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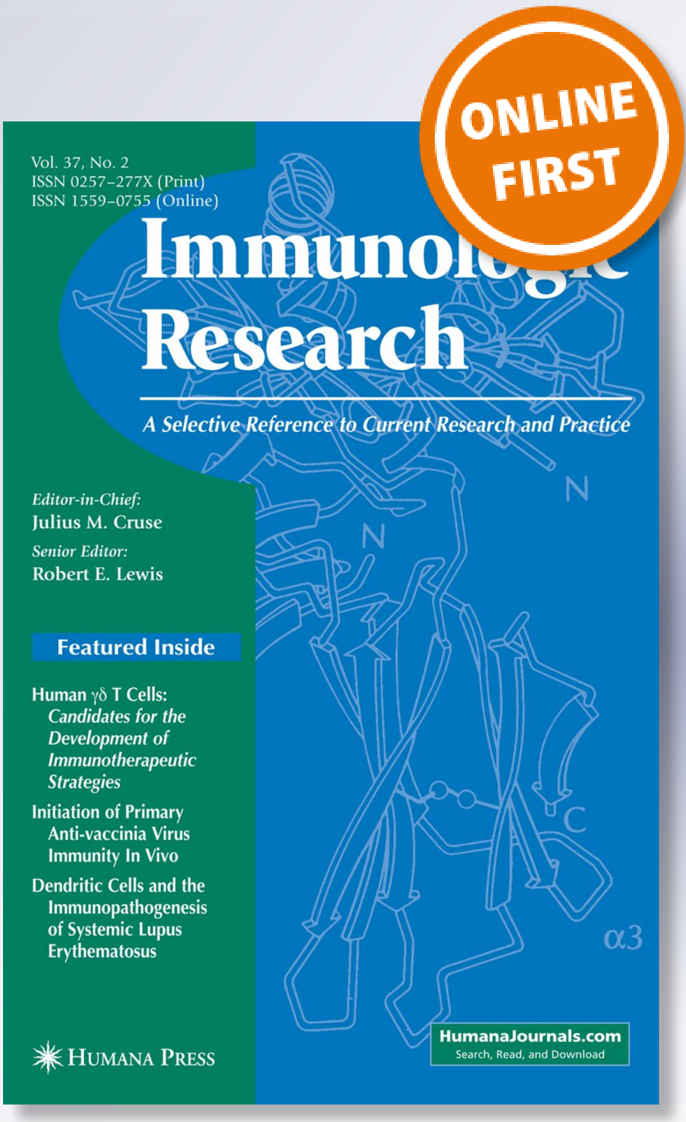

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IMMUNOLOGY IN COLORADO

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Abstract High school students in the United States are apathetic about science, technology, engineering and mathematics (STEM), and the workforce pipeline in these areas is collapsing. The lack of understanding of basic principles of biology means that students are unable to make educated decisions concerning their personal health. To address these issues, we have developed a simple, inquiry-based outreach lesson centered on a mouse dissection. Students learn key concepts in immunology and enhance their understanding of human organ systems. The experiment highlights aspects of the scientific method and authentic data collection and analysis. This hands-on activity stimulates interest in biology, personal health and careers in STEM fields. Here, we present all the information necessary to execute the lesson effectively with middle and high school students.

Keywords Science educational outreach · How-to · Easy · Inquiry-based · Mouse dissection · Immunology lesson plan · Body systems

Introduction

The apathetic attitude toward science held by many high school students in the United States has contributed to both health and economic crises for the country [1, 2]. Since only 21 % of 12th-grade students are proficient in science nationally [3], it is not surprising that the emerging adult population lacks the basic knowledge of biology needed to make informed and prudent health-related decisions. In particular, students need help comprehending issues like (1) the benefits of immunizations, (2) the transmission of STDs and other infectious diseases, (3) how and why to use antibiotics properly and (4) the need to maintain a reasonable weight. Moreover, significant shortages in the STEM (Science, Technology, Engineering and Mathematics) workforce have reduced the United States' competitiveness and economic positions nationally and internationally [4]. The United States ranked 23rd among developed countries in science performance in the most recent Program for International Student Assessment (PISA) of 15-year olds [5]. An overall lack of understanding about the scientific process is leading to distrust of scientists and scientific data as well as disinterest in funding scientific research. These issues are compounded by weak critical thinking skills which result in adoption of ideas without evaluating them. One method of combating this state of affairs is to engage middle and high school students in authentic science via hands-on, inquiry-based experiments led by scientists themselves.

