Mission 6
Venus Plates and Phase Mars Jars!

Did Earth Life Survive Conditions on Venus or Mars?

Overview

In mission 6.1, students culture *Penicillium notatum* in seeded soil from their Mars Jars, from seeded soil that has been heated to simulate the conditions on Venus, and from seeded soil that was left under cool (refrigerated) Earth conditions. In mission 6.2, students use their records of normal *Penicillium notatum* growth on Earth from mission 3 to analyze their results, and to see if it survived the simulated conditions of Mars and Venus.

Notes

In mission 5, students designed spacecrafi that could take them to Mars or Venus. If they took the Earth microorganism Penicillium notatum to Mars or Venus, would it survive there? Previously, students exposedPenicillium notatum to simulated conditions of Mars. Its survival would provide evidence that at least one form of Earth life could exist on Mars. Penicillium notatum's failure to survive would provide evidence that even a life-form that is highly adapted for survival in harsh conditions on Earth would find the conditions on Mars or Venus unsuitable.

Mission 6.1
Materials

For a Class of 30

- Mars Jars from mission 3
- Seeded soil from mission 3
- Sterile baking pan
- Sterile cookie sheet
- Oven space for an hour
- 400 ml of Sterigel Instant Medium (for an alternative recipe, see Making Your Own Medium, in appendix)
- Sterile sealable container

For Each Team

- Masking tape
- 3 sterile 60-by-15 mm Petri dishes (see Sterile Dishes, in appendix)

- 2 sterile soil-sample carrying dishes
- 3 stick-on labels or a grease pen
- Spatula
- 3 alcohol swabs
- Culturing *Penicillium notatum* on Mars and Venus directions.

Getting Ready

1. Remove the Mars Jars from the freezer. Allow them to warm to room temperature before using them in class.

2. Bake half the seeded soil left over from mission 3 in a baking pan at 400 F for an hour or more. Remove the pan from the oven, cover it with a sterile cookie sheet and allow it to cool to room temperature. This is the soil for making Venus Plates. Put the soil in a sterile sealable container when transporting it to class. If feasible, have students take home portions of seeded soil to bake in their own ovens (but keep a back-up supply).

3. If you are sterilizing your own Petri dishes (instead of buying sterilized Petri dishes, which require no preparation), do so the day before class. Follow the instructions in the appendix (see Sterile Dishes, in appendix).

4. If you are preparing your own medium (instead do so the day before class. Follow the instructions in the appendix (see Making Your Own Medium, in appendix).

5. Copy the Culturing *Penicillium notatum* on Mars and Venus directions for each team.

Classroom Action

1. Discussion.

   Mars-Present the Mars Jars (Erlenmeyer flasks) to the class. Ask students if they think there is still a low pressure (partial vacuum) in the jars. How could they find out? What would they expect to see if they released the clamp leading to the balloon? *(Air should rush in and fill the balloon.)*

   Show students that air rushes back in to fill the partial vacuum, which means that the simulated Martian conditions have been maintained. Ask students how we could know whether or not the *Penicillium notatum* survived these simulated Martian conditions. *(We can try to culture it on Petri dishes.)*

   Venus-Present the seeded soil for the Venus Plates and tell students that you have used the same soil seeded with *Penicillium notatum* that was used for the Mars Jars, and that you have baked it in the oven at 400 F for one hour or more, simulating the high temperature on Venus. Tell students that it would have been impractical to bake this sample for the same time that the Mars Jars were kept cold. However, if the *Penicillium notatum* cannot survive for one hour or more at this temperature, then it certainly cannot survive on Venus! Tell

students that it would have been impractical to create the high pressure on Venus. But again, if the *Penicillium notatum* cannot survive the high temperature, then it certainly cannot survive both the temperature and the pressure on Venus. Ask students if they think the *Penicillium notatum* has survived these simulated Venusian conditions.

Earth-Present the rest of the original seeded soil from mission 3 to the class. Remind students that living *Penicillium notatum* was present in this soil in mission 3. Ask them if it could have survived in cool Earth conditions since mission 3's lab. Tell them that they will need to culture the Earth seeded soil again as a control. If *Penicillium notatum* has not survived this long under Earth conditions, it certainly would not survive the conditions on Mars or Venus.

2. **Activity**. Divide the class into their teams from Mission 3. Hand out the Culturing *Penicillium notatum* on Mars and Venus directions to each team. Each team should now make three Petri dishes (or be given pre-made Petri dishes). Students should wash their hands and their work areas with soap and water. Give the team their sterile Petri dishes and six pieces of masking tape. Have students tape shut their Petri dishes without opening them; this makes a hinge on one side of each dish and a re-breakable seal on the other.

