Partners Belowground

Trace how two microbes help bean roots, and when the trade is worthwhile.

BOT.1.4 "Evaluate and explain how bacteria and fungi work symbiotically to enhance plant root function."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB As you read, underline what the plant receives from each microbe, circle what each microbe receives, and write 1 beside a sentence that connects the two partnerships.

A Bean Plant's Underground Partners

1 At a school garden, a bean plant faces two problems underground: little usable nitrogen and phosphorus that moves slowly through soil. Certain bacteria enter its young roots and live in nodules, small swellings the plant builds. Given sugars from the plant, these bacteria convert nitrogen gas from air spaces in soil into forms the plant can use to build proteins. The plant spends energy making those sugars, so the partnership is not free. A root can absorb some nutrients alone, but bacteria give it access to nitrogen that the root cannot obtain directly from nitrogen gas.

2 Another partner, an arbuscular mycorrhizal fungus, grows inside root tissue and sends thin threads into the surrounding soil. Its threads reach beyond the root's immediate zone and take up phosphorus and water, which the fungus passes to the plant. The plant supplies the fungus with sugars made during photosynthesis. Phosphorus helps a bean plant make the energy-rich molecules needed for growth and for maintaining active nodules. When phosphorus is scarce, fungal delivery can support the plant's bacterial partnership indirectly. Bacteria and fungus do different jobs, yet both depend on the same plant for carbon.

3 Imagine two sunny bean beds with the same low-nitrogen soil. In Bed A, phosphorus is also scarce and often lies beyond the reach of roots; in Bed B, phosphorus is plentiful near roots. If both beds contain the right bacteria and fungus, Bed A may gain more from fungal threads because extra phosphorus can help sustain nitrogen-fixing nodules. In Bed B, the plant may get enough phosphorus without needing fungal delivery, making the fungus's sugar cost harder to justify. Partnerships are not guaranteed to increase growth: the plant must gain more nutrients than it loses in the sugars it supplies. Soil conditions can change the balance.

2 ANSWER WITH EVIDENCE

Use the passage

1. How could the fungus increase the nitrogen benefit a bean plant gets from bacteria, even though the fungus does not fix nitrogen?

2. Why can the bacteria improve root function even though the root already absorbs some nutrients from soil?

3. Which bed, A or B, is more likely to gain enough from the fungus to justify its sugar cost? Explain using phosphorus access.

4. Suppose a bean plant is shaded but its soil remains low in nitrogen and phosphorus. Why might both partnerships be less helpful than they are for a sunny plant?

3 YOUR TURN

Your own words

Design a fair test in a sunny, low-nutrient garden bed to find out whether bean plants grow better with both partners than with only one. Name the groups, one condition you would keep the same, and measurements of growth and of both nutrient benefits.

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PART 1 · READ AND MARK

As you read, underline what the plant receives from each microbe, circle what each microbe receives, and write 1 beside a sentence that connects the two partnerships. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How could the fungus increase the nitrogen benefit a bean plant gets from bacteria, even though the fungus does not fix nitrogen?	**Fungal threads deliver phosphorus. The plant needs phosphorus to make energy-rich molecules and maintain active nodules, where bacteria fix nitrogen.**
2	Why can the bacteria improve root function even though the root already absorbs some nutrients from soil?	**The bacteria convert nitrogen gas into usable forms that the root cannot obtain directly from the gas.**
3	Which bed, A or B, is more likely to gain enough from the fungus to justify its sugar cost? Explain using phosphorus access.	**Bed A is more likely to benefit because fungal threads can reach scarce phosphorus beyond the roots. In Bed B, phosphorus is already plentiful near the roots, so fungal delivery may not justify its sugar cost.**
4	Suppose a bean plant is shaded but its soil remains low in nitrogen and phosphorus. Why might both partnerships be less helpful than they are for a sunny plant?	**Shade can reduce photosynthesis, leaving the plant with less sugar to supply both microbes. Their nutrient benefits may then be harder for the plant to sustain.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would grow four groups of bean plants: neither partner, bacteria only, fungus only, and both partners. I would give every group the same amount of sunlight and water. After the same number of weeks, I would measure each plant's dry mass to compare growth. I would also measure nitrogen and phosphorus in the leaves to see whether the groups received different nutrient benefits.

Accept explanations that link fungal phosphorus delivery to the plant's ability to support active nitrogen-fixing nodules. For the fair test, accept other valid growth and nutrient measurements if the groups differ only in which partners are present.