

The Explorer's Guide to Biology: A Free Multimedia Educational Resource to Promote Deep Learning and Understanding of the Scientific Process

Noah H. Green,^a Mike Walter,^a and Brittany N. Anderton^a
^a*The Science Communication Lab, Berkeley, California, USA*

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INTRODUCTION

Traditional teaching resources in the life sciences (such as textbooks) often present science as a series of known facts that are there to be memorized instead of a process to be uncovered and pondered. In addition, these traditional teaching resources are often expensive and not readily available to all learners. As a result of the structure of many of these traditional teaching resources, educators often need to do additional work to make the content more engaging and accessible for learners. In addition, the Vision and Change movement (1) has stressed the importance of teaching biology in a manner that integrates core concepts and competencies throughout the curriculum as well as emphasizing competencies that center around the process of science rather than just scientific knowledge. We are addressing the above points by creating a free, online, multimedia educational resource for introductory biology called [The Explorer's Guide to Biology](#) that presents the same knowledge that would be covered in a traditional teaching resource but in the context of stories of discovery. Teaching science through storytelling promotes motivation and engagement, and storytelling can also help broader audiences understand how science works and how it is relevant to their own lives (2–7). In addition, understanding the scientific process (also known as scientific literacy) is regarded by many education experts to be as important to success in science education as learning science facts (8). Finally, there is evidence suggesting that a multimedia approach to science teaching and learning promotes a deeper understanding of scientific knowledge and can reduce knowledge gaps between non-

experts with higher and lower levels of formal education (9, 10). The Explorer's Guide to Biology brings storytelling, multimedia and an accurate view of the process of science together to create a resource that provides an intellectual framework for the knowledge presented. By offering [The Explorer's Guide to Biology](#) online for free, educators and learners from around the world will benefit from this unique resource.

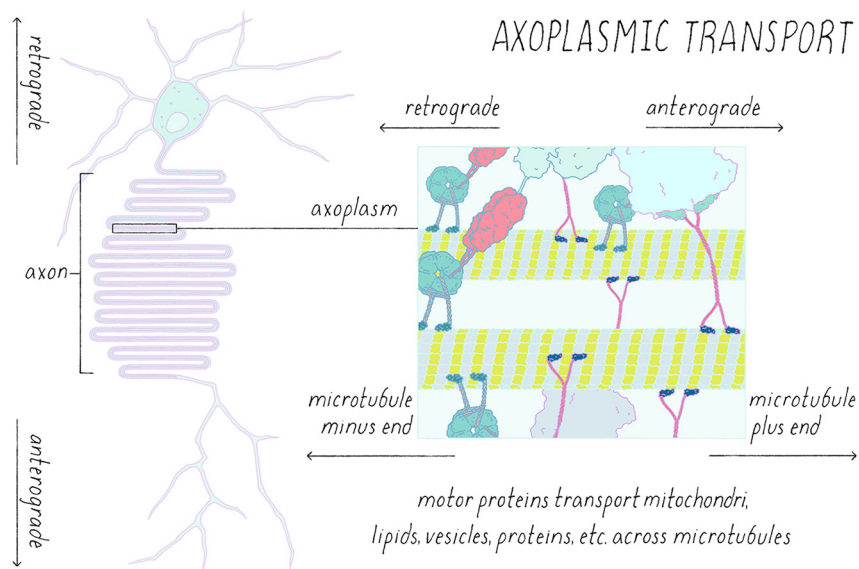
PROCEDURE

The primary audience of [The Explorer's Guide to Biology](#) is high school seniors, undergraduate students, and their educators. However, this resource is available to any curious individual who wishes to explore biology. We have two main types of content pieces: Narratives and Key Experiments. Narratives are ~10,000 words in length and cover major topics in biology. Narratives walk learners through a classic experiment(s) in the field in the “Journey to Discovery” section, utilize this experiment as a framework to provide learners with key information associated with the topic in the “Knowledge Overview” section and convey exciting advances at the leading edge of the topic in the “Frontiers” section. Key Experiments are ~3,500 words in length and tell the story of a single influential experiment, typically from the perspective of the scientist(s) involved. Narratives are designed to be covered over two to three class periods and Key Experiments over one to two class periods. For a full list of current Narratives and Key Experiments see Appendix I. Each Narrative and Key Experiment includes the following resources in addition to instructional text:

