AAI Education Committee Highlight: Teaching Tools

In 2016, the AAI Education Committee initiated a new session focused on improving immunology education: the Immunology Teaching Interest Group (ITIG). The ITIG is an informal group comprised of past speakers and attendees of the ITIG sessions, including current immunology educators spanning a range of institutions and levels. It serves as a resource for novel teaching tools and practices that can be implemented in courses to enhance immunology education. The session has grown from an audience of 20 in 2016 to more than 200 participants today. Because of the great interest in this topic, the AAI Newsletter *features "Teaching Tools" articles highlighting ITIG presentations.*

Expanding the Reach of Immunology with the Help of an Interdisciplinary Approach to a Faculty Community of Practice

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Immunology has taken center stage in public life as a result of the ongoing pandemic and is poised to inspire youth to pursue the field. Traditional undergraduate biology programs, however, may not be ready. The inclusion of immunology and related topics in introductory undergraduate biology curricula is limited.[1,2] To bridge this gap, we built a coordinated and diverse international network of educators called *ImmunoReach*, representing two-year, four-year, R1 and R2 post-secondary educational institutions (see Figure 1). A two-pronged approach adopted by ImmunoReach aims to integrate immunology into undergraduate biology curricula using the following approach:

Creating a Common Language that Highlights the Interdisciplinary Nature of Immunology

The *Vision and Change in Undergraduate Biology Education: A Call to Action* report published by the American Association for the Advancement of Science (AAAS) identifies five key concepts for life science education that undergraduate students must understand.[3] These include:

- Evolution
- Pathways and Transformation of Energy and Matter
- Information Flow, Exchange, and Storage
- Structure and Function
- Systems[3]

In the fall of 2019, ImmunoReach initiated a nationwide effort to solicit input from immunology educators, requesting them to weigh in on key topics,[3] concepts, and competencies for undergraduate immunology education. We aligned these concepts and competencies with those listed in the AAAS report with the intention of highlighting interdisciplinary connections (see this video at *https://bit.ly/3cmdd4X* and Table 1).[4,5]

This alignment of immunological concepts with general concepts in life science education allows educators from outside of the immunological niche to appreciate the interdisciplinary connections and make those connections obvious to students by using examples of immunological processes. For instance, the core concept of "Evolution" can be aligned with the germinal center B cell reaction, a process that features molecular selection

and adaptation to create the most effective antibody response. Similarly, the core concept of "Information Flow, Exchange, and Storage" can be related to the process of antigen presentation, which relays important signals required for T cell activation. Overall, creating a common language that highlights interdisciplinary concepts would aid in forming the next generation of immunologists.[6]

Faculty Community of Practice to Integrate Immunology Education into the Curricula

The next step was to take these interdisciplinary concepts to the classroom. For this, we invited immunology educators to collaborate with non-immunology educators who teach biology at the undergraduate introductory level. The goal was to develop classroom activities that could be used to teach foundational biology concepts in an immunological context.

Within a faculty community of practice created in collaboration with the BioQUEST curriculum consortium (see *https://bit.ly/3aFF0gA*), instructors participated in a semester-long process to create pedagogical resources that address interdisciplinary immunology-focused learning outcomes. This community of practice was created to provide ongoing support to educators to develop, assess, and implement immunology-focused interdisciplinary curricula. With the help of these collaborators, multiple activities using evidence-based pedagogical practices have been created. For example, a puzzle-based activity modelling the molecular components of tetanus toxin and the role of antibodies in neutralization allowed introductory biology students to connect the concept of structure and function to an immunological topic. A similar connection is made when students model the diversity of antigen receptors using multi-shaped clay subunits. Still other activities used immunology to make connections with the fields of nutrition, animal behavior, evolution, ecology, and chemistry.

This approach allows instructors to integrate immunology in a general biology classroom setting where immunology is not typically taught. The activities were discussed during group seminars throughout the semester, and participants received verbal and written feedback from network participants. These activities are currently being vetted by the instructors within their classrooms and will be disseminated to a broader audience through publication and/or presentation.

If you would like to get involved and participate in the next cohort, please contact one of the co-authors of this article to introduce yourself and request membership to this group on QUBES (see *https://bit.ly/3IHpP2R*).

Conclusions

Interdisciplinary approaches to immunology education are critical to broadening the awareness of immunology across the life sciences and establishing that immunology education can be adapted for all levels of student learning. Our two-pronged approach allows us to respond to the call for interdisciplinary education articulated in the *Vision and Change* report and to ensure that we are training scientists who are able to respond to a rapidly changing world. We look forward to many more ImmunoReach-facilitated projects that bring immunology to more classrooms to foster the development of future scientists.

Figure 1: ImmunoReach's Interdisciplinary Approach to Expanding the Scope of Immunology Education in Undergraduate Curricula

