Be Healthy as a Fish Educational Program at the International Institute of Molecular and Cell Biology in Warsaw, Poland

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Abstract

The purpose of the *Be Healthy as a Fish* educational program that is organized by the International Institute of Molecular and Cell Biology (IIMCB) in Warsaw, Poland, is to educate children about the ways in which zebrafish can be used as a model organism to help scientists understand the way the human body works. We introduce *Be Healthy as a Fish* workshops to children in fourth to sixth grades of primary school (9–11 years old), together with two kinds of materials under the same title: a book and a movie. We focus on the field of biology in a way that complements the children's classroom curriculum and encourages them to broaden their interests in biology in the future. The *Be Healthy as a Fish* educational program was inaugurated in 2014 at the Warsaw Science Festival. As of October 31, 2015, 526 primary school students participated in 27 workshops. Approximately 2000 people have received the book and nearly 1700 people have watched the movie.

Be Healthy as a Fish: Origin of the Title

There is a popular saying in Poland that someone is “healthy as a fish” meaning that one enjoys good health. Does this imply that fish are really that healthy? Obviously, some fish may not be healthy. Just like other animals and humans, they can and do get sick. However, this common and deceptive impression of “healthy fish” results from the fact that people hardly ever have an opportunity to observe a fish that is sick. Why does our educational program have such a possibly misleading title that may not always be true? We took advantage of this provocative title and commonly known expression and assigned to it a completely new meaning: fish can get sick, but they are important for human health. Notably, this catchy sentence intrinsically combines two keywords—health and fish—which, in our opinion, makes it a good title for a successful educational program.

Introduction

THE *BE HEALTHY AS A FISH* program seeks to educate children about how zebrafish as a model organism can help scientists understand the way the human body works, both in health and disease. The program is directed toward the children who are 9–11 years old. According to the Polish educational system, children at this age attend the fourth to sixth grades of primary school. At this level of education, “Biology” is not yet a separate school subject; instead, children begin their biological education with more general “Life Sciences” lessons. In these lessons, they are provided with basic information about different levels of the organi-

zation of life on Earth (e.g., cell, tissue, organ, and organism), simple human anatomy (e.g., digestive, blood, and respiratory systems), and the methods and tools that are used to investigate the nature (e.g., the concept of an experiment and a microscope).

All of the materials and activities for the program were created by an International Institute of Molecular and Cell Biology (IIMCB) team that comprised researchers, zebrafish caretakers, and public relations specialists. To make the program interesting and at the same time understandable for a young audience, all of the materials and activities that were prepared for the children were devised based on consultations with the Centre for Innovative Bioscience Education

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(BioCEN), a sponsored unit that was established by IIMCB to popularize biology in society, especially through workshops for students and their teachers. Once the outreach materials were created, they were incorporated into a workshop that also contained a book¹ and a movie², each under the title *Be Healthy as a Fish*. The inspiration for developing this program came from the FishMed project that was implemented at IIMCB and financed by the European Commission within the 7th Framework Programme and Polish Ministry of Science and Higher Education. FishMed stands for *Fishing for Medicines and their targets using Zebrafish models of human diseases*. The project seeks to develop zebrafish-based research at IIMCB, which also gave us the unprecedented opportunity to develop widespread public relations activities that are focused on both the research community and the wider society.

Materials for Outreach Activities

Be Healthy as a Fish book

The book brings the complex world of science closer to young readers. At the beginning, using a series of intriguing questions that are addressed to the readers, it encourages them to think about the question: “What do scientists need to find a cure for a disease?” By making a comparison to a machine that consists of intricate components that cannot work independently, the story leads the readers to the conclusion that health, in the human body, similar to the state of the normal functioning of a complex machine, results from the proper functioning of its components, namely cells. To help combat illness, scientists need to have a good atlas of the human body’s organization and function, similar to the way in which technicians need detailed manuals to fix equipment and machines when they are out of order. To construct such an atlas, a model organism is very helpful (Fig. 1). This introduction is an invitation for the readers to follow the story and discover the advantages of zebrafish as a model organism. The authors make several comparisons between humans and zebrafish to show, in a simple way, similarities between these two species, starting from the molecular level (i.e., DNA content³ (common genes) and cell structure (the same organelles) and finishing with a comparison between fish and human bodies to visualize anatomical and psychological

similarities between them. To explain why humans are so similar to animals, the authors take the opportunity to provide young readers with basic knowledge about the evolution of the animal kingdom. Importantly, the authors teach children that scientists can benefit from the similarities between zebrafish and humans and can exploit their differences (e.g., the development of fish offspring outside the mother’s body and their relatively short life span).

