To the Teacher

Humans were using biotechnology long before the word existed to describe what they were doing. Selective breeding was used on plants or animals with desirable traits to increase the frequency of the appearance of those traits. Recognising that certain natural processes could be adopted, early people used fermentation, often promoted by micro-organisms, to produce items such as beer, wine, cheese, yoghurt, bread, sauerkraut and kimchi (a fermented vegetable dish). Early people also discovered that parts of many plants and animals could be used to treat illness, as naturally occurring antibiotics, and to promote healthy crop growth as fertilisers and insecticides. People using willow bark tea to treat headaches, fever and even inflammation were unknowingly experimenting with biotechnology when they produced medicines.

All of these “classic” uses of biotechnology are still used by modern humans, but we have also added the field of modern biotechnology. This is a catchall phrase that refers to the use of living cells and organisms and their molecules, such as DNA, that we can extract or manipulate. This field encompasses work done in several diverse areas, such as bioremediation, gene therapy, genetic testing, cloning, biofuel production, waste treatment, crop production, biodegradable plastics, bioleaching, biological weapons, pharmaceutical production, the Human Genome Project, and many others.

The goal of this book is to address concepts and issues across many parts of biotechnological history. Students need to be aware that making cheese and extracting DNA from an onion are both forms of biotechnology. To that end, the activities are a mix of old and new. From making yoghurt to performing electrophoresis, a wide swathe of biotech activities will hopefully engage students’ curiosity about where this field can take them in the future. As they finish each activity, you may find it helpful to have a class discussion about information that students discover, whether the activity expressly recommends it or not. The more students talk about biotechnology, the more motivated they will hopefully become.

These activities are designed to stand alone as supplements to your instruction. While the activities can be performed in any order according to your teaching plans, please note that some activities are similar in concept to others. To reinforce student understanding and save you time and effort, conceptually similar activities are:

Activity 1: Making Yoghurt; Activity 3: Making Kimchi; Activity 5: Yeast Fermentation (fermentation and preservation of food).

Activity 2: Invasive Species (effect of introducing creatures to non-native areas).

Activity 4: GMO Pro, GMO Con; Activity 6: Bt, Borers and Butterflies; Activity 8: Do You Know What You’re Eating?; Activity 14: The Community and Genetically Modified Foods (community attitudes towards, and knowledge of, genetically modified foods).

Activity 7: Antibiotics from Nature; Activity 15: Oil Cleanup with Bacteria (positive uses of bacteria).

Activity 9: Gel Electrophoresis; Activity 11: Running a Gel (gels).

Activity 10: Building People; Activity 12: To Clone, or Not to Clone? (genetic engineering in humans).

Activity 13: Was It Alive? Activity 17: Enzymes (proteins).

Activity 16: Where Will the Money Go? (conservation and endangered species)

Activity 18: Forensics; Activity 19: Extracting DNA (forensics and DNA)

Activity 20: Biotechnology Careers

7. Antibiotics from Nature

Teacher Resource Page

Instructional Objectives

Students will be able to:

- determine which naturally occurring materials have promise as antibiotics
- compare the effectiveness of natural antibiotics to an over-the-counter antibiotic
- connect the production of medicine to fields involved in biotechnology

Science Benchmark

Years 7–8

Content description
Abilities necessary to do scientific inquiry
Understandings about scientific inquiry
Understandings about science and technology
Science and technology in society

Years 9–10

Content description
Abilities necessary to do scientific inquiry
Understandings about scientific inquiry
Chemical reactions
Abilities of technological design
Understandings about science and technology
Historical perspectives

VELS Standards (Levels 5 and 6) http://vels.vcaa.vic.edu.au/vels/science.html#
Demonstrate safe procedures of preparation, and safe, technical uses of a range of instruments and chemicals.
Make systematic observations and comment on the results of experiments.
Present experimental results in a clear and appropriate format.

