott Wetzel (CHCB 216, ph: 243-2168, scott.wetzel@umontana.edu)

Recommended Textbook: The Immune System, 5th edition

Date	Topic	Suggested reading
	August	
30	Intro to the Immune Response – Innate & Adaptive	Ch 1, 2, 3, 213-9, 262-3, 340-69, 281-96
	September	
1,3	Cells & Organs of the Immune System	Ch 1, 2, 3, 213-9, 262-3, 340-69, 281-96
6	**Holiday – NO CLASS**	
8,10	Cells & Organs of the Immune System	
13	Inflammation	Ch 3, 262, 287-8, 421-4
15	Inflammation/Phagocytosis	67-70, 72-79
17	Phagocytosis and the Respiratory Burst	72-79
20	**Exam #1**	
22,24	Complement Cascade	37-46, 80-84, 268-71, 390-1
27	Cytokines and Chemokines	70,
29	Antigens & Antibodies – Structure, Subclasses, Effector Functions	97-107, 118-23, 296-301
	October	
1	Antigens & Antibodies – Structure, Subclasses, Effector Functions	97-107, 118-23, 296-301
4	**Exam #2**	
6,8	Immunoglobulins - Genetic Rearrangements	108-16, 124-5, 253-8
11	B Cell Biology: Germinal Centers and Humoral Responses	114-20, 296-
13	T Cell Receptor (TCR) Generation and Structure/Ag Recognition	Ch 5, 195-202,
15,18	Major Histocompatibility Complex (MHC)	136-40, 150-8, 479-81
20	**Exam #3 NOTE: THIS EXAM IS ON WEDNESDAY**	
22,25	Antigen Processing and Presentation	140-50
27,29	Lymphocyte Development - B and T Cells	163-85, Ch 7
	November	
1,3	$CD4^+$ T Cell Differentiation: T_H1, T_H2, T_H17, T_{FH}, T_{Reg}	220-8, 232-235, 237-40
5	Immunological Synapse, T Cell Effector Functions	229-32, 235-6, 312-4
8	**Exam #4**	
10	Immunity to Viral Infections	64-7, 376-82
12	Immunity to Bacterial Infections	382-4
15,17	Vaccine and Immunotherapy	317-334
19	Immunological Tolerance and Autoimmunity	Ch 16
22	**Exam #5**	
24, 26	**Holiday NO CLASSS**	
29	Allergy and Hypersensitivity Diseases (I, II, III, IV)	Ch 14
	December	
1	Allergy and Hypersensitivity Diseases (I, II, III, IV)	Ch 14
3	Immunodeficienies	384-406
3	Tumor Immunology	Ch 17
8,10	Transplantation Immunology	Ch 15
14	**Final Exam (8-10am).**	

CoVID-19 Plans

PLEASE GET VACCINATED!!!!!

If you feel sick and/or if exhibiting COVID-19 symptoms STAY HOME and contact the Curry Health Center at (406) 243-4330 or your doctor.

If you are diagnosed with COVID-19, follow instructions for quarantine and contact your advisor so they can help you stay on track academically.

In order to help ensure the health and safety of the University of Montana (UM) community and the public**, all University employees, students, contractors, vendors and visitors ARE REQUIRED TO WEAR FACE MASKS while inside, regardless of vaccine status.**

In Class Seating Chart / Attendance: Where possible we will use social distancing to minimize potential transmission, so students will be asked to leave at least 1 empty seat between them in class. I will post a map of the classroom of the seating on Moodle and you will be asked to identify the seat you will occupy for the entire semester by the Friday September 3. This way we can identify potential close contacts in case a student in class is diagnosed CoVID-19 positive and will avoid a quarantine of all members of the class.

The university is committed to returning to in-class, person-to-person meetings. Accordingly, although this may change as conditions warrant, **initially I WILL NOT be live streaming the course via ZOOM this semester**. However, the lectures will be recorded and stored on ZOOM. If you are unable to attend class please let me know and I will send you the information to access the recorded lecture(s) that you missed.

Please contact me (if you haven't already) to make arrangements if you will be unable to attend in person for an extended period of time so alternate arrangements can be made.

The UM Corona Virus update webpage is an important source of information for you and I recommend that you take a look. http://www.umt.edu/coronavirus/

Course Information:

We will cover aspects of innate immunity, acquired immunity, and will conclude the course talking about the role of the immune system in human disease processes. This course is a 1/3 W course and includes a significant writing component.

