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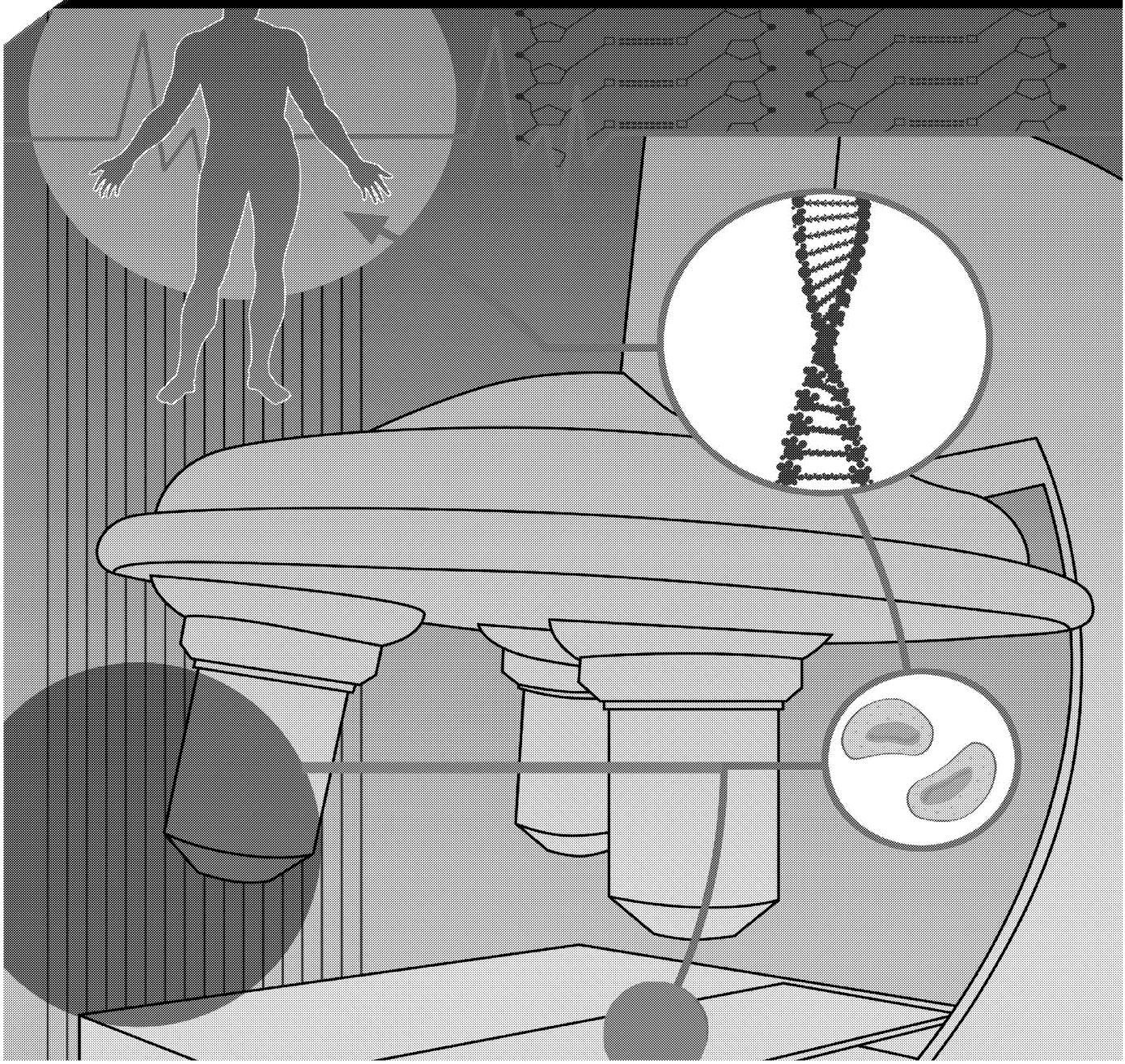
BIOLOGY



Gina Hamilton

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FUNGI AND PLANTS

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Safety and Ethical Issues

The *Top Shelf Science* series contains several laboratory experiments. Special care must be taken to ensure student safety when performing these experiments. Experiments involving living organisms should be done with careful respect for the health of the living specimen in mind. Here are some guidelines for general safety issues in a laboratory setting:

- Wear proper safety equipment at all times. This includes an apron, smock, or lab coat; safety goggles; and gloves. Do not wear open-toed shoes, such as sandals, during lab experiments.
- Do not eat or drink anything in the lab.
- Be sure to turn off heat sources when not in use.
- Perform any chemical experiments involving gas emissions within a chemical fume hood or in a well-ventilated room.
- Before disposing of chemical ingredients, be certain that they are neutralized, then dispose of them in proper containers.
- Establish a location for the disposal of sharp objects, such as broken glass or nails.
- Use extreme caution when heating solutions.
- Animals, plants, and other life forms are deserving of respect. Treat living specimens with care and, when possible, release them or replant them outdoors.
- Use care when using electrical appliances of any sort. Know how to recognize a short circuit or a blown fuse.
- Keep fire extinguishers on hand and properly charged, and know how to use them. Be sure that you have an ABC-rated extinguisher, as well as a Halon™ extinguisher for electrical fires.
- Follow all local, state, and federal safety procedures.
- Have evacuation plans clearly posted, planned, and actually tested.
- Label all containers and use original containers. Dispose of chemicals that are outdated.
- Be especially aware of the need to dispose of hazardous materials safely. Some chemistry experiments create by-products that are harmful to the environment.
- Take appropriate precautions when working with electricity. Make sure hands are dry and clean, and never touch live wires, even if connected only to a battery. Never test a battery by mouth.
- When using lasers, never look directly into the beam, and make sure students are conversant with the dangers of laser light.

Safety precautions unique to a given laboratory will be provided within the lab write-up itself. These safety precautions are provided as a guide only. They may be incomplete. Use common sense when working with any chemicals, electricity, or living organisms.

Parent/Teacher/Student Guide

Dear Parents, Teachers, and Students,

Thank you for choosing the *Top Shelf Science* series to help you better understand some of the difficult ideas in high-school science. We are confident that our books will help students who have a greater knowledge of the subject matter being studied; they can also be used to provide a lab-based program for students learning at home.

Each volume of the *Top Shelf Science* series is designed for a particular course of study. Within each volume, concepts build sequentially, and it is recommended that students begin with the first section and move forward.

Each book has sections that are thematically designed. The laboratory exercises associated with each section are specific to a deeper understanding of the overlying concept. In Appendix II, you will find a list of materials that are necessary to conduct the lab exercises, as well as a list of science equipment dealers who may help you acquire things you need in the course of the lab exercise; we have tried to keep the materials list small, as well as provide lab lessons in which materials are readily accessible. Therefore, we have also provided alternatives, where possible, to the lab glassware and other large pieces of equipment that may not be located in your kitchen cabinet or small classroom.

In Appendix I, you will find answers to the questions in each unit, as well as a suggested grading rubric for essays and lab reports. Share these rubrics with students so that they can correct areas that need to be corrected before the next assignment. In keeping with the national science standards, we have also included a time line of the history of each discipline. Each volume also contains an index and a glossary.

Whether you are using our product as the basis for a home school experience, a new and fresh way of supporting textbook material, or as preparation for a college placement test, we are confident that *Top Shelf Science* can meet your needs.

Thank you!

The authors and editors of *Top Shelf Science*

BACKGROUND

Monerans and Disease

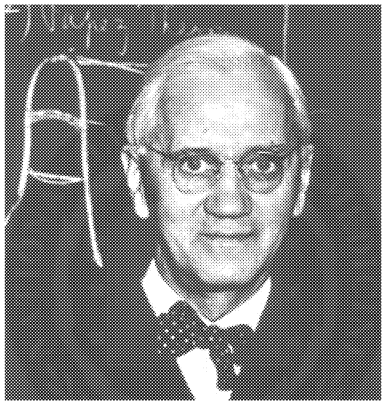
Monerans often live harmlessly within other organisms, sometimes, as in the case of *E. coli,* in a mutual relationship with the host. However, if too many of a particular bacterium enter the system of the host (for instance, if the host unknowingly eats meat tainted with billions of bacteria), or if the bacteria are excreting toxins, or if they enter the bloodstream instead of the intestinal tract, the host can develop an infection.

Diseases that have a bacterial origin include some of the world's great killers—black plague, tuberculosis, strep throat, and pneumonia.

Infection does not always mean the host will become ill. Each organism has a strong defense network. In mammals, this consists of an *immune system*—a virtual army of white blood cells that engulf and consume invading organisms, eliminating the danger. Occasionally, when the host is weakened from other infections, or is very young or old, moneran invasion can overwhelm the immune system of the host and cause disease. Once established, the monerans reproduce and cause systemic infection. As anyone who has suffered through a few days of food poisoning is aware, the entire body reacts to the infection, with fever, vomiting, diarrhea, great thirst, and other methods used by the body to rid itself of the troublesome bacteria or toxins.

