Solve MEDICAL MYSTERIES

by Leslie Miller

Wondering how to make the study of the immune system and infectious agents more relevant to your students' lives? The online adventure series, MedMyst (*http://medmsyt.rice.edu*), can provide the context and motivation. The adventure begins with this problem:

It is the year 2254, 12 years after the end of the Great Plague that ran through the Earth's population killing millions and causing the collapse of civilization. An elite team called the Reconstructors is charged with preventing the spread of infectious diseases that still plague the Earth and its population. You have been chosen as a new recruit to solve these medical mysteries. Are you ready for action?

The premise of the adventure is that the player must reconstruct medical knowledge in order to stop the occurrence of an infectious disease. Each mission contains simulated experiments, microscope slides of infectious agents, science-based games, and internal quizzes.

The series combines the drama of television's *CSI* episodes with science to address several of the National Science Education Content Standards. This free teaching tool incorporates online games with classroom activities for middle school students. The series was designed with input from 11–13 year olds (Miller 2000). The characters, the storylines, and the animations have been tested with middle school students.

The Medical Mysteries project has been developed with both home and school internet access in mind. Even with a dial-up connection, it only takes about five minutes to download a single mission. The files are also available on CD and can be sent to teachers, if requested, by e-mailing the author at *medmyst@rice.edu*.

The learning objectives for Medical Mysteries focus on the following Science Content Standards:

- Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for investigations, or develop new technologies to improve the collection of data.
- Specialized cells perform specialized functions in multicellular organisms.
- Disease is a breakdown in structures of functions of an organism. Some diseases are the result of intrinsic failures of the system. Others are the result of damage by infection by other organisms.
- The human organism has systems for digestion, respiration, reproduction, circulation, excretion, movement, control and coordination, and protection from disease.
- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models.
- Tracing the history of science can show how difficult it was for scientific innovators to break through the accepted ideas of their time to reach the conclusions that we currently have today.

FIGURE 1 Summaries of the four MedMyst missions

Mission 1: Orientation at O.R.B.
It is the year 2254 and there has been a Great Plague. The Reconstructors are recruiting for the Neuropolis Center for Disease Control. Students are required to pass five challenges. The challenges provide information about pathogens and the diseases they cause, the treatment of infectious disease, the methods infectious agents use to spread, the body's defense from these diseases, and the steps involved in linking a pathogen to a specific infectious disease.

Mission 2: Peril in Prokaryon
There has been an earthquake and survivors have been pouring into the province of Prokaryon, where an outbreak of diarrheal disease has occurred. Students must interpret epidemiological graphs and charts to uncover the cause of the mysterious outbreak. They are also familiarized with the different types of bacteria through a bacteria sorting game (Figure 3), and learn the roles of Robert Koch, Joseph Lister, and Louis Pasteur in the evolution of germ theory.

Mission 3: Nemesis in Neuropolis
A boy is admitted to the Neuropolis Hospital with what appears to be smallpox. The city is in a panic with the possibility of the spread of this disease that had long since been eradicated from the Earth. Students must track down the cause of the disease and confirm whether it is indeed a re-emergence of smallpox.

Mission 4: Malady at Mabuufo
An outbreak of malaria summons the Reconstructors to Mabuufo, where the mosquitoes may not be the only threat. Students replicate landmark experiments in malarial research, then study the life cycle of the mosquito and the plasmodia that cause malaria. Lastly, students learn the ways the immune system responds to this disease.

The virtual experiments engage students in analyzing data, interpreting charts and graphs, and drawing conclusions. The following are the characteristics of the program that make it so rewarding:

- **Efficiency:** The adventure episodes are free and easy to download. All it takes is the Flash plug-in that is included in the latest version of any internet browser, or the plug-in can be easily downloaded. Depending on the speed of the classroom connection, the MedMyst episodes can be downloaded within minutes. The average playing time of each mission is 40 minutes. Normally, a mission can be completed in one class period.
- **Engaging:** Our best critics are students. We constantly use their ideas to improve the series. A great deal of up-front research was done in middle school classes (Miller 2000; Miller et al. 2003).
- **Support materials:** Classroom activities to accompany the internet adventure are also available on the website through the For Teachers link. There you will find learning objectives, corresponding classroom activities for each mission, vocabulary terms, testing materials, and the schedule of workshops. In addition, a magazine for each mission in PDF format can be downloaded from the website (see Figure 2). The magazines focus on the disease at the center of each mission and include articles and puzzles that reinforce the web adventures' learning objectives.
- **Enrichment:** If you are looking for an activity that can be done independently, for extra credit, or as enrichment for students who desire materials that go

beyond the textbook, consider MedMyst. At home or even in a one-computer classroom, the episodes are easily available and normally take about 40 minutes to complete. Concluding each episode is a set of "cool links" that will take students to information of interest at other websites for further exploration.

- **No cost:** Because this project is grant funded, all MedMyst products are free. A Science Education Partnership Award from the National Center for Research Resources and a grant from the National Institute for Allergy and Infectious Diseases, both part of the National Institutes of Health, made these materials possible. There is no charge and no login registration required.

A tour of a sample mission: Malady at Mabuufo

The mission begins with three story characters from the Neuropolis Center for Disease Control (Beta, Delta, Eureka) and the player on their last day of vacation at Roboland, an amusement park. The player has a chance to try out his/her piloting skills against Beta in the game *Mars Lander*. After this game, the team proceeds to the *Vectorama* arcade, a game designed to introduce the player to vectors (organisms, usually insects that transmit diseases to humans).

