EYE

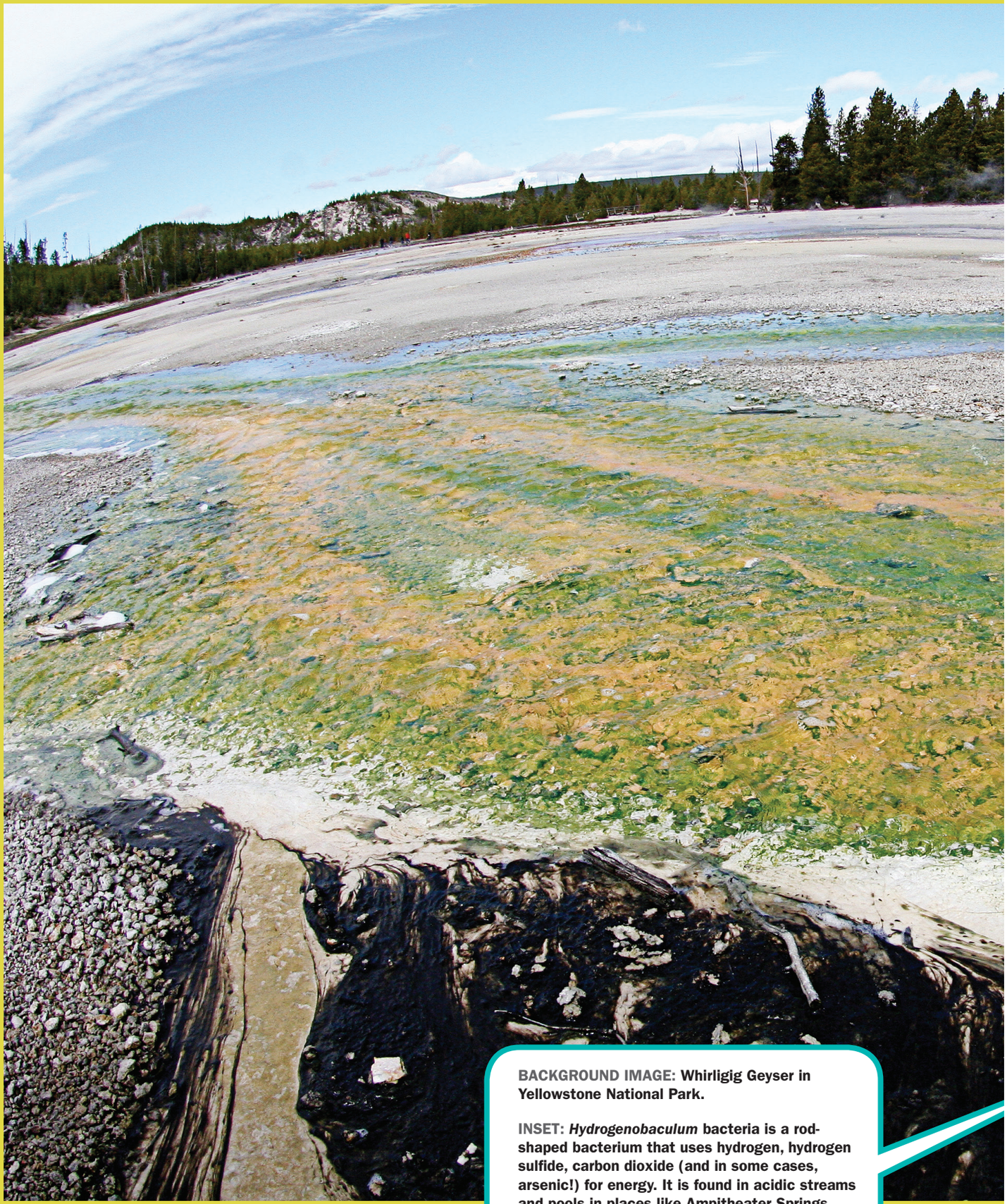
Extreme Yellowstone Expedition

LESSON 4

THE UNSEEN WORLD AROUND YOU

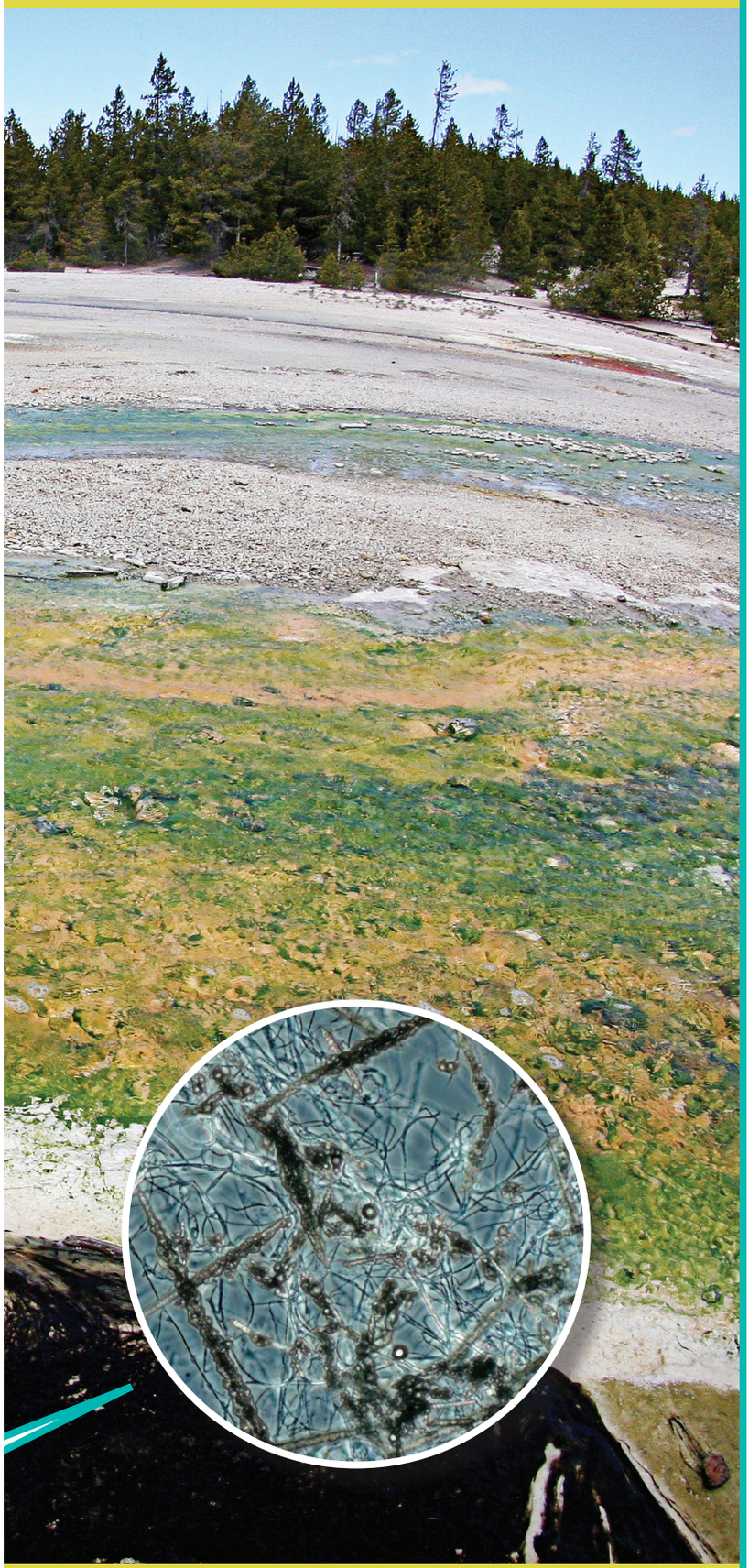
Student Activity Book

MONTANA STATE UNIVERSITY | Thermal Biology Institute



BACKGROUND IMAGE: **Whirligig Geyser in Yellowstone National Park.**

INSET: ***Hydrogenobaculum*** **bacteria is a rod-shaped bacterium that uses hydrogen, hydrogen sulfide, carbon dioxide (and in some cases, arsenic!) for energy. It is found in acidic streams and pools in places like Ampitheater Springs and Norris Geyser Basin.**



An unseen world

All around you is a microscopic world of life. A single gram of soil (a penny weighs 2.5 grams) can contain over a million bacterial cells. A liter of ocean water contains up to 1 billion bacteria and there are about ten times more bacteria living inside your body as there are "human" cells.

The majority of these critters are bacteria. Bacteria can be harmful to us, but without it we definitely couldn't survive. They help us digest and gather energy from our food.

What are bacteria?

Bacteria are single celled organisms that exist in a wide variety of environments on our planet. They are classified as prokaryotes, meaning they lack a "true" nucleus that is enclosed in a membrane.

Strength in numbers

Bacteria reproduce by cloning themselves and replicating their DNA, then dividing. They are really good at reproducing this way and it's one of the reasons they are so successful on our planet and in our bodies. For example, bacteria common in your intestinal tract, under optimal conditions, can reproduce extremely rapidly, dividing every 20 minutes. That means one bacterium in a petri dish can become two in twenty minutes, those two can become four in another twenty minutes, and so on. After four hours you can end up with 4,096 bacteria!

