

CASE TEACHING NOTES

for

“MDR Tuberculosis: A Case Study for Non-Science Majors Focused on Social Justice”

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INTRODUCTION / BACKGROUND

Portions of this case have been used in a variety of courses that span the undergraduate and graduate level curriculum. Depending on the student background and course goals, I have emphasized either the science or social issues underlying multi-drug resistance tuberculosis (MDR TB). Instructors of courses in genetics or evolution could use the case as a stepping stone for conversations about mutation, natural selection, and evolution. For instructors teaching a first year seminar course or a general education course, the case lends itself to different levels of scientific analysis, and demonstrates that science and social justice can be intimately intertwined. Instructors teaching infectious diseases might focus on Part III, which highlights the immune response to TB infection and how this information is used to develop diagnostic screening protocols. Public health instructors can focus on Part II to demonstrate the move to view health as a human right and complement the case with material referring to the Doha Declaration (see http://www.wto.org/English/thewto_e/minist_e/mino1_e/mindecl_e.htm) and the provisions of the World Trade Organization Agreement as they affect the distribution of essential medicines.

Objectives

- Understand how genetic variation arises through random changes (mutation) and recombination.
- Explain the role that environmental conditions can play in the overall frequency of mutations in a population.
- Explain temporal relationships among genetic variation, environmental change, natural selection, and evolution/adaptation.
- Recognize that there are some instances in which these *temporal* relationships are slightly modified by environments capable of inducing the *rate* of random change.
- Recognize that populations, not individuals, evolve.
- Make connections between immune responses and the development of vaccines and diagnostics for disease.
- Describe how political and social factors can influence people’s rights in the context of public health.
- Appreciate the relevance that evolution has on everyday life.

CLASSROOM MANAGEMENT

The entire case encourages a constructivist approach to interdisciplinary learning and follows the principles of the learning cycle: The videos and storyline in Part I engage students, introduce them to the players, outline the problem, and provide students with resources for learning the science behind MDR TB. Part II has additional readings that ask students to explore alternative viewpoints about how best to handle the challenges that accompany new immigration policies and provides them with the opportunity to explain via a debate or discussion the impact that this might have on public health. Part III asks students to extend their

knowledge to evaluate and improve on some of the strategies being employed to prevent the development of MDR TB.

The organization of the case allows for flexibility in the way in which it is taught, and the parts could be used alone or in combination. They could also be dispersed throughout the course, building a theme that is revisited every three to four weeks. The parts build in complexity and difficulty, but again the level of detail and depth of discussion can be determined ahead of time by the instructor. If the case serves as a “teaser” for lectures on specific scientific topics, no additional reading may need to be assigned, as a good deal of content is contained in the storyline and students could be asked to conduct research to address the questions. All of the texts in the reading lists are freely available on the Internet, so if students are to answer the questions at the end of each part, a selection from the reading list should be assigned.

It should be noted that in some cases students may not be able to answer all the questions. In these instances, the questions can serve as “appetizers” that create the desire and need to conduct more research and reading. Such examples are questions 9 and 10 in Part I that can be addressed more fully as students read through Parts II and III. Part III is the most advanced, and should only be used in courses where students have some background in immunology and molecular techniques like the enzyme-linked immunoabsorbant assay.

The reference to the QFT pamphlet in the reading list is most helpful for stressing the scientific method (sample collection, positive and negative controls, standard curve, etc). The animation reviewing the ELISA cytokine assay is important as most reviews or animations focus on the detection of antibody, but for TB tests the focus is on detection of antigen (cytokine) in the patient sample, and this difference should be highlighted.

The most difficult concepts for students with little background in biology to master are that proteins dictate cell behaviors and that mutations can alter those behaviors. For students with a biology background, the most difficult concepts to grasp often surface when they realize that mutations may not be random and that environmental conditions can alter the spontaneous mutation rate. If students seem to be struggling to give up old ideas, spend some time on these concepts before moving forward.

Advanced Level Students

For more advanced level genetics, infectious diseases, evolution, or capstone courses instructors may choose to have students read all three parts, but only address some or all of the questions in Part III. These questions require students to synthesize information to make informed decisions and are rather sophisticated, and they do presuppose that students have some background on tuberculosis disease. Completion can take the form of submitted answers or in-class/online discussion.

Small Non-Majors Classes

For small-sized classes the instructor may choose to take a more inquiry centered approach and refrain from handing out the story about Aisha and Dr. Sanjari. Rather, students would view three video clips, engage in discussion, and construct their own knowledge of MDR TB. Since the videos highlight the individuals and the impact that MDR TB has on them, students can immediately see the relevance that this phenomenon has on their daily activities.

