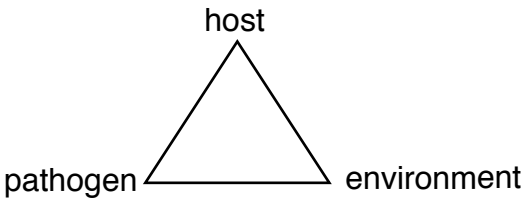
Experiment 1: Bread, mold, and environment: A lesson in biology and the environment

An organism's potential is defined by its genes. Whether the organism achieves that potential is defined by its environment. Tree height is limited by water, people's heights are influenced by nutrition, the thickness of cats' fur is affected by light, flower color is affected by metals in the soil, bacterial behavior is affected by the presence of other bacteria. Every organism responds to a profusion of signals from the physical, chemical, and biological environment that shape its anatomy, physiology, behavior, and longevity. The complexity of the interplay between the environment and genetic potential is exemplified by the debate over human intelligence and behavior. How much of who we are is defined by our genes and how much is a result of our environment?

The environment is a critical player in the occurrence of human disease. For example, people who live in crowded cities are more likely to develop tuberculosis than are rural people, and the incidence of dental caries caused by bacteria is influenced by ingestion of certain elements and compounds. The environment also affects plant disease. For example, the Great Famine that resulted from loss of the potato crop in Ireland occurred in the year 1848, which had a very wet, cold growing season. Irish potato plants succumbed to a pathogen that requires cold, wet conditions to infect plants.

An infectious pathogen and a susceptible host are not sufficient for disease to develop. The environment must play its part as well. Temperature, moisture, concentrations of chemicals, antagonistic or beneficial microbes, and numerous other factors must be aligned properly for the infection and spread of a pathogen. This concept is described by the disease triangle, which is a graphical representation of the contributions of the three partners-the pathogen, the host, and the environment-to the disease process.



This experiment provides an analogy for the disease triangle. Instead of using a pathogen/ host system, we will study the interaction between *Penicillium*, a fungus that causes bread mold, as the pathogen; bread, acting as the host; and the environment. The similarity to the disease triangle is that each partner plays a role in the growth of the mold on the bread. The analogy is not perfect, however, because disease requires a living host, and bread is not alive.

Penicillium is a famous genus of fungi whose members have many different properties. The first antibiotic discovered by Alexander Fleming in 1929 was penicillin, produced by a species of this fungus. One of the major ways that fungi reproduce is by producing spores that are light and can be dispersed in the environment in the air, by animals or by water.

Spores are a dormant, stress resistant state of the microbe. When they encounter favorable conditions, spores germinate and resume growth. Alexander Fleming's discovery of antibiotics started with a *Penicillium* spore that accidentally landed on his plate of bacteria, began growing, and secreted compounds that killed the nearby bacteria. Other species of *Penicillium* produce molecules that are toxic to humans, known as mycotoxins. Some species of *Penicillium* are plant pathogens, some are responsible for the flavor of certain kinds of cheese, and many grow on plant products in storage. The focus of this experiment is *Penicillium notatum* (also known as *Penicillium chrysogenum*), a common mold that grows on bread.

Resources about Fungi

To get acquainted with fungi, you can find background information about fungi in any introductory microbiology textbook. You can also find information about fungi at the following websites:

- http://www.apsnet.org/edcenter/intropp/PathogenGroups/Pages/IntroFungi.aspx
  This website provides a good overview of fungi. For class, focus on the first 4 topics and the sections on morphology and reproduction.

- http://botit.botany.wisc.edu/toms_fungi/nov2003.html
  This website provides general information about *Penicillium* and penicillin.

Key concept

Growth and behavior of organisms are influenced by the environment.

Challenge

You will be provided with a variety of breads (and bread-like products) and a suspension of *Penicillium notatum* spores. Develop a hypothesis about the environmental factors that might affect the ability of *Penicillium* to grow on bread and design an experiment to test your hypothesis. We will do our best to provide or construct the environments you need for your experiments.

Key questions

- How does growth of mold on bread differ from disease of a living host?
- What might be the benefits or risks associated with preservatives in bread?
- What factors in the physical environment play a critical role in plant disease?
- Based on the disease triangle, what do you think are the major strategies for preventing human or plant disease?
- How might the biological environment affect the ability of a human or plant to be infected by a pathogen?
- What factors in the bread might affect growth of the fungus on it?
- What environmental factors might affect growth of the fungus on bread?

This lab is adapted from Handelsman J., Houser B., Kreiger H. *1997*. Biology Brought to Life. Times Mirror Higher Education Group, Dubuque, Iowa.