Study Tips*:* Immunology is an exciting and dynamic field that is, unfortunately, filled with jargon. It is HIGHLY RECOMMENDED that students make a glossary and include immunologically related terms with a definition in your own words. *Immunology has a unique language* and to understand this subject and succeed in this course, you will have

to master this new language. Every exam will have a vocabulary section where you will define "immunologese" in your own words.

To succeed in this course, it is suggested that students take the time to read relevant material BEFORE each class session and that after each class, integrate lecture materials and material from the book by re-writing notes in your own words. These notes can serve as the study materials for the exams. *Lecture PowerPoints will be posted on Moodle before each lecture.*

GRADING will be based on the following:
500 points – 5 Exams (100 points each)
150 points – Final Exam. Semi-cumulative 90 pts from material after 4th exam, 60 points comprehensive
100 points – Research Article Review
Total Points Possible = 750 points

Final grades will be based upon a straight 10% grading scale based upon the total number of points (90% for A, 80% for B, 70% for C, 60% for D, below 60% = F). Late policy is outlined below.

Late Work:

Late work is strongly discouraged. **For assignments with a specified due date, a late penalty of 10% per day of tardiness will be subtracted from the grade**.

Exams:

Excuses for rescheduling or missing and exam must be approved BEFORE the exam. If not pre-approved, no makeup exam will be given and an F will be recorded for the exam. Anyone missing the final exam will receive a grade of F for the entire course. *Important Note: Cheating on an exam will result in a grade of ZERO for that exam and referral for disciplinary action by the University of Montana*.

Online Supplemental Materials: There is an online Moodle supplement with all PowerPoints in PDF format at 1/page, 2/page and 4/page.

Research Article Review:

DUE DATE - **Fri., November 19; 5:00 pm**

Directions: Choose a 2014-2021 research article in IMMUNOLOGY that interests you, read it thoroughly, and write a synopsis. The synopsis is basically a condensed summary of the article in your own words. Do not write a synopsis on a review article or a general topic – it must contain new, not previously published data. THE FOCUS OF THE PAPER MUST BE IMMUNOLOGY. Not microbiology, molecular biology, etc. If the article isn't focused on immunology or it only briefly mentions immunology, but is focused on another scientific discipline, it is NOT an appropriate paper.

Please limit yourself to a top-tier Immunology related journal for your article: The Journal of Immunology, Nature Immunology, Immunity, European Journal of Immunology, Journal of Experimental Medicine, Frontiers in Immunology, or *Infection and Immunity,* or the general journals *Cell*, *Science* or *Nature,* available in the Mansfield Library*. NO OTHERS WILL BE ACCEPTED WITHOUT PRIOR APPROVAL. You may scan articles in the journals or search online at the PubMed database (**http://www.ncbi.nlm.nih.gov./entrez/query.fcgi**) for particular key words or subjects that interest you. Remember, if there is no immunology in the article, it is not suitable for this assignment.*

You must include a copy of the original research article when you submit your colloquy or your paper will NOT be graded. The paper is to be turned in by email ONLY. Your emailed paper MUST be submitted as PDF document NOT a Microsoft Word or a Pages document.

The title of your document must be "Last Name – BIOB 410 Paper".

You are highly encouraged to begin searching for your paper early. If you have any questions or would like to discuss your chosen paper we can go through it together.

Purpose: To introduce prospective scientists to literature-searching and contemporary research in immunology and to read and write the "language of science". Every exam will also include a significant writing component (>30% of total points), but this will be your opportunity to write a formal paper and demonstrate your scientific writing literacy. This also fulfills the writing requirement, as this is a 1/3 W course.

Format:

- 4 full pages double-spaced and typed. Page 5 and above will not be read
- Begin with a brief introduction of the topic, goals of the research, etc.
- Follow this section with a discussion of the experimental approach, and justification (rationale), but don't go into excessive detail on methodology. Why did they use immunofluorescence? Why did they do a mixed lymphocyte reaction? etc. What did they find and how did they follow up with the next experiment? If there are any flaws or missing data (e.g. controls), note them.
- Finally, discuss the authors' conclusions. Do the data presented support their conclusions? If you do not agree with the authors, explain. How could the paper be improved?
- Discuss the significance of the paper to immunology. DO NOT start the sentence with "The significance to immunology is…"

The idea is to provide the reader with the background, rationale and data, and the conclusions (take home message) so that they can understand the "story" of the paper without reading the original article. Approach it like you were telling someone the key information in the paper. I will post several examples of excellent summaries on Moodle.