I suggest that in this context you begin by showing the PBS “Evolution” clips depicting a Russian prison and the “Rx for Survival” clip depicting DOTS-Plus in Peru, which will serve to impress upon students the international scope of the issue. Ending with the video clips and testimonials of “Debi French” brings the

topic home and allows students to make the transition to the discussion of the immigration bill that can be introduced via the short news article from the Associated Press listed in Part II.

Interdisciplinary First Year or Capstone Courses

Alternatively, in a first year seminar course, general education course, or capstone seminar, the case could be introduced midway or towards the end of the course via an interrupted format that would span three days. For each day, students would complete a selection of reading listed for each part and review the questions. During the first few minutes of class they would discuss their answers in pairs or small groups. Then each group would be responsible for leading a discussion on one of the questions with the larger class.

Part II could take the form of a debate where one half of the class supports the views represented in the editorial by Cosman (“Illegal aliens and American medicine.” *Journal of American Physicians and Surgeons* 10(1):6–10) and the other refutes it. Part II could also be supplemented with additional reading from Tracy Kidder’s most recent book titled *Mountains Beyond Mountains* (Random House, 2004), which reviews Paul Farmer’s personality and work, or *Pathologies of Power: Health, Human Rights, and the New War on the Poor* (University of California Press, 2003) by Farmer himself, or *Timebomb: The Global Epidemic of Multi-Drug-Resistant Tuberculosis* (McGraw-Hill, 2002) by Lee B. Reichman and Janice Hopkins Tanne. The debate could take the form of a written dialogue between Cosman and Farmer. Having students construct a conversation using their own language can prove insightful for the instructor.

Large Lecture Style Course

For larger courses, many of the questions could be restructured to be multiple choice. Using a personal response system (“clickers”), instructors could get immediate feedback on students’ misconceptions, comprehension, and ability to apply what they have learned to real-world problems in the lecture hall. Alternatively a think-pair-share model could be used and a few answers solicited from the class. Think-pair-share is a simple technique by which an instructor poses a question for the whole class to consider. Students are given a set amount of time to think of their own answer to the question, then told to work with one another, usually in pairs, to reach consensus on an answer to the question. In the final step, answers are shared with the class as a whole.

The video clips are freely available on the Internet and are rather short, so they could be used at the start of a lecture on mutation, evolution, infectious diseases, or microbiology to provide social context for the standard lecture.

Lab Demonstrations and Activities

A lab component could be added to more traditional science courses that allow students to mutagenize bacteria and select for resistance on agar supplemented with antibiotic. Alternatively, for non-majors courses, students could take swabs of a variety of objects or surfaces and streak this on agar with no antibiotic and replicate plate on plates containing different antibiotics. When I employed this activity in a non-majors course, the students became very engaged and were surprised to learn that the most contaminated surface on campus was on the vending machine and that luckily the bacteria were not drug resistant. I also used the Kirby Bauer disks to demonstrate zone of inhibition assays. The students decided to soak disks in commonly used hand sanitizers and compare them to disks soaked in oil, alcohol of various percentages, detergent, and “environmentally friendly” cleansers. Student may also become interested in soaking disks in plant extracts, allowing instructors to revisit the natural phenomenon of host-pathogen dynamics. Other experiments or simulations might be focused on the immunological perspective and employ the ELISA test; kits can be purchased or homemade

BLOCKS OF ANALYSIS

The theme of this case is the development of multi-drug resistant TB (MDR TB). Within this theme, two major lines of inquiry can be explored: the scientific principles underlying the evolution of drug resistance; and the social factors that contribute to the rise of drug resistant TB. A detailed analysis of these different lines of inquiry along with complete references is provided in a separate file—see below for details.

Detailed case analysis is provided in a separate file that is password-protected. To access this information, go to the [detailed case analysis](#). You will be prompted for a username and password. If you have not yet registered with us, you can see whether you are eligible for an account by reviewing our [password policy and then apply online](#) or write to answerkey@sciencecases.org.

ANSWER KEY

Answers to the questions posed in the case study are provided in a separate answer key to the case. Those answers are password-protected. To access the answers for this case, go to [the key](#). You will be prompted for a username and password. If you have not yet registered with us, you can see whether you are eligible for an account by reviewing our [password policy and then apply online](#) or write to answerkey@sciencecases.org.

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