

Supplemental Document: Instructional Challenges in Teaching Immunology in Higher Education Instrument.
Distributed through Qualtrics.

You are being asked to volunteer for a research study. It is up to you whether you choose to participate or not, you can also choose to discontinue participation at any point. It is expected that your participation will last approximately 10 min. Please email justine.liepkalns@colostate.edu if you have any questions or concerns.

The purpose of this research is to assess the challenges faced by immunology instructors at the undergraduate and graduate levels. This study is the first to formally assess challenges faced by faculty teaching immunology in a systematic survey of faculty across multiple institutions and of different types. Based on survey responses, we will make recommendations on how to address these challenges and share key target areas for immunology education research. We may follow up with you to learn more about your experiences for future studies if you share your email below.

More details of your participation in this study can be found [here](#).

Do you consent to have your responses included into this study?

- A. Yes, I consent to have my responses included in this study.
- B. No, I do not consent to have my responses included in this study but still would like to share my thoughts.

In the future, the investigators may want to follow up on this study or ask you to participate in new research projects. Please list your email below if you agree to being contacted in the future by the researchers. This is optional. [free response]

If you feel comfortable, please list the institution(s) in which you teach immunology as a course or a module in non-immunology courses, such as physiology or microbiology. This is optional. [free response]

Part I: Background, classroom and teaching approaches.

1. How long have you been teaching?
 - a. 0-2 years
 - b. 2-5 years
 - c. 5-10 years
 - d. >10 years
2. What is your highest level of education?
 - a. Doctoral degree (Ph.D.)
 - b. Master's degree
 - c. Professional degree (such as M.D., D.O., D.D.S., D.V.M.)
 - d. Undergraduate degree (B.S., B.A.)
 - e. Other (please specify) [open response box]
3. What is your position?
 - a. teaching track faculty
 - b. tenure track (not yet tenured)
 - c. tenure track (tenured) faculty
 - d. instructor (non-faculty)
 - e. staff
 - f. Part-time faculty
 - g. Other (please specify) [open response box]
4. What type of institution(s) do you teach at based on the Carnegie Classification. Follow link for more detail. (Select all that apply)
 - a. Minority-Serving Institution
 - b. Tribal College
 - c. Doctoral University / Research intensive (R1, R2) institution
 - d. Master's granting college or university
 - e. Liberal Arts College
 - f. Community College / 2-year college
 - g. Primarily Undergraduate Institution
 - h. Associate's college
 - i. Special Focus Institution
 - j. Other (please specify) [open response box]
5. Do you teach an immunology course/lab or a module as part of another course?
 - a. I teach an immunology course.
 - b. I teach an immunology module as part of course.
 - c. I teach an immunology laboratory course/module.
 - d. Other (please specify) [open response box]

Supplemental Document: Instructional Challenges in Teaching Immunology in Higher Education Instrument.
Distributed through Qualtrics.

6. If you selected above that you are teaching an immunology MODULE please answer:
The immunology module is part of which of the following course? Choose what best represents your course(s). (Select all that apply)
- a. Introductory biology course or series
 - b. Microbiology course
 - c. Physiology course or series
 - d. Science and Society course
 - e. Cell biology course
 - f. Plant biology course
 - g. Invertebrate course
 - h. Evolutionary or comparative physiology course
 - i. Other (please specify) [open response box]
7. Select from the following selections which best represents your audience. Do this for all the courses or modules you teach. If your audience is mixed, choose more than one based on audience composition. - (Select all that apply)
- a. Undergraduate students majoring in biological sciences
 - b. Undergraduate students that are NOT majoring in biological sciences
 - c. Graduate students
 - d. Medical students
 - e. Veterinary students
 - f. Clinicians
 - g. Other (please specify) [open response box]
8. What is the average class size? You can choose more than one option if you teach in more than one setting (ie., multiple courses or modules)
- a. 0-20
 - b. 20-50
 - c. 50-100
 - d. 100-200
 - e. 200+
9. What field best represents your background training and subject matter expertise? Select 2 at the most.
- a. biological sciences
 - b. Immunology
 - c. Physiology
 - d. Microbiology
 - e. Neuroscience
 - f. Ecology
 - g. Other (please specify) [open response box]
10. Please select from the list below what best reflect your approaches in the classroom. You may choose more than one. (Select all that apply)
- a. Lecturing
 - b. Active-Learning: students are thinking, talking or working in groups during class time.
 - c. Reading and analyzing papers
 - d. Students work on case-studies, problem-based or team-based learning, concepts mapping, or other
 - e. Other (please specify) [open response box]

Supplemental Document: Instructional Challenges in Teaching Immunology in Higher Education Instrument.

