The Course “Microbes and You”:
A Concrete Example that Addresses the Urgent Need for Microbiology Literacy in Society†

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INTRODUCTION

An editorial entitled “The urgent need for microbiology literacy in society,” published in April 2019 in Environmental Microbiology, argued that microbiology literacy needs to become “part of the world citizen job description,” considering the major impacts that microorganisms have on our daily lives and health. To attain this goal, microbiology should be incorporated into education curricula in formats that are adapted to various types of learners (1). We wholeheartedly agree with this philosophy, and in fact, 4 years ago, we created a complete course that invites the entire student body of our university to discover microbes. Reliable, engaging, and accessible education in microbiology to non-microbiology students is needed now more than ever, as demonstrated by public reactions during the COVID-19 crisis, false news, and misinformation circulating on social networks.

PROCEDURE

Many microbiologists, a science journalist, and two nonscientific beta testers participated in the development of this course, which we called “Microbes and You.” The main objective of this new course, offered only in French for the time being, is to allow students to discover the fundamental roles of microorganisms on Earth and their impacts, both positive and negative, on us and our health. We wanted to show that microbes (bacteria, fungi, viruses, etc.) are ubiquitous and that they have a great capacity to adapt, being found everywhere, including in and on us. We also wanted to show that microorganisms are essential to life as we know it, and that if they were to disappear, humans would not survive either. Most students are only aware of the negative impacts of microorganisms on our health. This course teaches them that our relationship with microbes is full of paradoxes. Some microorganisms can cause illnesses, which worries people, but other microorganisms are essential to good health. Microorganisms are essential to food production (bread, cheese, wine, beer, etc.), but can also spoil food. People are better able to make intelligent decisions when they have a deeper and more nuanced understanding of microbiology rather than the simplified and often misleading viewpoints spread by the press.

The course was designed with the goal of educating as many people as possible to help form a society that is better able to act and make choices regarding health, nutrition and the environment. It also seemed essential for us to make students aware of up-to-date knowledge on social issues such as antibiotic resistance and vaccination so students can share this knowledge and possibly enact change. We were able to be flexible and responsive with the content of this course to tailor it to student interests. During the COVID-19 pandemic, we improved the course content to discuss this pandemic with our students and to provide them with reliable, true scientific information.

Regardless of their field of study, this course is a fun way for students to discover the world of microbes. It is designed to be fully accessible online (including the content, teacher interaction, and assessments). The course is divided into 11 modules, each containing several sources of information, as shown in Table 1. An online forum for each module includes participation questions, such as: “Could Earth’s original microorganisms develop on Mars?” To complement the whole, we produced our own fun and informative illustra-
TABLE 1. Course content.

| Module | Subject\(^{a}\) | Content | Evaluation (all online)\(^{b}\) | Participation Questions\(^{c}\) |
|--------|----------------|---------|-------------------------------|-------------------------------|
|        |                 | No. of Pages of Reading | Narrated PowerPoint Video (duration in minutes) | Expert Interview Videos (duration in minutes) |                               |
| 1      | Microbiology history | 19 | 15:51 | No | 3% | No |
| 2      | Basic knowledge in life sciences | 18 | 5:05 | No | 5% | Answer at least 1 of the 3 questions asked for this block of three modules |
| 3      | Diversity and ubiquity of microbial life\(^{a}\) | 26 | 14:21 | Steve Charette, bacteria-protozoa interactions (5:37); Daniel Grenier, oral microbial ecology (8:34) | 10% | |
| 4      | Classical and molecular analytical methods | 21 | 17:48 + 6:29 | Steve Labrie, cheese production (3:32) | 8% | |
| 5      | Roles of microorganisms | 17 | 9:00 | Linda Saucier, meat preservation (8:37) | 10% | Answer at least 1 of the 3 questions asked for this block of three modules |
| 6      | The origin of life on Earth | 16 | 6:54 | No | 9% | Answer at least 1 of the 3 questions asked for this block of three modules |
| 7      | Domestic microbiota | 20 | 16:25 | No | 9% | |
| 8      | Infectious microorganisms\(^{a}\) | 33 | 12:00 + 7:47 + 7:03 | Caroline Duchaine, bioaerosols (8:07); Gary Kobinger, Ebola virus (7:40) | 10% | Answer at least 1 of the 3 questions asked for this block of three modules |
| 9      | Control of microorganisms | 19 | 26:43 | Sylvain Moineau, bacteriophages (4:41) | 10% | |
| 10     | Biofilms | 16 | 6:12 | No | 10% | |
| 11     | Intestinal microbiota\(^{a}\) | 23 | 21:34 + 25:04 | No | 10% | Yes |

\(^{a}\) Modules last 1 week with the exception of three modules that last 2 weeks (indicated by an asterisk next to the module name).

