GUEST COMMENTARY

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Vaccines: An Educational Imperative & Opportunity for Biology Teachers

In January, the World Health Organization (WHO) identified vaccine hesitancy, or reluctance to vaccinate because of concerns about vaccine safety, as one of the top 10 threats to global health in 2019. Climate change denial also made the list. Vaccines and climate change are among a group of scientific topics viewed differently by scientists and the public. In part, this divergence is the result of public misperceptions about current scientific understanding and agreement on the topic, but it also results from a lack of understanding of the scientific enterprise. These challenges provide a unique opportunity and responsibility for those who teach science.

As suggested in the WHO report, "the reasons why people choose not to vaccinate are complex," and concerns about vaccine safety have existed as long as vaccines themselves. Images of people slowly becoming cows were circulated in the early 1800s because the smallpox vaccine was made using cowpox. Many of today's concerns echo those of the 1800s, such as fear that vaccines cause a variety of chronic problems, a distrust of government and industry, a lack of understanding of how vaccines and immunity work, and general pushback against state mandates. Now, easy online access to information of varying quality and the tendency for individuals to seek information that aligns with preexisting beliefs also complicate whether individuals subscribe to the science or opt to forgo vaccinations for themselves and their families.

Because the reasons for not vaccinating are complex, so too are the solutions. In this case, "solution" does not mean getting more people to vaccinate per se, since most people make the choice to vaccinate. Rather "solution" refers to helping people find accurate information and understand its implications. Parents must not be terrified that their child will develop autism because of a vaccination or fear that a decision they have made could cause their child to develop a chronic condition. Science properly interpreted should provide comfort to parents because studies have clearly shown that vaccines do not cause conditions such as autism, asthma, multiple sclerosis or other such problems.

Scientists are comforted by the data because they understand that science is a way of thinking about problems. It provides a mechanism for learning about our world and using what is learned to make informed decisions. Questions can be answered in a controlled way and judged through peer review, and valid results can be reproduced.

Addressing confusion about how science works is an opportunity for biology and other science teachers to lead change. The *Next Generation Science Standards* contain explicit goals related to teaching aspects of the nature of science. When students develop a firm understanding of the tenets of a good scientific study, know how to look at information with a questioning mind, and have opportunities to develop skills related to logic, observation, reasoning, and evaluation, they will have a way to make informed decisions related to scientific topics.

Looking back at the list of vaccine concerns, this approach to teaching biology can provide students – who are the next generation of parents – with the skills needed to navigate not only vaccine decisions, but other science and health topics. This focus can help learners do the following:

- **Understand that science, and the knowledge it generates, evolves and is self-correcting –** By reviewing all of the information at our disposal, whether in a class experiment or a professional research paper, we can draw conclusions that help us understand what is happening, and make decisions based on the best available information.
- **Distinguish between facts and beliefs –** Although not a scientist, former senator Daniel Patrick Moynihan stated it best when he said, "Everyone is entitled to his own opinion, but not his own facts." Science is different from some other coursework that students complete because scientific findings aren't different based on who shares them. Data are separate from the messenger. And, while people's reactions to the data can differ, the facts stand.
- **Critically evaluate information –** We live at a time in which more information exists than anyone can consume, and not all available information is equally valid. It is essential to distinguish good information from bad. When it comes to ill-founded concerns about vaccines, the WHO has developed criteria to evaluate websites about vaccine safety. Websites that have been evaluated and met the criteria are listed on the Vaccine Safety Net program website, www.vaccinesafetynet.org.
- **Understand basic aspects of infectious diseases and immunology –** Some concerns about vaccine safety relate directly to a general lack of understanding about how diseases spread and how the immune system works. Therefore, we argue that this topic should be taught to every student in biology classes to provide them with the skills they will need to make future health-related decisions for their families.

Whether you teach about vaccines or not, equipping your students with the skills practiced in the field of science will help them well beyond the walls of your classroom.

The Vaccine Makers Project of the Vaccine Education Center at Children's Hospital of Philadelphia is committed to public education about vaccine science via scientifically supported, historically accurate, and emotionally compelling content related to infectious diseases, immunology, and vaccines. Visit https://vaccinemakers.org to explore these free resources, or visit https://vaccine.chop.edu for vaccine information and for links to the WHO's website evaluation criteria.

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