All students, even in countries with strong science education programs, benefit from increased experimentation. As expressed in the core assumptions of the National Science Education Standards [6], "students develop an understanding of the natural world when they are actively engaged in scientific inquiry" via individual and group processes in similar manners to scientists who construct their knowledge base through investigation. Not surprisingly, students' mastery of course content is enhanced when laboratory experiments include metacognitive activities like "predict-observe-explain" components and are

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linked appropriately with curriculum subject content [7]. Moreover, analytical and communication skills are enhanced when students are asked to evaluate and defend their own data [8]. Notably, students who participated frequently in hands-on demonstrations and experiments surpassed their peers on the National Assessment of Educational Progress (NAEP) for 8th-grade science by 40 % of a grade level [9, 10]. These data support the assertion that learning content is not as important as learning how to solve problems and think critically [11].

Immunology is a complex field in which most secondary school educators lack training. As a result, immunologic concepts are presented minimally. However, a basic understanding of core immunologic principles is important for all students as evidenced by the new emphasis on immunology in the 2012 Advanced Placement Biology standards [12]. Through educational outreach activities, immunologists can provide additional exposure to and help re-enforce core concepts. Additionally, visiting scientists can address students' questions that are beyond the expertise of their teachers. Although these comments are presented in the context of immunology, they are applicable to any field of science. Finally, as described below, including staff at all levels in outreach activities exposes students to the vast array of careers in biomedical research. This provides students with opportunities to discuss educational requirements and career paths on a one-on-one basis with someone in the field. Such information can be invaluable to students whose only resources may be their teacher and school counselor who likely lack experiential knowledge of careers in STEM.

The lesson and "how-to" procedures presented here allow one to execute an inquiry-based immunology lesson that is easy to prepare and inexpensive (under $100 US). The exercise can be adapted easily to any area of study, or specialization within immunology, that utilizes murine models. The lesson contains a brief review of immunologic principles which is followed by a hypothesis-driven mouse dissection, data collection and analysis of the hypothesis. The entire lesson can be completed in 50 min. In total, it requires the scientist who is organizing the event to spend approximately 5 h, from contacting a local school to completing the lesson in the classroom. The commitment for additional volunteers includes the lesson time and travel to and from the school.

The lesson addresses and re-enforces broad science standards, beyond immunology, including (1) human body systems, (2) genetics, (3) use of animals in research, (4) the scientific process and (5) data analysis. Since the data are straightforward measurements of spleen sizes, students can have confidence in their accuracy. Thus, they have the opportunity to think critically to justify their results, as opposed to discounting them, if the data do not support their hypotheses [8]. Teachers can extend and broaden the lesson on subsequent days by having their students graph the data, compare sample sizes (student, group and class) and discuss a myriad of topics related to the experience. Additionally, the lesson can be geared for interdisciplinary work, including writing, ethics and social studies. The experiment provides a rare hands-on opportunity for "students [to] relate their knowledge of normal body function[s] to situations, both hereditary and environmental, in which functioning is impaired [and to investigate] explanations for various disease conditions in physiological, molecular, or systems terms" [13]. The lesson has been optimized in the classroom over a five-year period and is suitable for students older than 10 years of age.

Materials and methods

The premise of the lesson is for students to learn about the cells and organs of the immune system through inquiry. The leader of the lesson reviewed the immune system briefly and provided basic information about the mice with which the students were working. Each student made an informed hypothesis concerning the size of the spleens in mice that were RAG-sufficient and RAG-deficient. The hypotheses were tested by collecting data on spleen sizes from mice with the indicated genetic backgrounds.

The following is a complete list of materials required for the lesson: Mice, forceps, scissors, pushpins, Styrofoam boards, isopropanol, small plastic beakers or cups, pencils, rulers, gloves, biohazard bags, collection bags for dissected mice, Styrofoam boxes and freezer packs.