Mystery bacteria may be useful

Scientists estimate that they have studied less than 1% of the number of microbe species. Many types of microbes are yet to be discovered and may have important characteristics that could make them useful for solving problems. For example, the Extreme Yellowstone Expedition visited Yellowstone to collect samples of microbes from hot springs. The researchers hope that microbes that can live in extreme environments such as hot springs may have the potential to help improve medical cures for diseases or clean up hazardous waste sites, or be a source for alternative fuels such as hydrogen or biodiesel.

Microbes are all around us

It's your turn to be the scientist and see what you can discover around you. You are going to collect some samples of microbes, but first you need to think of a question or hypothesis you want to explore.

Write a hypothesis or question about an idea you want to investigate and be precise. A hypothesis is an educated guess that you can test to see if it is correct.

Each time you collect a sample, you will actually collect *two* samples. One that you will place in the dark for a few days to see what grows, and one that you will place in sunlight for a few days.

Write your question or hypothesis

Hypothesis: _____

_____

For example, "I think samples taken from outdoor areas will have less microbial growth than samples taken from indoors after being left in the dark for a few days, because samples from outside will have more microbes that use photosynthesis and rely on the sun for energy. Therefore many or all of the microbes from the outside samples will not be able to grow in the dark."

Describe your methods

Where you are going to take samples from and why you are choosing those locations?

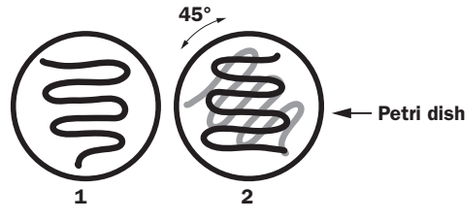
Methods: _____

_____

_____

Directions:

1. Listen closely to your teacher's directions.
2. Collect any supplies you will need such as cotton swabs and agar plates. An agar plate is a petri dish that contains a jello-like substance upon which is very easy for many types of microbes to grow. If possible, wear gloves while working with the cotton swabs and agar plates to avoid contamination of the samples. If gloves are not available, wash your hands thoroughly before gathering samples.
3. Plan where you are going to collect samples and take two from each site: one that will be kept in the dark for a few days, and one that will be kept in the light for a few days. Try not to take your samples from the exact same spot because your first effort to sample might have removed many of the microbes.
4. To collect a sample, run your cotton swab over the site several times for approximately 10 seconds. Make sure you use a new cotton swab for each sample.
5. Open the petri dish and rub the cotton swab gently across agar plate many times in a zig-zag pattern (as shown above). Rotate the plate 45 degrees and swab the agar plate again for maximum coverage. Repeat as needed to cover the entire surface area of the agar.



Make sure the agar plate is exposed to the air for the least amount of time possible to avoid airborne microbes falling onto the agar.

6. After each plate has been streaked, it should be taped with scotch tape on each side to seal it. Flip the plate upside down so that the air and moisture are on the bottom (this helps prevent the agar from drying out and promotes bacterial growth).
7. Once you have sealed the dish closed with tape, do not open it again.
8. Each plate should be labeled with masking tape of the sample location and name(s) of group members.
9. Place each plate in a clear plastic sealed sandwich bag and leave it in the bag for the duration of the experiment.
10. Place one plate of each sample in a totally dark area in the classroom (such as in a box), and place the other in a light area.
11. Return any extra materials to your teacher.

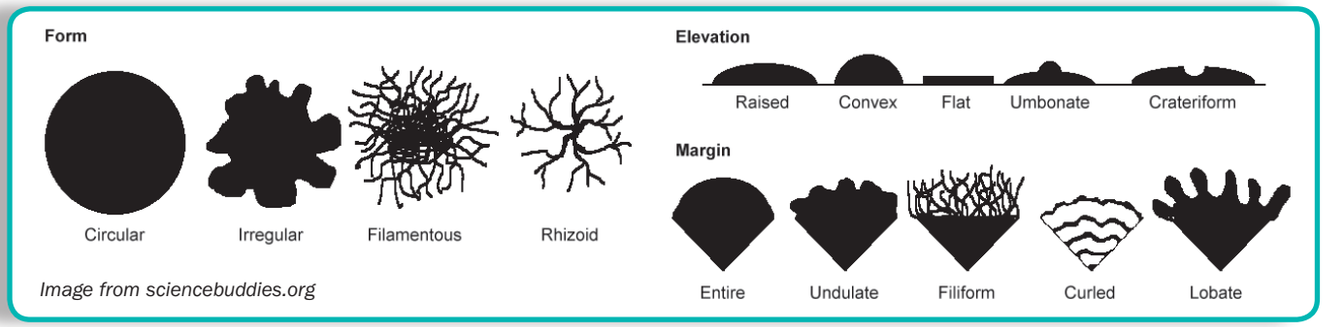


Image from sciencebuddies.org

Draw and label your first observations here.

