

# A Multimedia Active Learning Approach to Introducing Human Parasitic Diseases in an Undergraduate Parasitology Course†

Carissa N. Ganong

Department of Biology, Missouri Western State University, St. Joseph, MO 64507

## INTRODUCTION

Student learning in undergraduate science courses is well known to benefit from the use of active learning methods (1, 2) and the incorporation of multimedia techniques (3–5). Here, I describe a multifaceted, multimedia teaching technique that familiarizes students with key aspects of major human parasitic diseases while also giving the students opportunities to increase their (i) ability to read and analyze primary literature, (ii) oral presentation skills and ability to articulate and discuss scientific concepts, (iii) laboratory skills in microscopy and organism identification, and (iv) cultural awareness.

I teach an upper-division undergraduate course in Medical Parasitology that typically enrolls 15 to 20 students majoring in zoology, health science, or general biology. While this course is relatively small and specialized, the teaching approach described here could be easily used or adapted for most courses that involve eukaryotic parasites, including lecture-only courses. Each “Parasite of the Week” module is essentially stand-alone and could be used in less specialized courses that feature an in-depth look at only one or a few parasites.

## PROCEDURE

The course meets for three 50-minute lecture periods and one 110-minute lab period per week. For 10 weeks of the course, 1.5 of the lecture classes per week are spent covering material from a general parasitology textbook in an interactive lecture style. These lectures involve the use of low-text PowerPoint (Microsoft) slides focused on interpreting diagrams and figures that illustrate key concepts. The remaining 1.5 classes each week focus on a major eukaryotic

parasitic disease of humans (full list in Table 1). The “Parasite of the Week” is introduced in five steps during two consecutive classes and the following lab period.

### Step 1. Introductory lecture

In the first class, students are presented with basic information on the parasite, including the disease agent, life cycle, and a brief overview of pathology, diagnosis, and treatment, in a concise (20- to 25-minute) lecture with accompanying PowerPoint slides. This provides students with the background knowledge needed to complete step 2.

### Step 2. Reading and summarizing primary literature

Prior to the second class, students are expected to read a peer-reviewed journal article, which is posted ahead of time on the course’s Canvas website and involves the parasite in question. The articles are chosen because they provide succinct explorations, understandable at the undergraduate level, of a range of selected concepts while also introducing students to different types of articles and publication styles (Table 1). Some articles involve practical applications of a combination of medical and ecological concepts, such as the use of biological control agents to prevent schistosome transmission (6) and examination of the role of competitive exclusion in human filarial worm infection (7). Other articles are less recent but well known in the field, such as the highly cited paper describing *Toxoplasma*-infected rats’ “fatal attraction” to cat odor (8), or they provide straightforward examples of key concepts, such as vector-parasite mutualisms (9). After reading the article, students electronically submit a one-paragraph summary and two discussion questions. These must be thought-provoking original questions that could be conducive to a class discussion. Students receive 6 points for each complete online submission, including 4 points for an adequate summary that covers the article’s key points in the student’s own words and 2 points for discussion questions. The course includes a total of >1,000 points, so each assignment has a minor effect on the student’s overall grade but helps to ensure that students are completing the reading assignment and engaging with the material.

Mailing address: Department of Biology, Missouri Western State University, 4525 Downs Dr., St. Joseph, MO 64507. Phone: 816-271-4520. E-mail: [cganong@missouriwestern.edu](mailto:cganong@missouriwestern.edu).

Received: 4 June 2020, Accepted: 21 December 2020, Published: 29 January 2021

†Supplemental materials available at <http://asmscience.org/jmbe>

TABLE I.  
Discussion articles and films used to introduce major human parasitic diseases.

| Parasitic Disease                | Discussion Article                | Key Concept of Discussion   | Film <sup>a</sup>  |
|----------------------------------|-----------------------------------|---|--|
| Malaria                          | Rossignol <i>et al.</i> 1985 (9)  | Role of vector-parasite mutualisms in disease transmission                  | BBC's "Malaria: Kill or Cure, Series 1"  |
| Trypanosomiasis (Chagas disease) | Coura & Viñas 2010 (10)           | Global spread of a "tropical" disease                                       | BBC's "Chagas disease: Kill or Cure, Series 2"   |
| Leishmaniasis                    | Coleman <i>et al.</i> 2015 (11)   | Importance of quantifying success of vector control programs                | BBC's "Kala-azar: Kill or Cure, Series 1"  |
| Toxoplasmosis                    | Berdoy <i>et al.</i> 2000 (8)     | Parasites' ability to manipulate host behavior                              | TED talk by Ed Yong: "Suicidal wasps, zombie roaches and other parasite tales" <sup>b</sup>        |
| Schistosomiasis                  | Sokolow <i>et al.</i> 2015 (6)    | Use of native species for biological control of vectors/parasites           | BBC's "Bilharzia: Kill or Cure, Series 1"  |
| Tapeworm infestation             | Hegglin <i>et al.</i> 2015 (12)   | Effects of human-wildlife interactions in disease transmission              | Segments 2, 3, 9, 12, 17, and 18 from BBC's 2014 film "Infested!: Living with Parasites"           |
| Lymphatic filariasis             | Molyneux <i>et al.</i> 2014 (7)   | Role of competitive exclusion in determining parasite location within hosts | BBC's "Lymphatic Filariasis: Kill or Cure, Series 1"   |
| River blindness                  | Basáñez <i>et al.</i> 2006 (13)   | Importance of coordinated disease control strategies                        | BBC's "River Blindness: Kill or Cure, Series 2"  |
| Guinea worm disease              | Molyneux <i>et al.</i> 2017 (14)  | Role of reservoir hosts in human disease                                    | American Museum of Natural History "Science Bulletins: Guinea worm—Countdown to Zero" <sup>c</sup> |
| Geohelminth infection            | Weinstock <i>et al.</i> 2012 (15) | Beneficial uses of parasites (helminth therapy)                             | BBC's "Hookworms: Kill or Cure, Series 2"  |

<sup>a</sup> BBC films are available from the Films on Demand database.