Cost of the lesson

The costs for the experiment are minimal. The lesson can be executed for free with support from the institutional animal facility and vendors. Many schools have dissection kits. However, thirty dissection kits were produced for less than $10 US. Each dissection kit contained a dissection board, scissors, forceps, six pushpins, a ruler and a pencil. We collected lids from Styrofoam shipping packages to use as dissection boards (no cost). We used scissors and forceps from our laboratory and sets borrowed from another laboratory (no cost). The instruments were marked with tape to assure repatriation to the proper laboratory. We purchased pushpins for positioning the euthanized mice and pencils for recording data for $4 and $2 US, respectively, at a local office supply store. Upon request, the store may be able to donate the items. Small plastic rulers were donated by a vendor (no cost). Alternatively, paper rulers can be produced easily and cheaply by Xeroxing a ruler. Gloves were donated by two vendors and the institute's animal facility (no cost). We purchased two 473-mL bottles of 70 % isopropanol at the local supermarket for $2 US per bottle. The isopropanol was aliquoted into small plastic beakers from our laboratory (no cost). We used 2 large biohazard bags from our laboratory stock for collecting waste ($3 US).

The main cost for this lesson was mice. We used mice from our animal colony. The mice lacked the appropriate genotypes for research experiments and were going to be euthanized. We maintained the mice one additional week beyond weaning age at a cost of approximately $45 US per lesson. Additionally, our institutional animal facility provided mice for several lessons free of charge. Animal vendors are sometimes willing to donate mice and shipping costs for educational purposes. Our animal facility provided extra collection bags for the dissected mice. We transported the euthanized mice to the school in Styrofoam shipping containers on warmed cooling gel packs in which reagents for the laboratory had arrived (no cost). After the experiment, mice were returned to the containers and frozen gel packs (no cost).

Mice

One mouse per student was optimal. One mouse per team leader was required for demonstration purposes. The team leaders' mice had smaller spleens than the mice the students received. To add variability to the experiment, mice of different ages, weights and coat color were used. This enhanced the discussion and use of critical thinking and analytical skills. Mice were euthanized in our animal facility according to approved institutional IACUC policies.

Dissection materials

Each student had a dissection kit (see *Cost of the lesson* above for kit details). Pushpins were used to secure the euthanized mice during the dissection. Plastic beakers or cups with 70 % isopropanol were placed at each workstation for soaking the euthanized mice prior to the dissection. Each student used at least one pair of latex-free gloves. A range of glove sizes from extra-small to large was required. Writing instruments and rulers were provided and collected before students removed their gloves at the end of the experiment. This assured that students were not exposed to contaminated items after the experiment was completed.

Clean up

All mice were collected and returned to the institute in accordance with standard IACUC policy for our institute. All instruments, including writing implements and rulers, were collected and cleaned by the students and team leaders at the end of the lesson. All contaminated trash (gloves, paper towels, etc.) was collected in biohazard bags and returned to the institute as per institutional policies.

Lesson procedure

Volunteers (Team leaders)

This lesson required the support of approximately six volunteers (team leaders) for a class of 35 students. We determined empirically that the activity was most successful when one team leader works with groups of six or fewer students (Fig. 1). This ratio ensured that students received the support they required to complete the exercise in a timely manner. Consistent with our experience, it has been observed that "millennial" students, which encompass today's middle and high school populations, prefer collaborative work [14]. The team leaders (1) demonstrated dissecting the mouse in a stepwise progression, (2) pointed out immune and other organs, (3) kept the students on task with the experiment and (4) fielded questions concerning science, their educational backgrounds, career paths and jobs. All members of the laboratory served as team leaders and brought unique perspectives to the students. Our team leaders included post-doctoral fellows, undergraduate and graduate students, technicians and staff from the institute's animal facility.

Transportation of mice

Mice were euthanized in the institutional animal facility just prior to departure for the school. All procedures met with approved, institutional IACUC policies. Mice were transported to schools in Styrofoam boxes containing gel packs that were warmed with hot water. The gel packs are usually used for cooling packages. They can be frozen at the school and used cold for transporting the mice back to the institute.