   Teacher's Note: *To reduce the number of Petri dishes and media used, consider making class controls- two or three dishes with Earth's seeded soil.*

   While students are taping their Petri dishes, prepare the Sterigel at a central area in the classroom: Close any windows to prevent drafts. Open an alcohol swab and place it on the table. Open the two jars in the Sterigel kit. Place their lids on the alcohol swab. Pour the Sterigel liquid into the bottle of Sterigel powder and shake the bottle for 30 seconds. Sterigel must be used quickly after it is made; it cannot be melted for later use.

   Each team should now obtain nutrient sterile Petri dishes by bringing them to the Sterigel Area. Make sure –students remove only one piece of tape from each. The teacher should pour the Sterigel, enough to halfway cover the bottom of each Petri dish. Students should then quickly close and retape their dishes, swirling them gently to evenly distribute the Sterigel. Work quickly and swirl the Sterigel bottle frequently to keep the nutrient suspension even. The Sterigel in the Petri dishes will set quickly, and students can add soil samples to their dishes within a few minutes.

   Teacher's Note: *The following instructions assume the use of Sterigel Instant Medium. If you have prepared your own medium, refer to the appendix at this point.*

   Students should obtain and plate out the seeded soils from Mars, Venus, and Earth. Review and demonstrate the plating techniques if necessary.

   Ask students to label their Petri dishes with their names and Venus, Earth, or Mars. Store at room temperature until mission 6.2.

Mission 6.2
Materials

For Each Student

- Growth of *Penicillium notatum* After Alien Conditions worksheet
- Did *Penicillium notatum* Survive? worksheet
- Pencil

Getting Ready

1. Copy the worksheets Growth of *Penicillium notatum* After Alien Conditions and Did *Penicillium notatum* Survive? for each student.

Classroom Action

1. **Activity**. Reassemble the class into mission 6.1's teams. Hand out the Growth of *Penicillium notatum* After Alien Conditions worksheet to each student. (Note that this worksheet has no teacher's key because student responses will vary; accept all reasonable attempts.) Return to students their Growth of *Penicillium notatum* worksheets from mission 3**.** Over the next few days, have students check their Petri dishes for growth of *Penicillium notatum.* Observations should be made at the same time intervals as the original observations in mission 3. Have students compare these new results with their previously recorded observations of *Penicillium notatum* growth and form their own conclusions.

2. **Discussion**. It is a good idea to have each team share their results and then pool the class data. Two problems may have arisen: 1) growth might have failed to occur where it should have occurred, and 2) growth might have occurred where it should not have occurred. In the first case, the random sample that was plated out might have failed to contain viable spores, even though spores were present in the seeded soil. In the second case, Petri dishes might have become contaminated with other species of microbes. Encourage students to make sure each new growth they see is *Penicillium notatum.*

The following results are expected:

Earth-Normal *Penicillium notatum* growth

Mars-Normal *Penicillium notatum* growth

Venus-No *Penicillium notatum* growth

Ask students if the results mean that there is life on Mars but not on Venus. *(This does not tell us whether or not there is life on Mars, but only that some forms of Earth Life could survive briefly under the low pressure and low temperature conditions on Mars.)*

Discuss the fact that there are other Martian characteristics that could prevent life from developing, including soil chemistry, reduced oxygen, high ultraviolet radiation due to the thin atmosphere, and desiccation due to low pressure. Each of these might affect life on Mars. Various tests simulating these conditions could be performed in a lab.

Present a wrap-up and reinforcement of the control idea and the fact that Earth conditions have not affected the *Penicillium notatum*. The simulated conditions of Mars and Venus are the variables. Discuss what this means for the possibility of life existing on Mars and on Venus.

3. **Activity.** Hand out the Did *Penicillium notatum* Survive? worksheet to students and have them answer the questions in class or as homework.

4. **Disposal.** After all observations of the Petri dishes have been made, the cultures need to be disposed of. A teacher should dispose of the cultures because they may contain harmful, even pathogenic, microbes. Your school may require certain disposal procedures. Disposal bags can be ordered from any biological supply catalog. Ideally, the cultures should be sterilized (autoclaved or micro-waved) before disposal. If micro-waved, heat on high for several minutes and watch for boiling. Avoid touching or inhaling spores from the microbial colonies; you may wish to wear a dust mask.

   You may be able to reuse the Petri dishes if they are sturdy enough to be autoclaved or otherwise sterilized.

Going Further

Activity: Longer Exposure

If there is time, have the class leave one or more Mars Jars in the freezer for longer periods as a simulation to see how long *Penicillium notatum* could survive the conditions found on Mars. Ask students to make another set of Mars Jars and freeze them, thawing out one or two every month and making cultures.

Activity: Is *Penicillium Notatum* Unique?

Ask students about *Penicillium notaturn's* ability to survive harsh conditions. Is it the only microbe that could survive conditions on Mars? Is it the only microbe that could not survive conditions on Venus? Have students repeat the procedures that they used in this mission using different microbes. Many kinds of microbes may be ordered from Carolina Biological Supply Company (see Ordering Information, in appendix).