Feedback: Students must turn in your writing assignment at least 1 week before the deadline (November 12) to get feedback so that you can revise the document before you turn it in for grading***.***

Grading: 100 pts will be given based upon writing clarity, grammar, conforming to format, the overall flow of logic and how well the article is summarized. A 10% reduction in points per day will be penalized for late colloquies. Plagiarism will result in an automatic ZERO for the assignment and referral for academic discipline according the University of Montana Student Conduct code.

I recommend a book available online called "Writing Science in Plain English" by Anne Greene. It is a short, $17 book and is an easy read that will be very helpful in improving your writing for this and your other science classes. I also strongly encourage you to visit the writing center if you need help with this writing assignment.

Office Hours: Because I am required by the university to set formal office hours, I will be available after class 10 – 11 am to meet with you in my office (Clapp 216). You will be REQUIRED to wear a mask in my office. If you'd prefer, we can set up a zoom chat. Let me know and I'll set up a meeting time.

That said, I do not believe in restricting your access to formal office hours and I am available to meet and discuss the class with students pretty much anytime.

If you'd like to set up a meeting at a different time, please contact me via email or after class and I can set up a meeting or zoom conversation that fits your schedule

Students with Disabilities (ODE Accommodations): The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Office of Disability Equity (formerly DSS) (https://www.umt.edu/disability/). If you anticipate or experience barriers based on disability, please contact the ODE at: (406) 243-2243, ode@umontana.edu, or visit www.umt.edu/disability for more information. Retroactive accommodation requests will not be honored, so please, do not delay. I will work with you and ODE to implement an effective accommodation, and you are welcome to contact me privately if you wish.

Any questions please contact me

Financial Aid Ramifications of Attendance: ***This is an issue ONLY if you withdraw from the course before the end of the semester***. To be eligible to receive federal aid students must participate verifiably at least once in the course, and to be eligible to receive the full amount (whether loans or grants), must have participated through 60% of the course, or roughly the 45th day of classes. We will have an exam on

October 4, which will allow me to confirm your participation through the 43th day of classes. Another way is to log into Moodle on or after October 7.

Please note: You are bound by the University of Montana student conduct code. All work will be performed solely by the student. Plagiarism and cheating of any kind will result in referral for disciplinary action and you will receive a zero on the assignment. This will significantly impact your final course grade.

ALL electronic devices (phone, iPad, etc.) are to be POWERED OFF and stored in bags during examination periods. If your phone or other electronic device disrupts the exam in any way, your will lose 25 points from your total grade on that exam – TURN IT OFF!

Learning Outcomes:

Cells & Organs

- The students should understand the major underlying principles of the study of immunology.
- They must be able to explain barrier functions and the general concepts of innate and adaptive immunity; comparing and contrasting all three types of immune function.
- They must be able to identify functions and distinguishing characteristics of the leukocytes that are discussed in the class: neutrophils, basophils/mast cells, eosinophils, dendritic cells, macrophages/monocytes, innate lymphoid cells, and the lymphocytes.
- The students should be able to distinguish the differences between primary, secondary, and tertiary lymphoid organs and describe the major functions that take place in each.

Innate Immunity

- At the end of this series of lectures, the students should understand basic concepts of the function of the innate immune system, its role in controlling pathogens, and the effector mechanisms associated with innate activation. (
- The students should be able to explain the mechanism of antigen recognition in the innate immune system – specifically the receptors for molecular patterns associated with pathogens (PAMPs) and damage (DAMPs), the Toll Like Receptors, the Inflammasome, and acute phase proteins. (

Phagocytosis

- At the end of this lecture, the students should be able to explain the mechanism of phagocytosis, the cells that carry out this phenomenon, the role it plays in immune function, the role of opsonins, and how the phagocytic cells destroy phagocytosed pathogens and toxins (respiratory burst and oxygen-independent mechanisms). (