Introducing the lesson and the team leaders

A "Do Now" is an activity that focuses students on the day's lesson as soon as they enter the classroom. Do Now's for this lesson included (1) "Write down three safety rules to follow during the lab" and (2) "Read the lab handout. Don't make your hypothesis, yet, you need more information." We reviewed the Do Now work with the students to validate their efforts and discuss safety guidelines for the experiment. Team leaders distributed materials while students completed the Do Now if it was not possible to do so in advance.

Fig. 1 Student teams in the classroom. A team of four students observed a team leader demonstrating steps of a mouse dissection

SWBATs (Students Will Be Able To) are used by many teachers to convey the goals of a lesson to students. The following SWBATs, or lesson goals, were applicable for this lesson: (1) explain where the organs of the immune system are located, (2) explain the importance of the organs of the immune system, (3) explain the importance of B and T cells in fighting disease and their locations, and then (4) describe the appearance of other body organs (if the class time is longer than 50 min).

Team leaders introduced themselves to the entire class, stated their current positions and their career paths to the position. If time permitted, volunteers explained their jobs briefly. This process reduced barriers between the students and the volunteers. Additionally, it encouraged students to inquire about careers in science.

The lesson leader introduced the day's topics and reviewed the experiment with the students based on a one-paged summary slide (Fig. 2). A *brief* review of the immune system was followed by an explanation that RAG-1 and RAG-2 are required for the production of B and T cells. Students learned about David Vetter, who suffered from Severe Combined Immunodeficiency (SCID), to engender student "buy-in" and to establish a basis for discussing bioethics. The concept of murine animal models as tools to study the immune system and develop therapeutics was introduced. Next, the lesson leader briefly highlighted the steps in the experimental procedure (Fig. 3). Finally, students were asked to store all their personal writing instruments and to refrain from accessing their personal items until the end of class. Pencils were provided for the remainder of the exercise to avoid contamination of students' belongings with animal material from dirty gloves. In total, the introduction was limited to 10 min of a 50-min class period.

Experiment handout and student hypotheses

Each student was provided with a mouse harvest handout (Fig. 3), including a diagram of a dissected mouse (Fig. 4). The handout contained seven key components. The first items reminded students about safety guidelines and the goals of the experiment. Armed with the information from the introduction, students were asked to make and record a hypothesis about the impact of RAG deficiency on the size of a mouse's spleen (section II). While students made and recorded their hypotheses, teams obtained their gloves and team leaders distributed mice. Students located, sketched and answered questions about immune tissues in section III A. Sections III B and C required students to measure the spleens of their mice and those of the RAG-deficient mice dissected by their team leader. Students were prompted to record their data and enter it into the table in section III D. Teams shared the data for the RAG-deficient mice with other teams to complete the RAG KO portion of the table. Thus, students had more than one set of measurements for each section of the table. This enabled students to evaluate and appreciate the differences between pooled data sets and single measurements. Section III E of the handout asked students to evaluate their hypotheses based on the data they collected.

Performing the mouse dissection

In accordance with all IACUC and federal guidelines, mice were euthanized prior to being removed from the animal facility. Each team leader demonstrated a basic mouse dissection in his or her own style. For simplicity, all the team leaders had mice of one genotype while the students had mice of the other genotype. For example, the team leaders used RAG-deficient mice while the students dissected wild-type mice. During the demonstration, the immune organs were highlighted and the bone marrow was exposed. It was important that students removed the spleen quickly so they could measure it and collect their data for sections III B-D of the handout (Fig. 3). Data for RAG KO mice were written on the board for expedient dissemination.

If RAG-deficient mice are not available, mice with any genotype that results in reduced spleen size or smaller mice than the RAG-WT mice may be substituted. The goal is for the spleens of the team leaders' mice to be smaller than those of the students' mice. However, the lesson can be adapted for mice with any attributes.

During the dissection, team leaders helped students stay on task and assisted students with aspects of the dissection. They encouraged students who were reluctant to participate in the experiment. Team leaders also focused students on completing their data collection and documentation in sections III B-D of the handout so that they could evaluate their hypotheses in section III E (Fig. 3). If time allowed, team leaders assisted students in investigating additional organs of their mice.