<sup>b</sup> The film on parasite manipulation of host behavior is available at <https://www.youtube.com/watch?v=CfqOIU6lfDs&t=198s>.

<sup>c</sup> The film on Guinea worm disease is available at <https://www.youtube.com/watch?v=HCG0YxO5sjw>.

### Step 3. Films

The first half of the second class involves watching one of the short films listed in Table I; two of these films are freely available online, and most are from the BBC "Kill or Cure" series, a collection of ~25-minute films that follow medical personnel treating a specific parasitic disease in the field and explore the development of a candidate drug to treat that disease. This film series is available through a subscription to the Films on Demand database. The films reinforce previously presented information about the parasite's biology and also give students the chance to see (i) effects of the disease on patients' everyday lives, (ii) conditions that healthcare providers face in the field, often in less-developed countries, (iii) stages in the drug development process, and (iv) impacts of the disease in global health policies and economy. In addition, the films allow students an often eye-opening glimpse of day-to-day life and culture in countries around the world—including Tanzania, Bolivia, and Vietnam—that students from this institution rarely have the chance to visit in person. The "Kill or Cure" films were produced in 2004–2005, and while a 15- to 16-year time gap may initially seem like a disadvantage, basic factual information about each disease has changed very little and

the time gap provides an opportunity for the class to explore the development of each drug since filming.

### Step 4. Class discussion and article analysis

The second half of the second class consists of a group discussion of the article, co-led by two students who prepare a question-oriented PowerPoint discussion guide with questions focused on the paper's objectives, experimental design and key methods, interpretation of figures and tables, and the "take-home message." The leaders guide and moderate the discussion of their prepared questions and then provide the opportunity for other students to voice their own questions about the article or film. This part of the discussion frequently includes questions involving cultural, sociopolitical, and economic ramifications of the disease, and often discussion turns to differences between students' lifestyles and those of the people shown in the film, for example, the lack of commodities that most North Americans take for granted (healthcare infrastructure, sanitation systems, potable water) and differences in societal organization (e.g., tribal elders and priests guiding healthcare decisions for their villages).

While 25 minutes is a short amount of time for a discussion, the restricted time period forces students to focus on identifying and articulating the key points of the paper, while also noting any points of confusion or unclear details. Students receive 4 points for participating in each discussion by answering or raising a question or offering a substantive comment (i.e., not a simple “yes/no” answer). This has a minor impact on overall grades but encourages class participation, and most students choose to participate, sometimes by simply asking the discussion questions that they have already submitted (see step 2). Discussion leaders each receive 50 points due to the time and effort required to prepare well for the discussion. Leaders often read additional background information on the topic so that they are better prepared to address class questions.

This approach could also be adapted for large classes by forming smaller breakout groups for a targeted discussion. For example, the instructor could select a few student questions from the online submissions (see step 2) before class (perhaps with an additional assigned question that incorporates information from the video), give groups time to discuss those questions in class, and then regroup the class to compare answers.

### **Step 6. Microscopy and lab skills**

The first lab period of the semester is devoted to a review of basic microscopy techniques, including oil immersion and use and calibration of an ocular micrometer; prerequisites for this class include courses with heavy microscope use, e.g., cell biology, and so student familiarity with microscope use is assumed. In each subsequent lab period, the class briefly reviews the life cycle of the parasite discussed in the previous two lecture periods, and the students then examine and sketch some or all of the life stages of that parasite, honing their skills in microscopy, parasite identification, and creation of formal scaled drawings (see the supplemental material). These drawings, along with brief descriptions of each morphological characteristic and clinical symptoms and diagnostic techniques, form a lab notebook that is used to study for lab practicals. Parasites are examined on prepared slides except during the final lab, in which students follow a fecal flotation procedure to isolate helminth eggs from wildlife feces. Safety protocols include wearing gloves throughout the procedure and disposing of equipment and fecal samples in a biohazard bin.

### **CONCLUSION**

Student feedback on the course was collected from written comments on regular end-of-semester evaluations. Student responses to this specific teaching method have been generally positive, and different aspects of this approach strike a chord with different students (Table 2). The combination of traditional lecture, critical reading and

**TABLE 2.**  
Representative student feedback on this technique of introducing parasites.

|   |
|---|
| “Parasite of the Week is cool because [it allows] learning new parasites in-depth.”                 |
| “I like the real-world looks into parasites each week.”   |
| “I like [how this brings] attention to world issues, mainly through reading the papers and videos.” |
| “Videos used in class help information stick.”  |
| “I like the video/discussion combo.”  |
| “Parasite of the Week is a good way to learn more and discuss.”                                     |
| “I like that we can help lead the course as then we feel we are more a part of it.”                 |
| “...good job of [going] through multiple parasites while not overwhelming [the class].”             |
| “I like how labs reinforce lecture material.”   |

analysis of primary literature, films, oral presentations, and student-led class discussions, together with hands-on lab work, provides an effective method of introducing students to key parasitic diseases, as well as to broader themes in fields ranging from public health to ecology to interactions between science and culture.

### **SUPPLEMENTAL MATERIALS**

Appendix I: Example of a student diagram

### **ACKNOWLEDGMENT**

The author has no conflicts of interest to declare.

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