\(^{b}\) Evaluations are online questionnaires including multiple-choice questions, true-or-false questions, and matching questions. An example is provided in the supplemental material.

\(^{c}\) Answers to participation questions represent 6% of the final grade.

... and the great diversity of microorganisms and the great diversity of microorganisms forming the microbiota in homes. 2) A review of the scientific methodology used to study domestic microbiota to determine their origin and composition (referring to earlier modules, in which molecular methods are described in more detail). 3) How domestic microbiota can serve as a signature of the inhabitants (humans or animals) of the home, or of different...
FIGURE 1. One of the images used to illustrate the course “Microbes and You.”

FIGURE 2. A screenshot of the narrated PowerPoint console. The students listen to an audio clip with each slide. Some images include animations. The students can navigate in the narrated PowerPoint at their leisure by using the Menu to go to the desired slide or by clicking PRÉC (back) and SUIVANT (next) buttons. The tab Commentaires (comments) includes printed text of the audio clips.
areas in a house, as they harbor different populations of microorganisms. 4) Consequences, both positive and negative, on the home inhabitants of the presence of so many microorganisms in their daily environment. 5) Two concrete examples of the importance of domestic microbiota: a) the deleterious effect of the massive use of antimicrobial products on the domestic microbiota’s diversity and richness, and the negative effects of this decline on our health (the hygiene hypothesis), and b) the drastic effects of water damage in homes, detailing the changes in domestic microbiota and the potential impacts on the home inhabitants’ health.

We have translated a sample of the course materials into English: Module 10, Biofilms. This sample, available as a supplemental file, is accompanied by a compilation of the slides used to make the narrated video and a sample of evaluation and participation questions. This supplemental file also presents the list of questions asked to two of the six experts participating in the course.

The course has now been offered every semester since winter 2018. We promoted the course through social networks and a video on YouTube (https://www.youtube.com/watch?v=3pQnQnpqMKw; the video and the course are in French). The response from students has been remarkable. We began with 34 students registered in the first semester and have so far reached over 2,000 students from almost 70 different programs spread across fields as diverse as pharmacy, law, psychology, engineering, music, philosophy, and many more.

Each semester, student feedback has been extremely positive. Students specifically mention that it has helped them to better understand important social issues such as vaccination, antibiotic resistance, and the role of microorganisms in the development and cure of several diseases, as well as practical aspects of their lives, such as hygiene and food preparation, and grasp the impact of gut microbiota on their mood. Health students (about 35% of students enrolled) learn through this course that microbiology is not just the study of infectious microorganisms, whereas the perception of students from nonbiological programs is more general, allowing, as one student put it, “a better understanding of the microbial world and even a modulation of the often negative perception of microorganisms.” Future workers in a variety of fields get significantly interested and eager to learn more about microbiology and the impact of microbes on their own lives.

CONCLUSION

With this article, we wanted to share our experience about the extremely positive response of students to this course content. We hope that the need for microbiology literacy in society will continue to be addressed and that other microbiologists will be encouraged to teach similar courses. Since our course is in French, we hope similar initiatives will be undertaken by colleagues in other languages to set up basic courses in microbiology for non-scientists, or for scientists who lack basic knowledge in this particular science. We believe that this is a win-win situation: students learn and understand the importance of microbiology in their daily lives while being able to better understand some of the big issues related to microbiology. They then become vectors for the transmission of this information, which will cause a positive change in human behavior and decision-making over time. What we learned from the student reaction is that microbiology knowledge needs greater visibility and understanding in our society.

SUPPLEMENTAL MATERIALS

Appendix 1: Reading assignment for Module 10: Biofilms
Appendix 2: Slides for Module 10: Biofilms
Appendix 3: Sample of evaluation questions for Module 10: Biofilms
Appendix 4: Sample of participation questions in the course’s forum for Module 10: Biofilms
Appendix 5: Sample interview questions for experts from Modules 8 and 9

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