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 is 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.

A Perfect Fit: 3D-Printed Kit to Teach Students Principles of Antigen-Antibody Recognition and Herd Immunity

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The immunological principles underlying vaccines are a critical part of understanding human health and disease but are typically not included in K–12 curriculum (1). The COVID-19 pandemic underscored the importance of science literacy, as a lack of understanding regarding vaccine biology in the general public contributes to vaccine hesitancy (2–3).

Recognizing this knowledge gap, we developed innovative learning activities that would make the concepts of adaptive and herd immunity accessible to middle and high school students. Herein, we present one such learning activity intended to help students visualize the structural features of an antibody and the specificity of antibody-antigen interactions. This active learning exercise has been effective for teaching middle and high school students in stand-alone workshops ranging from 40–60 minutes.

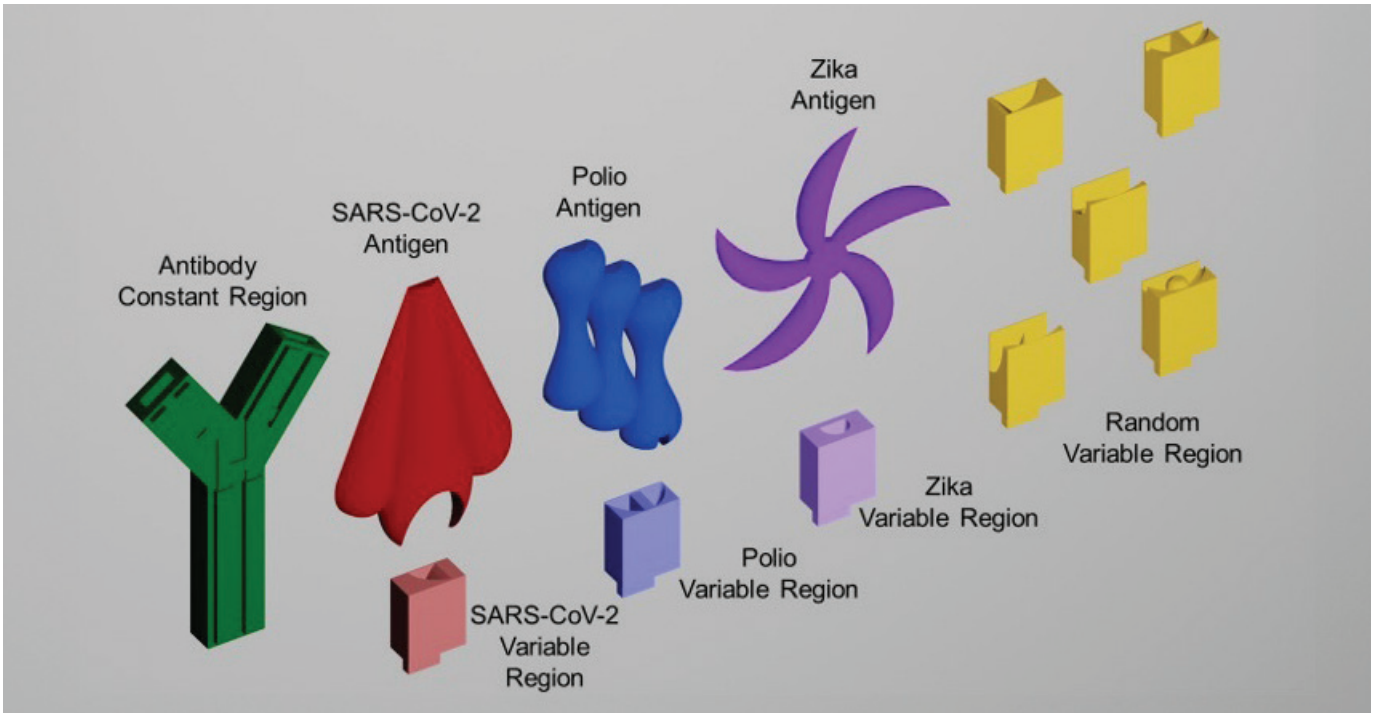

Figure 1. Rendering of 3D-printed antibody components. Variable regions interchangeably lock into the antibody constant region. For ease of reading, the color of the variable regions match the antigen in this figure, but we do not recommend retaining this color-matching when printing.

For the antibody activity, each student is provided with a 3D-printed antibody constant region, three model pathogen protein antigens, and three sets of variable region domains that can be exchanged into the constant region of the antibody. Students then explore the ability of their antibody combinations to recognize the different pathogens. This activity illustrates the specificity of antibody-antigen interactions, while providing tactile means for students to understand antibody structure.

To introduce herd immunity, some students receive variable region domains that do not bind the provided antigens; inclusion of these non-binding regions allows instructors to vary what fraction of their class receives antibodies targeting a particular pathogen. The kits can then be used in a game where which students witness how an infectious pathogen spreads through a community depending on vaccination rates (the fraction of students who have an antibody/immunity to a given pathogen). If few students have a given antibody in their kit, the microbe is passed along to more of the students. This activity models how vaccines elicit protection against pathogens at both an individual and population level.

Thus far, these kits have primarily been utilized to teach high school students at Yale's annual Day of Immunology outreach event. In an anonymous survey, students indicated that they enjoyed the activities and content of this vaccine workshop (Mean: 4.56 out of 5 with 5 being most enjoyable; STDEV: 0.65). Moreover, students found the material very understandable, with a mean score of 3.50, STDEV: 0.79, in which 3.0 corresponded with "just right" (1="too easy", 5="too difficult"). Students also reported increased confidence in their ability to explain how vaccines work to a friend or family member. Inclusion of this active learning activity in STEM outreach events or classroom curriculum may, therefore, provide an opportunity for early educational intervention to promote vaccine literacy.

The designs for the 3D-printed antibodies/antigens and all supplementary materials are freely available upon request: *outreach-yaleibio.weebly.com/3d-printed-antibodyantigen-kits.html*. We are working on developing interchangeable constant regions to teach the concept of isotype switching to students at higher educational levels.

Acknowledgements:

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References:

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