After completing the Vectorama game, the team ends their vacation and returns to work at the Center for Disease Control in Neuropolis. The team's leader, Alpha, shares an incoming message from Sirius, a public health officer stationed in Africa. There is an outbreak of malaria in the region of Mabuufo. The team is needed immediately to help with treatment and prevention efforts. The player gets an overview of the worldwide impact of malaria, through a short quiz. Prior to leaving Neuropolis, Beta calls in to report that her daughter is ill and she cannot go to Mabuufo.

On the flight to Africa, Eureka shows the player a short segment about investigations in the 1800s to discover the cause and transmission of malaria. Included is a re-enactment of one of the experiments linking mosquitoes to malaria. Two of the three scientists that are introduced won a Nobel Prize for their work. Dr. Alphonse Laveran discovered that malaria is caused by a protozoan parasite. Dr. Ronald Ross and Dr. Patrick Manson worked out the transmission between humans and mosquitoes. At the conclusion of the interactive, there is a quiz to summarize the contributions of the three scientists.

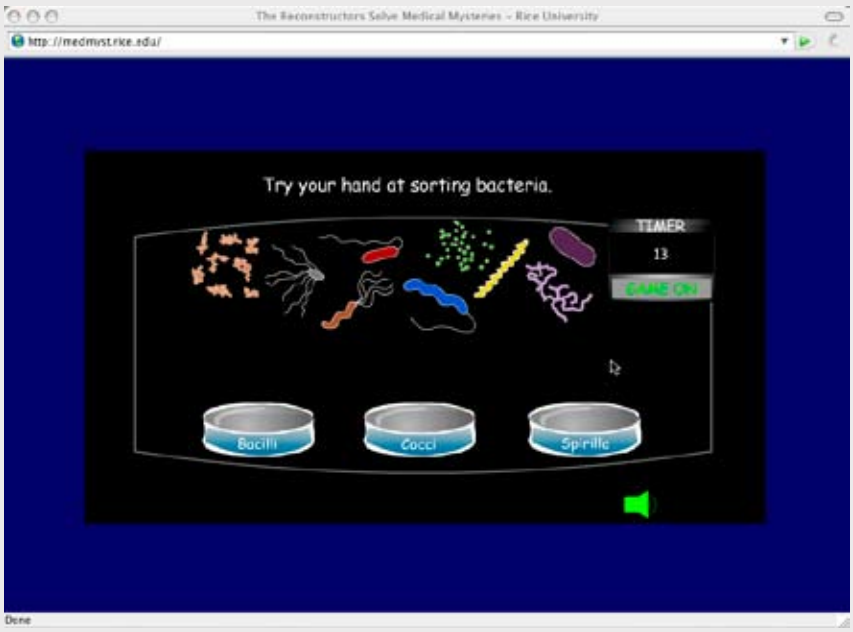
Upon arriving at Mabuufo, the player is introduced to Kamili (local doctor) and Sirius (public health officer). Eureka volunteers to deliver supplies and bed nets

FIGURE 2 Sample magazine

to outlying villages. Meanwhile, both Kamili and Sirius need help in Mabuufo. If the player selects Sirius, he/she receives training in mosquito control. The training includes short videos about the stages in the life cycle of the mosquito. The video is followed by a training game called Mosquito Massacre. The objective of the game is to kill each stage of mosquito with the appropriate weapon—a water pump for draining breeding sites of eggs, larvae, and pupae; a larvacide for killing larvae; and insecticide for killing adult mosquitoes. After completing training, the player interactively searches the village to find ways to protect the residents from mosquitoes using the newly trained techniques.

If Kamili is selected, the player goes to the clinic and is introduced to the symptoms and treatment of malaria. The Plasmodia Invaders segment teaches the player that malaria plasmodia invade red blood cells and cause a toxin to be released that results in a cyclic high body temperature. In Immune Response, the player sees the body's reaction to the invasion with responses from B cells, antibodies, and phagocytes. The player shows what he/she has learned by answering training review

FIGURE 3 Bacteria sorting game



questions. The next game, Plasmodia Invasion, shows the body being invaded while the player tries to fight off the plasmodia. Following that game, Plasmodia Invasion 2 shows how much easier it is to battle the invaders when anti-malaria drugs are present.

At the completion of Plasmodia Invasion 2, Kamili asks for help identifying symptoms in the patients at the clinic. A phone call interrupts and the caller reports that Eureka never arrived with the supplies. It appears that Eureka is being held ransom in exchange for diesel fuel the rebels need, but fortunately, the robot escapes and reports the mission of delivering supplies was completed. The work of spraying and delivering bed nets continues and the scene flashes forward two months. The Reconstructors are going home after a successful mission. Delta hopes next time no one is kidnapped in the process!

Add a little mystery to your classroom

MedMyst was designed to teach science content through the use of narrative storylines and games. This innovative style appeals to students with diverse learning styles, including those who would otherwise have no interest in the science content. As one student put it, "Awesome! It was so much fun—it made learning easy! I will recommend this site to my friends. Can you make more of these?" The interactive web adventures and the accompanying classroom activities can be incorporated into any health or science curriculum, either as embedded activities or as a stand-alone unit. Try it at *http://medmyst.rice.edu,* and see for yourself how excited students become once they engage in solving Medical Mysteries. ■

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