Once students completed their dissections, team leaders collected the mice. Students washed their instruments

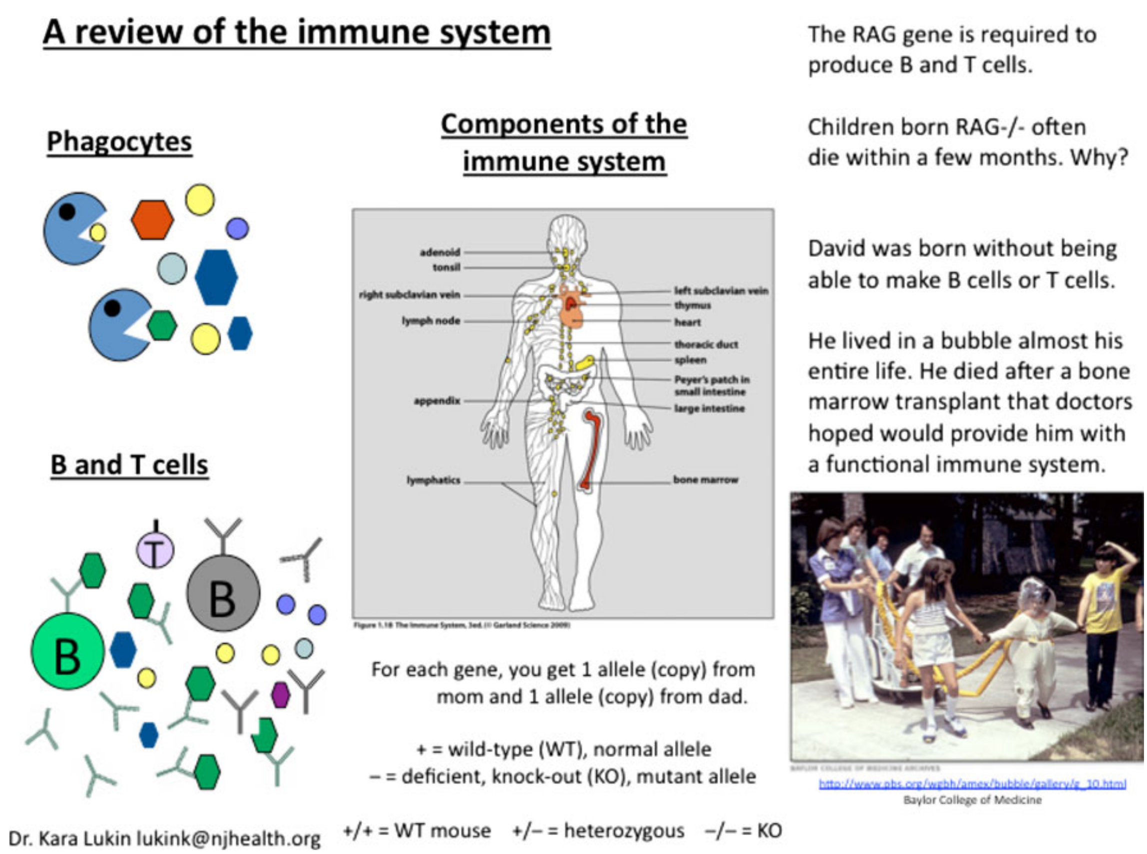

Fig. 2 Immunology review sheet. The review sheet is used to remind students about the main principles and cell types of the innate and adaptive immune systems. A few comments about primary and secondary immune organs are supported by the diagram of the immune system. The concept of wild-type and mutant alleles is reviewed with the example of Recombination Activating Gene (RAG). The importance of RAGs, T cells and B cells, and research with animal models is emphasized by David Vetter's story. The handout is available from the author

while team leaders collected the dissection boards, pins, rulers and writing implements. After this point, students returned to using their personal items. Photographs were taken during the experiment only by team leaders and with the permission of the teacher.