Distributed through Qualtrics.

11. Approximately, what percent of class time do you use for lecturing on average? The rest of the time would be used for student thinking, talking, working, reading.
 - a. 0-25%
 - b. 25-50%
 - c. About 50%
 - d. 50-75%
 - e. 75-100%

12. Do you address any of the following in your immunology curriculum? (Select all that apply)
 - a. Have students analyze Flow Cytometry plots or histograms.
 - b. Have students analyze cytokine graphs and draw conclusions on immune responses.
 - c. Have students diagnose a patient based on Flow Cytometry or cytokine graphs.
 - d. Have students run Flow Cytometry samples.
 - e. Have students perform antibody-based assays (eg., ELISAs)

13. Are there any challenges that prevent you from teaching immunology more effectively or more to your liking? Please explain.
[open response]

14. How do you overcome or address the challenges you listed above?
[open response]

Part II: For the following set of questions, please indicate the degree to which you agree or disagree with each statement below by selecting the level of agreement for each of the following statements.

Options: Strongly Agree; Somewhat Agree; Neither agree nor disagree; Somewhat Disagree; Strongly Disagree

1. "I identify as an immunologist."
2. "I find it difficult to teach students how to navigate the jargon in immunology."
3. "I think that students rely too much on memorization to earn their grades in my course."
4. "One of my learning goals is for my students to understand the immune system as an interconnected network of cells and organs."
5. "I do not have time to cover everything needed for my students to get a full understanding of the immunology during a semester/quarter or module."
6. "My students struggle with organizing system structures and relationships to explain how the immune system accomplishes its function, such as clearing (ie., resolving) an infection."
7. "I find it challenging to stay up to date with the latest immunology research findings"
8. "The amount of memorization required in teaching immunology negatively impacts the way I teach"
9. "I struggle to find ways for students to 'see' the 'big picture' and the broad view of an immune response."
10. "I find my students do not see how immunologic processes relate to societal issues."
11. "My students know about antibodies but struggle to put them in the context of an immune response."
12. "It is challenging to have students apply what they learned in immunology to solve problems like use of immunotherapies to treat cancers."
13. "My students struggle to predict and explain direct effects of relationships on the immune system's signals and cell-cell communication (e.g., MHC II presentation along side signal 2)."
14. "My students struggle to identify how the immune system intersects with other systems in order to explain the ways the immune system functions and impacts an organism (ie., other physiological systems like the gut, lungs or neurons)."
15. "My students struggle to explain emergent immunological phenomena (recent discoveries) based on broad principles of biology, such as antigen receptor development and the principle of the central dogma & gene expression."
16. "My students can predict and explain consequences to the immune system's function resulting from changing conditions (eg., responses to allergens, self, or pathogens)."
17. "I find that my students are struggling to make connections with previous knowledge"
18. "My students have many misconceptions about immunology."
19. "I find it challenging to identify the misconceptions my students have in immunology."
20. "I find it challenging to address and correct misconceptions my students have in immunology."
21. "My students have many misconceptions that are challenging to address sensitively, such as those relating to vaccines."
22. "My students struggle to recognize patterns across immune responses in order to make generalizations about the immune responses with similar underlying structure or function (eg., receptor-ligand interactions, signal cascades, signaling for appropriate responses to viruses)."
23. "I find it challenging that my students lack experience or knowledge in immunology prior to coming to class"
24. "I use Artificial Intelligence (such as Chat GPT) to help design a lesson plan and create new exam questions."
25. "I find plenty of materials (ie., learning resources) to use to teach immunology at the undergraduate level"

Supplemental Document: Instructional Challenges in Teaching Immunology in Higher Education Instrument.

Distributed through Qualtrics.

26. "I find it challenging to mitigate student's use of Artificial Intelligence (like Chat GPT) on assignments and exam preparation."
27. "I do not find it helpful when students have previous experience with or background (pre-requisite) knowledge in immunology prior to beginning my course or module."
28. "I struggle with finding engaging activities in immunology appropriate for the level of my students."
29. "My students know about vaccines but do not know how they work."
30. "I hesitate to discuss vaccines in a class due to the political or social implications."
31. "My students lack the foundational knowledge to grasp immunology topics"
32. "I do not have access to lab equipment to teach Flow Cytometry."
33. "I do not have access to antibody-based assays to illustrate this type of assay for my students."
34. "My institution does not have access to well-equipped immunology laboratories"
35. "I would like expose my students to more antibody-based assays as part of my curriculum."