- **The Bio-Dictionary:** a visual glossary with original illustrations that explain unfamiliar terms (Fig. 1).
- **Explorer's Questions:** questions interspersed throughout the text to help engage learners in active and critical problem-solving.
- **Dig Deeper Sections:** supplemental information that takes learners beyond what is essential to understand the main points of the piece.
- **Guided Papers:** annotated versions of a key paper central to the content piece that help learners read and analyze a scientific paper.

Address correspondence to The Science Communication Lab, Berkeley, California, USA. E-mail: mike@scicommlab.org. The authors declare a conflict of interest. Noah H. Green, Mike Walter, and Brittany N. Anderton are employees of the Science Communication Lab (SCL), which is the parent organization of [The Explorer's Guide to Biology](#). The SCL is a non-profit, open-access science education and filmmaking organization. For more details, visit scicommlab.org. Received: 30 September 2021, Accepted: 31 December 2021, Published: 28 March 2022

Axoplasmic Transport



A cellular process responsible for the movement of mitochondria, lipids, synaptic vesicles, and proteins to and from a neuron's cell body through the cytoplasm of its axon.

FIG 1. Example image and definition from our Bio-Dictionary for the term “Axoplasmic Transport” from the Motility in a Test Tube Key Experiment by Ron Vale.

- **Videos:** short videos accompany each content piece to help explain and expand on concepts and experiments.
- **Practice Questions:** assessments designed to help learners assess their knowledge at the end of the content piece.

The above resources provide educators with multiple modalities to accomplish their teaching goals. Similarly, these resources allow learners to personalize their experience with a suite of audiovisual materials. We recommend that these resources be used in a flipped or blended strategy in which learners engage with the materials outside of class and then educators use class time to discuss or implement active learning activities to reinforce the main concepts. Suggested discussion questions and active learning exercises can be found in our educator materials for each content piece, discussed further in Appendix 2 and on our [educator resources page](#).

As an example, educators teaching the concept of mutation can use a story of interest to many learners, such as our “[CRISPR-Cas9 A New Tool for Genome Editing](#)” piece by Dr. Jennifer Doudna and colleagues. In this Key Experiment, Dr. Doudna discusses her thought processes and experiments that led to the ability to adapt the CRISPR-Cas system to edit the DNA of any organism. In the context of these experiments, she discusses how mutations can occur naturally as well as how they

can be corrected using the CRISPR-Cas system along with concepts related to mutation such as transcription, coding RNA, non-coding RNA, and others. Learners can engage with this material in one to two homework assignments. During class, educators can then utilize our educator assessment questions for small group or whole-class discussions. Alternatively, during class, educators can have learners engage in one of our suggested active learning activities associated with this content piece. All of our materials are designed in a modular fashion so that educators can pick and choose materials that will best fit their goals.

SAFETY ISSUES

No biological or chemical safety concerns are associated with the use of this online resource.

CONCLUSION

Preliminary surveys of educators familiar with The Explorer’s Guide to Biology suggest that the majority of educators in our online community have already used our

resources or plan to in the future, and those who have used it find it useful. Similarly, we found that educators who are familiar with this resource are very likely to recommend it to other educators.

Our preliminary surveys with learners suggest that the majority of students find our resources “interesting” or “very interesting.” In addition, the majority of learners classified the following resource features as “important” or “very important” to them: explanation of experiments, data and evidence; free of charge or no paywall; online platform; an emphasis on conveying the process of science.

Taken together, our evaluations suggest that learners find the content of The Explorer's Guide to Biology engaging and its features to be valuable. We are continually working to improve this resource, including by broadening the representation of the scientists featured in our pieces, so if you have suggestions for new content or perspectives, or would like to help us test our materials in your classroom, please contact us: admin@explorebiology.org.

SUPPLEMENTAL MATERIAL

Supplemental material is available online only.

SUPPLEMENTAL FILE 1, DOCX file, 0.02 MB.

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