Engaging students who are hesitant about the experiment

Invariably, some students were hesitant to participate in the experiment for a variety of reasons. Some students felt that it was inappropriate to use animals for dissection. Others found the process "gruesome." Some students were afraid to participate due to a poor understanding of the content or a language barrier. In all cases, we encouraged reluctant students to participate in the lesson. The team leader coached the students through developing the hypotheses, so they were ready for the dissection. Then, steady reassurance and detailed positive feedback were provided as the student began the dissection. Thus, the students saw that the team leader was impressed by the attempt to participate even if they did not complete the dissection. On occasion, there was a student who had to leave the classroom. This was handled best by the teacher. In our experience, even students who reported that the dissection was "gruesome" and "disgusting" indicated that it was a positive learning experience.

Safety

Safety is a key issue for any experiment. We discussed *all* the details of the experiment with the teacher well in advance of the outreach event. Each school and school district had specific safety guidelines to which the lesson was required to adhere. For some schools, it may be necessary to obtain a parental waiver. Additionally, it was important to confirm that none of the students were allergic to rodents or the gloves used. One student, with significant food allergies, had a reaction to the nitrile gloves we provided. Pushpins were used for positioning the mice for dissection if the teacher did not have access to dissection kits. Needles and other sharp instruments were avoided. During the introduction to the lesson, it was made clear that no one was to handle the mice or anything touched by the

Fig. 3 Experimental handout. This handout is provided to students for the mouse dissection. It is usually accompanied by the labeled diagram in Fig. 5. The handout is available from the author

Name: Date:

Mouse harvest handout

The most important ground rule is: *No goofing around with mice or during this lab.*

I. Goals of the lab:

A. Learn where the organs of the immune system are located in a mouse and what the organs look like in real life.

B. Determine if there are visible effects of *RAG*-deficiency (*RAG KO*) on the immune system. (*RAG* is the recombination activating gene. It is required for the generation of T and B cells).

II. State your hypothesis (concerning the effects on the organs of the immune system if a mouse lacks functional *RAG*):

III. A. Compare the organs of the immune system between mice that are *RAG wild-type* and *RAG-KO.*

Locate and sketch the main organs of the immune system (Spleen, Lymph nodes, Bone Marrow, Thymus).

Why do you think the spleen is red?
Why do you think the bone marrow is red?

B. Measure the size of the spleen of your *WT* mouse (width, thickness, length in centimeters). Record your data here and in the chart.

C. Measure the size of the spleen of a *RAG KO* mouse (width, thickness, length in centimeters). Record your data here. Record the class' and your data in the chart.

D. Data table

***WT* Mice**	Sp length	Sp width	Sp thickness		***RAG KO* Mice**	Sp length	Sp width	Sp thickness
1					**1**			
2					**2**			
3					**3**			
4					**4**			
5					**5**			

E. Based on your data, was your hypothesis correct (part B)? Explain your answer.

mice without wearing gloves. Additionally, students were instructed not to touch any personal items when their gloves were on. This eliminated the possibility of "contaminating" their belongings with murine blood, tissue or urine (which is highly immunogenic, reviewed in [15]) that was on their gloves. Directions for cleaning up were explained prior to initiating the experiment. If developing safety rules was part of the "Do Now" for the lesson, these were reviewed at the start of the class. The students were excellent at addressing all of the issues discussed above on their own or with minimal prompting when asked for their ideas.

Post-experiment discussion

The last 5–10 min of the period were used to discuss the lesson as a class. Students shared their hypotheses with the class and whether or not the hypotheses were supported by the data they collected. Additionally, students were asked to communicate what else they learned from dissecting the mice or to discuss information concerning careers in science which they garnered from their team leaders. In particular, students who were reluctant to participate initially discussed aspects that altered their opinions about the experiment and performing the mouse dissection.

United States national science education standards addressed

This lesson addresses the following national science education content standards for grades 9–12 in the United States [6]. (1) Standard A, Science as Inquiry: Abilities necessary to do scientific inquiry; Understanding about