Research: Life on Other Planets

Have students research the conditions on Mercury, Saturn, or any other planet. Ask student why the search for life has been narrowed to Mars and Venus. Have we skipped even better candidates for life-bearing planets or moons? Could we devise experiments that would simulate the conditions on Mercury, Saturn, or any other planet or moon?

Research: Life on Antarctica's Ice

Exobiologists are at work in Antarctica, investigating microbes that live in this frozen, rainless desert that is so like Mars. There are microbes that live in the rocks. Have students research the kinds of microbes. Is there higher life as well? How do we detect these microbes? How do the conditions where they live compare with conditions on Mars? There are also microbes living in freshwater lakes in Antarctica that are always covered with as much as 18 feet of ice. How do they survive? Where did they come from? Are there microbes living in permafrost? Could these microbes survive in the frost on Mars?

Venus Plates and Mars Jars! (Phase ll)

Did Earth Life Survive Conditions on Venus or Mars?

Culturing *Penicillium notatum* on Mars and Venus—Directions

You have seen how *Penicillium notatum* grows on Earth, and now that it has been exposed to the simulated environments of Mars and Venus, you can see if it has survived in those harsh environments.

Today, you will prepare three Petri dishes with a food supply for microbes-a nutrient gelatin medium. You will use seeded soil (containing *Penicillium notatum*) from Earth (to serve as a control), from Mars, and from Venus. You will culture the Mars and Venus seeded soils, which still contain *Penicillium notatum*, though it is your task to determine whether it is still alive or now dead. You will observe all three dishes for a few days, and record any growth of *Penicillium notatum.*

Procedure

1. Wash your hands and your work areas with soap and water.

2. Obtain three sterile Petri dishes and six pieces of masking tape. Tape shut your Petri dishes without opening them; this makes a hinge on one side of each dish and a rebreakable seal on the other. Write your names on all three dishes. Write Earth on one dish, Mars on the second, and Venus on the third.

3. Take your Petri dishes to the central area of the classroom where the nutrient gelatin medium is being prepared. Remove one piece of tape from each dish. Your teacher will

pour the nutrient medium into your Petri dishes. You must work quickly to close and re tape them. Gently swirl the dishes to evenly distribute the gelatin.

4. Obtain seeded soil from Earth, Mars, and Venus using three sterile carrying dishes.

5. Be careful when adding the seeded soil containing Penicillium notaturn to your Petri dishes. Do not inhale close to the seeded soil. Some people have an allergic reaction to this organism. If you are allergic to penicillin, let your partner handle the seeded soil while you handle the pure soil.

6. Sterilize a spatula with an alcohol swab. Sterilize the spatula before each use.

7. Plate out a sample of the seeded soil from Earth onto the nutrient gelatin of one Petri dish by using the sterilized spatula to lightly sprinkle about 114 teaspoon of the soil over the surface of the cooled, set gelatin.

8. Plate out a sample of the seeded soil from Venus onto the nutrient gelatin of the second Petri dish, using the same procedure.

9. Plate out a sample of the seeded soil from Mars onto the nutrient gelatin of the third Petri dish, using the same procedure.

10. Draw an arrow on each Petri dish. Use the arrow to orient your dishes the same way each time you look at them; this way you can identify colonies and chart their progress as they grow bigger. Store your Petri dishes. You will be observing them over the next several days. Your dishes should be left at room temperature.

Venus Plates and Mars Jars! (Phase ll)
Did Earth Life Survive Conditions on Venus or Mars?

Did *Penicillium notatum* Survive?—Teacher's Key

1. Earth conditions allowed the *Penicillium notatum* to survive and grow normally. This is known because the growth appears the same as it did in the Earth cultures in mission 3**.**

2. The simulated conditions of Mars do not seem to have affected the *Penicillium notaturn's* growth patterns! (They survived the cold and the low pressure! Maybe they could even live on Mars!) This is known because the growth appears the same as i t did in the Earth cultures in mission 3**.**

3**.** Earth organisms (at least this microbe!) can survive in the conditions on Mars for a short period of time, but we really don't know if they could survive these conditions for one year or five years or longer.

4. Venusian conditions have severely affected the *Penicillium notatum's* growth patterns; there is no growth.

5. Apparently, *Penicillium notatum* cannot survive in conditions on Venus. They all died in just an hour in the heat of an Earth oven. In all probability, there are no Earth organisms that could survive Venusian conditions.

6. This experiment is significant in our search for life on Mars and Venus because it shows that Mars could support life as we know it. This does not prove that there is any life on Mars. We can also see that Venus is not as hospitable an environment as Mars is-at least for one kind of Earth microbe!

7. Yes, we should be careful. We might introduce an Earth microbe into an environment in which it might grow wild and destroy any native life. Or a microbe could later fool investigators into thinking that it was a species of life that had always lived on Mars.