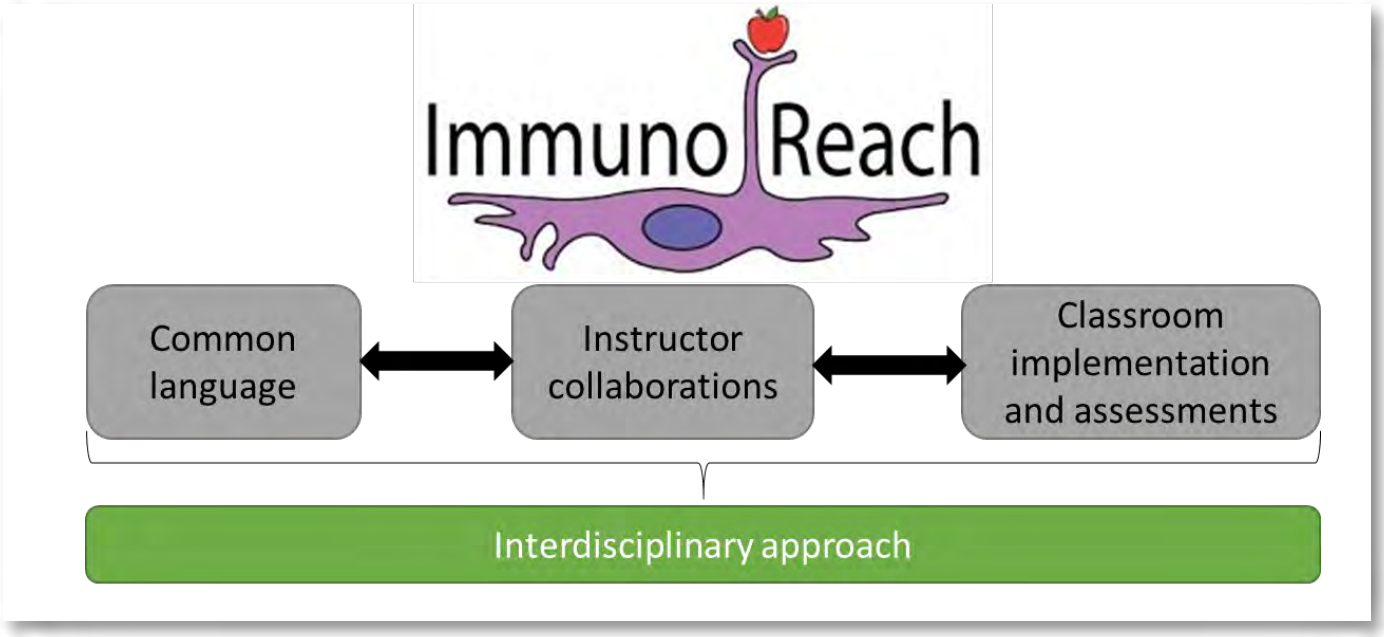

Table 1: Aligning Immunological Concepts with Core Concepts for Undergraduate Life Science Education, Based on *Vision and Change*

Core Concept in Life Sciences	Immunology-Specific Illustrative Concept	Example Learning Outcome
Evolution	Microbes and hosts dynamically co-evolve	Describe the mechanisms of seasonal antigenic shift and drift in the influenza virus and how that influences immunological memory. Describe how this relates to the germinal center B cell reaction, where B cells evolve and become better able to recognize their antigen.
Pathways and Transformation of Energy and Matter	Cells of the immune system utilize biochemical pathways for transport, synthesis, and breakdown of nutrients and macromolecules	List the bioenergetic demands of an immune cell.
Information Flow, Exchange, and Storage	Genome organization determines antigen receptor diversity	Describe the process of V(D)J recombination in T-Cell Receptor and B-Cell Receptor generation. Describe how this relates to MHC antigen presentation, where Antigen-Presenting Cells (APC) present antigen to T cells, resulting in their activation.
Structure and Function	Immune cell size, shape, and/or granularity can aid in its laboratory identification	Distinguish between dendritic cells (DC) and granulocytes based on overall cell morphology, staining patterns, and granule contents.
Systems	Immune system plays a role in defense and repair processes	Compare and contrast the role of M1 and M2 macrophages in an immune response.

References

1. Cheesman, K.; French, D.; Cheesman, I.; Swails, N.; Thomas, J. Is There Any Common Curriculum for Undergraduate Biology Majors in the 21st Century? *BioScience* 2007, *57*, 516-522, doi:10.1641/B570609.
2. Bruns, H.A.; Deaver, J.; Justement, L.B. Out of the Curricular Shadows: Revolutionizing Undergraduate Immunology Education. *Frontiers in immunology* 2019, 10, 2446, doi:10.3389/fimmu.2019.02446.
3. American Association for the Advancement of Science. 2011. *Vision and change in undergraduate biology education: a call to action*. 2010. [Online.] *http://www.visionandchange.org/VC_report.pdf*
4. Bruns, H.A.; Wisenden, B.D.; Vanniasinkam, T.; Taylor, R.; Elliott, S.L.; Sparks-Thissen, R.; Justement, L.B.; Pandey, S. Inside the Undergraduate Immunology Classroom: Current Practices that Provide a Framework for Curriculum Consensus. *Journal of Microbiology and Biology Education* 2021, Manuscript in press. *https://doi.org/10.1128/jmbe.v22i1.2269*
5. Bruns, H.A.; Taylor R.; Wisenden, B.D.; Kleinschmit A.; Liepkalns J.; Lal A.; Vanniasinkam, T.; Mixter P.F.; Paustian T.; Sletten S.; Sparks-Thissen, R.; Condry D; Pritchard R.E..; Elliott, S.L.; Justement, L.B. and Pandey, S. Curricular Framing of the Undergraduate Immunology Classroom (conference abstract) *J. Immunol* 2021, 206, Supplement 1, 54.02
6. Pandey S., Bruns H. A., Condry D. L. J., Kleinschmit A. J., Lal A., Sletten S., Sparks-Thissen R. L., Vanniasinkam T., Taylor R. T., Justement L. B. J. and Elliott S. Antigen and Immunogen: An Investigation into the Heterogeneity of Immunology Terminology in Learning Resources. *ImmunoHorizons* 2022, 6, 312-323, doi: 10.4049/immunohorizons.2200004