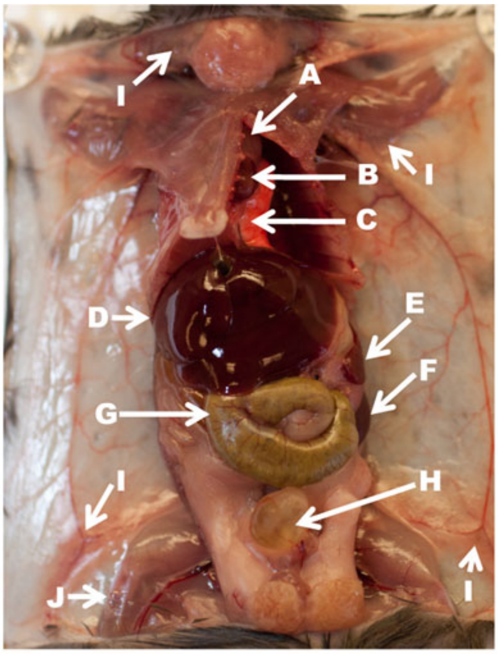

Fig. 4 Labeled mouse. Students are provided with a photograph of a dissected mouse with relevant anatomical items labeled. This provides a guide for the students during the dissection and can be used by students who choose to abstain from the dissection. The handout is available from the author

scientific inquiry. (2) Standard C, Life Science: The cell; The molecular basis of heredity; Interdependence of organisms; Matter, energy and organization in living systems; The behavior of organisms. (3) Standard E, Science and Technology: Abilities of technological design; Understandings about science and technology. (4) Standard F, Science in Personal and Social Perspectives: Personal and community health; Population growth; Science and technology in local, national and global challenges. (5) Standard G, History and Nature of Science: Science as a human endeavor, Nature of scientific knowledge.

Straw poll evaluation to direct internal improvement of the lesson

In the United States, approval is required from the Institutional Review Board (IRB) to assess students following an intervention (i.e., this lesson). Policies and arrangements with individual school districts vary. Therefore, we consulted with the IRB representative at the institution prior to any assessment of the lesson. The straw poll question used for internal program investigation to improve the lesson quality was, "Do you feel that the mouse dissection was a useful learning tool? YES NO." We prepared slips of paper with the question on it. Students circled their answers and dropped the papers in a bag for collection. Some students chose to write additional, unsolicited comments on the paper slips.

The students were asked not to write their names on the slips. Thus, the individual responses were not identifiable.

Results

The schools we targeted for the mouse dissection lessons have limited resources and large student populations from minority (32–97 %) and socio-economically disadvantaged backgrounds (as indicated by students who are eligible for free and reduced price lunch, 32–87 %). This outreach experiment is sometimes the only chance the students have to perform a dissection experiment. Students are so excited by the opportunity that those studying biology with other teachers often request to participate in the lesson.

During the 2011–2012 academic year, six classes of high school biology students in the Denver, Colorado, area participated in the exercise. A straw poll was taken to review students' self-reported perception of the experiment and overall lesson. The feedback was collected for internal program investigation designed to help improve the quality and structure of the lesson. Students were given paper ballots containing the following question: "Do you feel that the mouse dissection was a useful learning tool?" Students were asked to reply by circling "Yes" or "No." Some students chose to provide additional comments that are presented in the discussion. One hundred and five students chose to participate in the straw poll. Of these students, 97.14 % (102 students) replied in the affirmative, 1.90 % (2 students) replied "No" and 0.95 % (1 student) wrote in "Not sure" (Fig. 5). Thus, students indicated the experiment was a positive experience from which they extended their knowledge. The teachers reported that a key aspect of how the dissection interested students and re-enforced content knowledge was the appropriate coloration of the internal organs of the mice. Unlike prepared, preserved specimens in which the organs are gray and brown in color, the mice used in the dissection were euthanized just prior to transportation to the school. Thus, the tissues retained much of their proper physiologic color. Finally, the team leaders reported having extensive discussions concerning careers in science with the students (personal communications to KL). These results suggest that the outreach lesson, as presented here, is beneficial for students on multiple levels.