Finally, the book describes the future challenges for science, focusing on as-yet undiscovered medicines. The authors use Alzheimer’s disease and Parkinson’s disease as examples, for which successful therapies have not yet been discovered. They explain how the using of short life span zebrafish as a model of age-related human disease may help scientists discover therapies to effectively cure people who suffer from such diseases. At the end of the book, the readers are invited to join the scientific community as future scientists and explore—what is still unknown.

Because the book is addressed to primary school children with elementary knowledge of the life sciences, it is illustrated with comic and eye-catching cartoons to make the content more interesting for a young audience. All of the cartoons have two main heroes: a boy and a zebrafish. One of the cartoons presents a boy who looks in the mirror and sees a zebrafish. This image was selected for the cover of the book as a “graphical abstract” of the *Be Healthy as a Fish* educational program (Fig. 2). Moreover, to help readers absorb the story’s message, in addition to the cartoons, the book provides engaging assignments. At the end of the book, a short glossary defines terms used in the book that may be difficult for some readers to understand. Importantly, the factual content of the book was created in consultation with an educational biology expert to ensure that the message of the story is both understandable and inspiring for a young audience.

The book is distributed to all of the participants of the *Be Healthy as a Fish* workshops as an invitation to broaden their

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FIG. 1. Fifth grade pupil reading the *Be Healthy as a Fish* book. Color images available online at www.liebertpub.com/zeb

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FIG. 2. The cover of the *Be Healthy as a Fish* book. Color images available online at www.liebertpub.com/zeb

FIG. 3. Frames from the *Be Healthy as a Fish* movie. Color images available online at www.liebertpub.com/zeb

knowledge beyond the issues that are discussed in their classes. The content of the book was written such that it can be regarded as an independent story that even those who do not participate in the workshops can understand. Both Polish and English versions of the book are available on the IIMCB website (www.iimcb.gov.pl/be-healthy-as-a-fish)¹ and can be downloaded for free. We are convinced that this book can be interesting additional material for teachers to support discussions about the evolution of life, cell biology, heredity, anatomical similarities between humans and animals, and differences in the development of amniotes and anamniotes. We also believe that this book is a valuable starting point for discussions about why scientists need animals, what we can learn from observing their physiology, and how this affects discoveries of new medicines.

Be Healthy as a Fish movie

The aim of the movie is to familiarize viewers with the IIMCB facilities and scientific interests and show what scientists' everyday work looks like. This 6-min movie is mostly animated. However, part of it shows the real images of various locations within the institute (e.g., laboratories, fish facility, a lecture hall, and office of the Director of IIMCB [Fig. 3]). The storyline of the animation consists of a humorous tour around the institute that is guided by two cartoon characters: the Professor and his pet, a zebrafish. During the tour, the children are told the reason why the zebrafish facility was established, and they can witness the formation of a new international team of scientists. Viewers can also observe the everyday life of "zebrafish town," which is composed of hundreds of tanks. The characters assist in feeding its small residents. Similar to the educational book, the movie content is replete with valuable facts about zebrafish development and biology and depicts the genetic and anatomical similarities between humans and zebrafish.^{3,4} Moreover, the viewers are informed that science has no borders, and new discoveries result from the joint efforts of scientists around the world, who exchange information during seminars and conferences. The movie is available in both Polish and English and can be downloaded from the FishMed website (<http://fishmed.iimcb.gov.pl/eduen/>)² for free (Fig. 4). Moreover, to maximize its accessibility to a young audience, the movie was also placed on YouTube (Fig. 4).

Be Healthy as a Fish workshops

A typical workshop begins with presentation of the *Be Healthy as a Fish* movie.¹ The children are then shown two

tanks: a classic glass aquarium with gravel, plants, and other decorations and a bare plastic tank from the fish facility. Guided by the tutor, the children are asked to describe the differences between the two fish housing systems. The children then observe 1- to 2-day-old zebrafish embryos under a stereoscopic microscope (Fig. 5). Their attention is first focused on the embryos, where the yolk and various organs of the developing fish can be seen. The children are frequently fascinated by the beating heart of the little fish and movement of its eyes. The tutor then explains how zebrafish are fed in zebrafish facilities. Using a stereoscopic microscope, the children get the chance to observe live brine shrimp (*Artemia*) larvae and rotifers. Next, children are instructed about zebrafish embryogenesis, and pictures of different developmental stages are distributed among the children. They work in groups and are instructed to arrange the pictures in the

FIG. 4. The downloads statistics and views on YouTube. Color images available online at www.liebertpub.com/zeb

FIG. 5. The tutor showing embryos of zebrafish. Color images available online at www.liebertpub.com/zeb

correct order according to the developmental stage as described in the Zebrafish book.⁴ The next part of the workshop focuses on zebrafish as a model organism that is used at IIMCB. The children are asked to recall the reasons for choosing zebrafish as a model organism that were mentioned in the movie (e.g., genetic similarity to humans, embryo development in water, transparency of zebrafish at early stages of development, and fast growth). The similarities between humans and zebrafish are then discussed. The tutor explains that the simplest organisms are unicellular (e.g., bacteria, yeast, and paramecium), whereas complex multicellular organisms' cells are organized into organs. Children receive stencils in the shape of fish and humans with names of organs that are written on them (i.e., heart, brain, liver, kidney, stomach, gallbladder, intestine, lungs/gills, and spine).