Vocabulary

- **antibiotic:** a substance that kills, or at least hinders the growth, of bacteria

7. Antibiotics from Nature

TEACHER RESOURCE PAGE

MATERIALS

- sterile filter paper
- sterile tweezers or sterile forceps
- over-the-counter antibacterial ointment
- potential natural antibiotics:
  - garlic
  - salt
  - aloe vera
  - green tea extract
  - honey
  - tea-tree extract
  - lemon juice, etc.
- nutrient agar plates of *Escherichia coli*
- distilled water
- sterile hole punch
- gloves
- goggles
- sterile 50-ml beakers or other similar small containers
- glass stirring rod
- incubator
- metric ruler
- lab coat

= Safety icon

HELPFUL HINTS AND DISCUSSION

Time frame: two days
Structure: individuals or partners
Location: classroom

Students will test a variety of naturally occurring substances to see if they have any promise as antibiotic agents. They will also use an over-the-counter antibiotic as a comparison. They will need nutrient agar plates that have been inoculated with *E. coli.* Although *E. coli* is generally safe for humans to handle, it would be best if you prepared the plates of *E. coli.* If you are unfamiliar with the procedure, check the second site listed under Recommended Internet Sites for an overview. The list of potential natural antibiotics to test is a suggested list, and students may bring in other substances to test if they wish. Students will be putting four samples on each plate, so you will need a large number of plates. You might consider having students limit their number of samples to eight or twelve, including the over-the-counter antibacterial ointment and one disc of sterile distilled water to use as a control. To clean all of the materials that are contaminated with *E. coli,* soak them in a 10% solution of bleach for at least 2 hours.

MEETING THE NEEDS OF DIVERSE LEARNERS

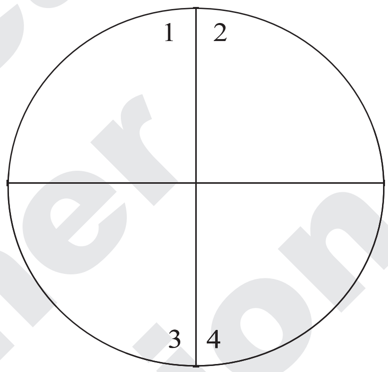
Students who need extra challenges should complete the Follow-Up Activity and the Extension Option. These students should also be encouraged to work with struggling students with the use of equipment and maintaining a sterile work environment. Students who need extra help will benefit from instruction on how the agar surface will appear with and without growth. They should also be allowed to work with a partner if necessary.

Name ________________________ Date ________________________

7. Antibiotics from Nature

STUDENT ACTIVITY PAGE

5. If the material is not liquid, add 10 ml of distilled water to the beaker and then mash the material as much as possible with the glass stirring rod. Be sure to clean the rod between substances or to use a new rod for each substance.
6. Add one small filter paper disc to each beaker. Be sure the disc is covered with the liquid from the material, but avoid getting any large pieces of the samples on the disc.
7. Determine how many *E. coli* plates you will need. You will put four discs on each *E. coli* plate. In addition to the substances in your beakers, you will also test an over-the-counter antibiotic ointment, and you will include one disc of sterile distilled water to use as a control. Collect enough plates from your teacher for all of the substances you will be testing.
8. Turn each plate upside down (so that the agar is at the top) and draw lines on the outside of the plate to divide it into quadrants as shown in the diagram. Number the quadrants 1 to 4 on the first plate, 5 to 8 on the next plate, and so on.
9. Using the forceps, collect the small paper disc from your first potential antibiotic and place it carefully in the centre of the agar in quadrant 1. In your data table in the Data Collection and Analysis section, record this as substance 1.



10. Clean your forceps and repeat step 9 for each of your potential substances. Be sure to record the number associated with each substance in your data table. If you need more room, create a similar data table on your own paper.
11. If you have not done so already, be sure to include one paper disc with the over-the-counter antibiotic ointment in one of your plates. Also, include one paper disc with sterile distilled water to use as a control.
12. Put the cover back on your plate and place it in the incubator at 37°C for at least 48 hours. Be sure to invert the plate so that the cover is on the bottom and the agar and samples are on the "ceiling" of the container.
13. If there is no clear growth on the plate after 48 hours, put it back in the incubator until growth is seen.
14. Remove the samples from the incubator and DO NOT open them. Using a ruler, measure the diameter of the area around each substance (in mm) where there is no *E. coli* growth. Record the measurements in the data table. If the sample is covered in growth, record the diameter as zero.
15. Return your samples to the teacher for disposal. DO NOT open them.

EXTENSION OPTION

Repeat this activity using a number of known antibiotic ointments to compare their effectiveness.

Name ______________________ Date ______________________

7. Antibiotics from Nature

STUDENT ACTIVITY PAGE

DATA COLLECTION AND ANALYSIS

Substance	Diameter (mm)	Substance	Diameter (mm)
1		7	
2		8	
3		9	
4		10	
5		11	
6		12	

CONCLUDING QUESTIONS

1. Which of the natural samples showed some promise as an antibiotic?

2. Which natural sample provided the widest diameter with no growth?

3. Which samples showed little or no promise as an antibiotic?