Discussion

Our goal is to eliminate barriers for scientists interested in supporting education in the classroom. By providing

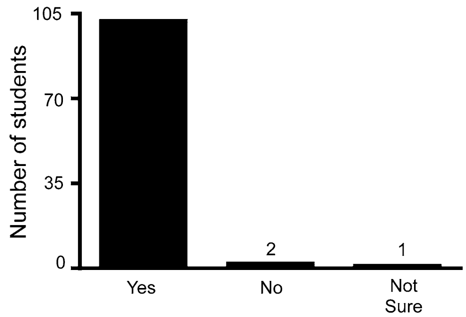

Fig. 5 Students self-report the lesson was beneficial. At the end of the class, students were asked to respond "yes" or "no" to the following question: "Do you feel that the mouse dissection was a useful learning tool?" Answers were provided anonymously on paper ballots. Of the 105 high school students who replied, 97.14 % (102 students) replied in the affirmative, 1.90 % (2 students) replied "No" and 0.95 % (1 student) wrote in "Not sure."

vetted, classroom-ready materials, members of the scientific workforce can share easily their expertise with students and spark students' interests in STEM via a hands-on experience. To this end, the processes for preparing and executing an inquiry-based mouse dissection are discussed. Customizable electronic copies of all the handouts are available from the author. The materials may be used as is or adapted as needed. For example, the use of RAG-sufficient and RAG-deficient mice is not necessary. The research question can be adapted to any mice.

The responses from the straw polling of participants in the mouse dissection experiment suggest that students believe this lesson has been developed to the point that it is a useful learning tool (Fig. 5). Moreover, extensive, unsolicited and de-identified anecdotal information has been conveyed by students, teachers and team leaders. Some students had performed dissections previously. However, their teachers reported that students appreciated the opportunity to work with fresh specimens because they retained the normal coloration of the tissues. In the preserved specimens, the tissues were gray and brown. Students voluntarily indicated on their straw poll sheets that they were excited about working with "a real animal" because they could "really see organs in the mouse which is similar to us humans." One student commented that "although it was unpleasant I now know exactly where the organs are located." Other comments included that the lesson "definitely further my understanding of the immune system" about which the students had learned a minimal amount. Interestingly, teachers communicated that students who usually do not engage in experiments, including dissection, or who are withdrawn from the class participate actively in the mouse dissections. Teachers attribute this to the special status and excitement created around the lesson and the opportunity to work with "real scientists."

Team leaders reported that students were particularly interested in laboratory and animal technician positions and the qualifications required for these positions. This suggests that there is interest among high school students in careers related to science. More extensive exposure to all levels and varieties of careers in STEM may be critical for increasing the numbers of high school graduates who enter the STEM workforce.

Team leaders reported answering a variety of questions pertaining to immunizations, transmission of infectious diseases and cancer. Students viewed the team leaders as experts in the field of science, in general and immunology. Thus, the team leaders answered questions, allay students' concerns about the safety of vaccines and provided examples of their utility. The dissected mice highlighted the fact that the outside world runs through the inside of our bodies, providing continual assaults to the immune system. In small group settings, and with someone they viewed as highly knowledgeable, students raised questions about immunology, and biology in general, which might otherwise have gone unanswered.

The experiment provided a unique experience to view the organs of the body in an animal whose structures are similar to those of a human being. Students often commented that they were surprised by the location and appearance of the organs although they had all studied the human organ systems prior to performing the dissection. These statements highlight the importance of hands-on experimentation to solidify content knowledge for students [16]. Moreover, it suggests that the lesson enhanced students' conceptions of the organ systems, including the immune system.

Interestingly, students were shocked by the amount and localization of fat in older and larger mice. They saw for themselves how the fat presses on the internal organs and why surgery is so complicated for patients who are overweight. This provides an opportunity for team leaders to emphasize the importance of maintaining a healthy weight and to relate the students' personal health to the experiment.

While a single hands-on lesson is insufficient to ignite most students' passion for STEM, our experience suggests that it is sufficient to enhance students' interest in biology, if only temporarily. It provides an opportunity for students to engage in critical and analytical thinking activities, which are crucial for success in an age of virtually unlimited access to information of varying quality [17]. Since the collected data are straightforward measurements, students trusted their data. Therefore, the team leaders coach them in investigating possibilities for why a piece of data did not align with the data of their teammates or that of the class. This "trust and defend [your] results" process promoted a deeper understanding of the scientific process as well as analytical skills [8].

While many countries, like Finland, have created excellent networks between science teachers and scientists, this is not universal. We encourage scientists at all levels to establish connections with local K-12 educators and perform educational outreach annually. When we ask what we can do for our country, it is clear that all scientists have one day during which they can pass the torch of scientific inquiry to the next generation.

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