FIRST OBSERVATION OF SAMPLES:

***WARNING:* Keep your samples sealed at all times.** The microbes growing in the dishes may be hazardous to your health! Most of what you see growing in your samples will be bacteria, but you might also have yeast, mold, and types of fungi. Many of these microbes have the potential to be toxic to humans.

1. How many days have your samples been growing? _____
2. Draw what you see in each of the petri dishes. Make sure to write labels about which petri dish you are drawing (where was the sample taken and has the sample been in a light area or dark area for the past few days).
3. Estimate what percentage of each plate is covered with growth. _____, _____
4. How many distinct types of growths (microbial colonies) can you see? The more colonies you have, the more diverse your sample is.

   _____
5. Number each colony on your sketch and describe its morphology (morphology means the form and structure of organisms which includes shape, structure, color, pattern, and texture). Use the drawings above to describe the form, elevation, and margin of each colony.
6. What is the difference between the growth in the samples incubated in the dark vs. those incubated in light?

Petri Dish #1 (incubated in the light)

Petri Dish #2 (incubated in the dark)

_____

_____

_____

7. Are all the microbial colonies you see multiplying (getting bigger) at the same rate? Why or why not?

_____

_____

_____

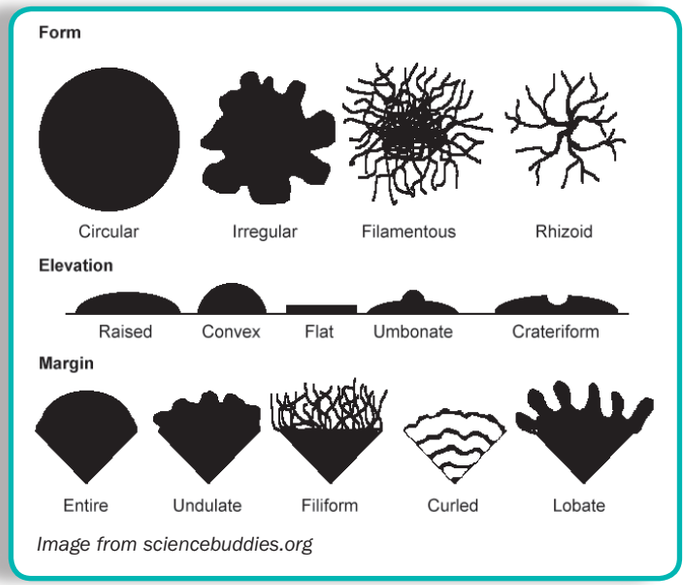


Image from sciencebuddies.org

Draw and label your second observations here.

Petri Dish #1 (incubated in the light)

Petri Dish #2 (incubated in the dark)

SECOND OBSERVATION OF SAMPLES:

***WARNING:* Keep your samples sealed at all times.**

1. How many days have your samples been growing? _____
2. Draw what you see in each of the petri dishes. Make sure to write labels about which petri dish you are drawing (where was the sample taken and has the sample been in a light area or dark area for the past few days).
3. Estimate what percentage of each plate is covered with growth. _____
4. How many distinct types of growths (microbial colonies) can you see? The more colonies you have, the more diverse your sample is. _____
5. Number each colony on your sketch and describe its morphology (morphology means the form and structure of organisms which includes shape, structure, color, pattern, and texture). Use the drawings above to describe the form, elevation, and margin of each colony.
6. Put a star next to the sample that has the most diversity. Why do you think this sample might have been the most diverse? *(Think about where the sample was taken, the conditions the sample was left in over the last few days, the possible metabolisms of the microbes, the resources available to the microbes during the last few days, etc.)*

   _____

   _____

   _____

7. What is the difference between the growth in the samples incubated in the dark vs. those incubated in light?

   _____

   _____

8. Do you think the microbes growing in the dark use light for energy? Why or why not?

   _____

   _____

9. Do you think all the microbes growing in the light use light for energy? Why or why not?

_____

_____

10. Are all the microbial colonies you see multiplying (getting bigger) at the same rate? Why or why not?

_____

_____

RESULTS:

What conclusions can you draw based on your results? Was your hypothesis correct or was your initial question answered?

_____

_____

_____

_____

Were there any results or conclusions you can make that were not included in your hypothesis or question?

_____

_____

_____

Do you think you might have collected samples of microbes that didn't grow in the dishes? Why or why not?

_____

_____

_____

What surprised you most about this experiment?

_____

_____

_____

_____

What would you do differently if you had the chance to redo the experiment?

_____

_____

_____

_____

Microbes such as bacteria and fungi are some of the oldest forms of life on Earth and microbes account for the majority of the Earth's biomass (the total weight of all living things). If we find life on another planet, scientists think it will most likely be microbial life. Why do you think microbes are so successful?

_____

_____

_____

_____

WARNING: **Follow your teacher's directions about how to discard of the samples. They might be very hazardous!**