In the last part of the classes, the children are divided into three groups that work in parallel. The first group is given a stencil of a fish and stickers that depict various organs with

the task of sticking them in the right places (Fig. 6). The second group completes a crossword puzzle to help them memorize the information that they learned in the workshop. The third group examines water properties by performing calorimetric tests and measuring the pH and hardness of tap water and aquarium water. For this purpose, they use commercial aquatic test kits (Fig. 7). These tests were chosen because they are relatively easy to use and yield colorful reactions. Water analyses are supervised by research technicians who take care of the zebrafish at IIMCB. Children are permitted to perform water tests themselves and have the opportunity to ask questions concerning zebrafish husbandry, fish biology, operation of the fish facility, and other issues. At the end of the workshop, the students are given the *Be Healthy as a Fish* book and a three-dimensional bookmark with an image of a zebrafish. They also have some spare time to take humorous pictures that show their faces in the body of a zebrafish or a shrimp (Fig. 8).

Conclusion

The *Be Healthy as a Fish* campaign was initiated by IIMCB in September 2014 during the Festival of Science. In the 2014/2015 school year, 90-min workshops were held, an average of three times per month. In the first semester of the 2015/2016 school year, the program is still being run, and the workshops are conducted twice per month. Information about booking a reservation is available on the IIMCB website (www.iimcb.gov.pl/) and FishMed project webpage (<http://fishmed.iimcb.gov.pl/>) and sent by the BioCEN to primary schools in the Mazowieckie voivodeship. All of the available dates were reserved on the first day of booking, clearly indicating that our educational program is highly interesting to both students and their teachers.

The *Be Healthy as a Fish* book was released in 2014 in two editions, and 2800 copies were printed. In only the first year of implementation of the zebrafish educational program, more than 1200 people received the book in Polish, and nearly

FIG. 6. The stencil of a fish. Color images available online at www.liebertpub.com/zeb

FIG. 7. Children performing calorimetric tests. Color images available online at www.liebertpub.com/zeb

700 people received it in English. Among other distribution outlets, the book was distributed during the regular workshops for school classes and among the participants of the “Heart of Europe: Zebrafish Meeting” (an international scientific conference that was organized by IIMCB in September 2014) and at the “Zebrafish in Teaching Workshop”

at the 9th European Zebrafish Meeting in Oslo in July 2015. We are also going to distribute the book among the participants of the International FishMed Conference on Zebrafish Research (FishMed2016), March 18–19, 2016, in Warsaw, Poland (<http://fishmed2016.pl/>).

FIG. 8. Pupils taking pictures as a zebrafish and a shrimp.

FIG. 9. The zebrafish picture – children’s artwork. Color images available online at www.liebertpub.com/zeb

After the class, the children are asked to indicate their favorite part of the workshop. They usually choose the water tests, followed by the microscopic observations. We also ask teachers to complete an evaluation questionnaire. As of October 31, 2015, 36 teachers evaluated particular elements of the classes. The teachers unanimously agreed that all core elements of the workshops are related to each other and show the importance of scientific work. They indicated conducting experiments and the possibility to observe zebrafish embryos under a stereoscopic microscope as two main advantages of the workshops. We also asked them whether the workshop is complementary to their school curriculum (34 answered with “yes,” and only 2 answered “I don’t know”). The teachers indicate that the consolidation and review of the new information help students retain the material and reinforce it. They also mentioned the good atmosphere that encourages children to try their best. One good indication of the beneficial effects of the classes is that many children later spontaneously send us pictures that are drawn at home or school (Fig. 9). The collection of this artwork indicates that the program is both educational and entertaining and leaves them with pleasant memories.

Professor Leonard Zon, one of the leading scientists in the zebrafish world, introduced zebrafish as a model of vertebrate development and disease. He once expressed the view that zebrafish research should be given “a more public face.”⁵ We are convinced that the *Be Healthy as a Fish* program, which has attracted much attention in Poland and abroad, will contribute to a better understanding of the importance of using zebrafish as a model of human diseases.

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Disclosure Statement

No competing financial interests exist.

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