Inflammation

- The students should be able to distinguish between acute and chronic inflammation. This would include the functions, characteristics, mechanism, cellular extravasation (rolling, LFA-1 inside/out signaling, extravasation, etc.), timing, and the potential damage associated with inflammatory processes. (
- They should have an understanding of the dangers of inflammation in human disease and what the underlying causes of these inflammatory diseases are. (
- They should be able to explain Neutrophil Extracellular Traps (NETs): composition, immune function, diseases associated with NETs
- They should be able to explain the constituents and function of the Inflammasome and briefly identify and explain diseases associated with the inflammasome. (

Cytokines:

- At the end of this lecture, the students should be able to identify the general functions of cytokines and chemokines. (
- They should have an appreciation for the role cytokines and chemokines play in hematopoiesis and immune function. This will form the basis for the discussion of cytokines throughout the semester. (
- They should also be able to explain the basic classes of cytokines, with particular attention paid to the interferons, common gamma chain, hematopoietic and gp130 cytokines. (

Complement:

- The students should be able to explain the functions of the complement cascade including opsonization, inflammation/anaphylaxis, clearance of immune complexes, and target cell lysis (the membrane attack complex). (
- They should be able to differentiate between the classical, alternative and MBL pathways including initiating events, the C3 and C5 convertases, and be able to trace the steps of the various cascades. (
- They also need to be able to explain several of the regulatory mechanisms presented in class that control complement activation.
- **I**dentify and briefly explain the mechanisms associated with diseases associated with deficiencies of complement components and regulatory proteins. (

Antigens and Immunoglobulins:

- At the end of this series of lectures, the students should be able to:

  - distinguish between antigens recognized by B and T lymphocytes
  - explain the differences between conformational versus linear epitopes
  - identify characteristics of antigens that increase immunogenicity

- They should know the structural components of immunoglobulin molecules including:

  - the heavy and light chains,
  - F_C
  - F_{ab}
  - $F(ab')2$
  - C_H domains
  - hinge region

- Identify the basic effector functions of immunoglobulin molecules and explain and how those functions protect from infection.

- They should be able to provide the characteristics of each of the 5 classes of immunoglobulins including:

  the relative abundance
  valency
  effector functions
  distinguishing characteristics (size, structural composition, effector functions, additional components, etc.).

Ig/TCR Genetic Rearrangements

- At the end of this series of lectures, the students should be able to explain the process of V(D)J recombination in the formation of Ig and TCR molecules:

  - recombination signal sequences (heptamer and nonamer) are and their role in recombination
  - the 12-23 rule
  - the molecular process of V-D and D-J joining
  - the formation of hairpin loops
  - resolution of hairpin loops to form P nucleotides
  - generation of V_H N nucleotides

- They should be able to explain the molecular mechanisms of generating Ig/TCR diversity: somatic recombination, imprecise junctions, and complementarity determining regions (CDRs) of the Ig V regions

- They should be able to explain the process of isotype switching including the molecular mechanisms, the role of T cells and specific T cell-derived cytokines, the role of CD40-CD40L interactions and the generation of sterile transcripts.

- They should have a basic understanding of somatic hypermutation/affinity maturation including the role it plays in an immune response, the basic mechanisms including the role of T_{FH} T cells and Follicular dendritic cells (FDC)

- They also need to understand the germinal center reaction including the processes that occur in the light and dark regions of the germinal center.

MHC:

- At the end of this series of lectures, they need to be able to explain the structure and immunologic functions of Major histocompatibility complex Class I and Class II molecules. (

- They should understand and explain MHC restriction and the Nobel-winning experiment that proved MHC restriction. (

- They need to be able to explain the polymorphic nature of these molecules, explain how these polymorphic differences influence the binding of different peptide antigens, and how these differences influence disease susceptibility

- They should be able to explain co-dominant expression and how inheritance of MHC haplotypes occurs and can be used to identify parental status for an individual.
- They should be able to explain the reason behind the extensive MHC polymorphisms and how that benefits survival of a population of individuals.