When bacteria release toxins, as they do in the case of food poisoning, the body must and does purge itself as quickly as possible. However, other bacterial infections, while they cause pain and fever and more serious problems to the internal organs and glands, do not cause the systemic response that toxic bacteria cause. These quiet infections actually caused many more deaths in the years prior to the discovery of antibiotics than food poisoning did.

Diseases that have a bacterial origin include some of the world's great killers—black plague, tuberculosis, strep throat, and pneumonia. Unlike viral illnesses, most bacterial illnesses do not have a vaccine.

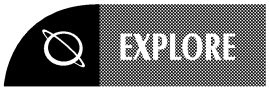


Sir Alexander Fleming, discoverer of *Penicillin notatum*

Most, however, do have a cure. In 1928, Sir Alexander Fleming discovered penicillin. Penicillin is produced by Penicillium, a fungus, typically seen as bread mold. It kills bacteria by interfering with the enzyme that links the sugar chains in the cell wall of the bacteria. This creates holes in the cell wall, which allow water into the cell. This ruptures the cell, killing it.

Fleming noticed that an airborne mold particle fell onto a dish of staphylococci bacteria. He was not interested in the mold, until he noticed that the bacteria near the mold particle began to die. His discovery would save millions of lives, but it took another 12 years to come to market. The discovery led to research in antibacterial drugs, called antibiotics, which can, today, cure all but the strongest bacterial infections.

Antibiotics have, in turn, led to the evolution of drug-resistant strains of bacteria, largely because of overuse and prescription for infections that are not bacterial in origin. It is very important that humans use antibiotics only for known bacterial infections.



Exploration Activities

1. How do bacteria cause disease?

2. Who discovered penicillin? How?

3. What are the dangers of overuse of antibiotics?

BACKGROUND

Moneran Adaptation

Various monerans obtain nutrition from light, from simple inorganic molecules, and from complex organic molecules.

Monera exist almost everywhere in the world, including in environments no other living thing could possibly tolerate. They live under the Antarctic Ocean ice, along deep-sea vents where the water temperature is close to 400° C, within hot sulfur springs, and in the Dead Sea. Monera live in water, under the ground, within and on other living organisms, in the hottest deserts in the world, and in the air.

How can such simple organisms survive in such varied environments? Key to understanding moneran adaptation is understanding their methods of metabolism. Various monerans obtain nutrition from light, from simple inorganic molecules, and from complex organic molecules. Most require oxygen for respiration. These are called the *obligate aerobes*. Others are killed by oxygen—the *obligate anaerobes*. Still others can live with or without oxygen. These have two types of metabolism and can obtain their energy from respiration (aerobically) or from fermentation (anaerobically). Some have even more complex metabolisms—green sulfur bacteria, for instance, use hydrogen sulfide rather than water during photosynthesis, and produce sulfur, rather than oxygen, as a waste product.

The cell structure of the moneran can also help to protect it. Some monerans have sticky outer capsules, which often prevent them from being absorbed by immune systems. Some have pili, which can be used to cling to other individuals of the species, presenting would-be predators with a large chain or cluster of organisms, rather than one small bacterium.

Even with all of these adaptations, the environment is sometimes too hostile for survival. When this happens, many monerans can produce a structure called an *endospore*. Endospores have a hard outer covering that is resistant to drying out, boiling, and chemicals. While in the endospore form, the bacterium's metabolism slows—the bacterium enters a state of suspended animation, and it does not reproduce. When conditions become better, the endospore germinates, and the bacterium begins metabolizing, growing, and reproducing once again.

One group of endospore-forming bacteria are those that produce a toxin that causes botulism, a food poisoning.

Because endospores can resist boiling, canned and bottled food must be placed in sterile containers, or endospores will survive. One way to do this is to boil the containers in water under pressure.

Have you ever watched someone make jam or pickles? The first step is to sterilize the jars, usually in a pressure cooker, and then to pressure-cook the jam or pickles in the jar. The pressure cooker elevates the boiling point of water, and the higher temperature can kill the endospores. Similarly, medical instruments are "boiled" under high pressure in an autoclave, making them sterile for use in operations. If canned food is not sterilized properly, endospores can survive. One group of endospore-forming bacteria are those that produce a toxin that causes botulism, a food poisoning. Another group produces a toxin that causes tetanus, a serious nerve disease, which is one bacterial infection that does have a vaccine. Puncture wounds, because they admit little air, are prime sources for tetanus infections.