Antigen Processing:

- At the end of this series of lectures, the students must be able to outline the pathways for the generation of MHC Class I and MHC Class II peptide epitopes and their loading into the MHC molecules. (
- For MHC Class I they need to trace the steps of MHC Class I antigen processing from the formation of the nascent Class I heavy chain in the ER, the role of chaperones (calreticulin and calnexin) in Class I formation, the generation of peptide epitopes by the immune proteasome, their transport into the ER from the cytosol via the TAP complex, the role of tapasin and ERP57 in peptide loading and the subsequent trafficking of peptide-loaded MHC Class I to the plasma membrane via the Golgi. (
- For MHC Class II, they need to be able to trace the steps of antigen processing including the role of the Invariant chain (Ii), the CLiP component, the trimerization domain, the trafficking of the nascent MHC molecules to the MHC Class II loading compartment (MIIC) where it encounters antigens generated in the lysosomes, the role of cathepsins and HLA-DM in CLiP removal and loading of antigenic peptides. (

T Cell Development Lectures:

- At the end of these lectures, the students should be able to explain the basic processes of positive and negative selection and how they relate to T cell maturation in the thymus, including the architecture of the thymus and the location of these processes. (
- Students should also be able to identify the cellular components (cTEC, mTEC, DN, DP, SP cells) and their roles in the process (
- Finally, students should be able to explain the process of the differentiation of $CD4^+CD8^+$ double positive cells to each of the single positive ($CD4^+$ or $CD8^+$) subsets, including the role of Th-POK, strength of signal, and co-receptor engagement. (

T Cell Subsets and Effector Functions

- At the end of these lectures, the students should be able to describe the distinctive characteristics (transcription factors, effector functions and cytokine products) and the mechanisms of differentiation of Treg, T_H1, T_H2, T_H17, T_H22, and T_{FH} $CD4^+$ T cell subsets. (
- They must explain the formation and function of the immunological synapse. (
- They need to explain the effector mechanisms of $CD8^+$ T cells (cytolytic granule components and FasL) and how they relate to Natural Killer cells. (

Anti Viral Immunity

- They must be able to explain the innate and adaptive mechanisms that protect against viral infection.
- They must be able to identify and explain mechanisms or both innate and adaptive responses that are involved in clearance of viral infections (i.e. humoral responses, NK, CTL).
- They must be able to identify and briefly viral immune evasion strategies, particularly inhibition of inflammation and MHC Class I antigen processing and presentation.
- Explain and differentiate antigenic shift and antigenic drift

Anti-Microbial Immunity

- Students much be able to identify direct and indirect mechanisms of bacterial pathogenesis
- They must identify and explain the innate immune response to bacterial infection including the role of pro-inflammatory cytokines, and the inflammasome
- Identify and explain the mechanisms of the adaptive response to intracellular and extracellular bacteria and clearly explain how these responses differ.
- Explain bacterial immune evasion strategies to hose responses

Vaccine

- At the end of these lectures they should be able to distinguish passive versus active immunity, describe the components of a successful vaccine, describe vaccine development and the necessity of vaccination for the population (herd immunity, etc.) (

Hypersensitivity

- • At the end of these lectures the students should be able to distinguish between the four classes of hypersensitive disease and be able to provide critical details of each (immune mediators, physiologic responses, exposure routes, nature of antigens involved, disease symptoms and progression, and treatments). (

Immunodeficiencies

- They need to be able to distinguish primary and secondary immunodeficiencies. (
- They should be able to describe and provide characteristic symptoms, molecular basis, and the diagnostic criteria for several primary immunodeficiency diseases such as X-linked agammaglobulineima, X-linked hyper IGM syndrome, SCID, bare lymphocyte syndrome, and ADA deficiency. (

Transplant Immunology

- After these lectures, the students should be able to describe the three types of rejection to solid tissue transplants (hyperacute, acute, and chronic) including the mechanisms, whether they respond to immunosuppressive therapy, methods to prevent rejection. (

- They should be able to explain the role of Major and minor histocompatibility antigens, the mechanisms of typing tissues to limit rejection and the mechanism of immunosuppressive dugs (cyclosporine A and FK506) (
- They need to be able to describe the mechanisms and treatment of graft versus host disease (GVHD) after bone marrow transplantation. (

Tolerance and Autoimmunity

- • At the end of this series of lectures, they should be able to describe mechanisms of central and peripheral tolerance. (
- They should be able to relate central tolerance to the T cell development (positive and negative selection) (
- They should be able to explain the generation of immunological tolerance and how it differs from negative selection (

Tumor Immunology

- Students should be able to describe the role of cellular and humoral responses to tumors
- They should be able to describe tumor antigens and the role the immune system plays in selective non-immunogenic tumors (i.e. loss of MHC).
- They should be able to discuss passive immunotherapy approaches to treating cancer including monoclonal antibodies and CAR-T cells.