Area: Microbial Ecology

Microorganism: *Rhizobium meliloti*

Reference: Hornez, J.-P., Timinouni M., Defives, C., and Derieux, J.-C. 1994. Unaffected nodulation and nitrogen fixation in carbohydrate pleotropic mutants of *Rhizobium meliloti*. Current Microbiology 28:225-229.

*Rhizobium meliloti* is a Gram-negative bacterium that forms nodules in the roots of alfalfa plants. Fixation of nitrogen in these nodules provides ammonium as a nitrogen source for both the bacteria and the plants. To identify the compounds used as carbon sources by the bacteria in the plants, Hornez et al. isolated a mutant of *R. meliloti* that could not take up and degrade monosaccharides. They then tested this mutant for its ability to cause nodulation and nitrogen fixation in alfalfa.

1. Nitrogen fixation in root nodules is an example of:

a. commensalism

b. mutualism

c. competition

d. predation

2. The initial stage of infection of alfalfa by *Rhizobium* involves:

a. penetration of the stem by insects.

b. entry of the bacteria through the leaves.

c. formation of infection threads in root hairs.

d. penetration of the root by insects.

3. The enzyme that carries out the nitrogen fixation reaction usually contains:

a. nitrogenase

b. nitrogenase + nitrogenase reductase

c. nitrogenase + nitrogenase reductase + ferredoxin

d. nitrogenase reductase + ferredoxin

Hornez et al. began with a wild-type strain of *R. meliloti* designated M5N1 and isolated a mutant called 2-10 by mutagenesis in the laboratory. When they compared the ability of the parental strain and the mutant to grow in a minimal medium with various compounds as carbon sources, they obtained the results shown in the following table.

Diagram

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4. Which statement is best supported by these data?

a. The parental strain uses only monosaccharides as carbon sources.

b. The parental strain uses only organic acids as carbon sources.

c. The mutant strain uses only monosaccharides as carbon sources.

d. The mutant strain uses only organic acids as carbon sources.

Hornez et al. then compared the growth the strains M5N1 and 2-10 in a minimal medium containing both glucose and succinate. They obtained the results shown in the following graph.

Diagram

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5. These results indicate that:

a. the growth rate of the parental strain is the same with either glucose or succinate.

b. the growth rate of the parental strain with succinate as the carbon source is faster than that of the mutant.

c. the parental strain first uses glucose as the carbon source and then uses succinate as the carbon source.

d. the parental strain first uses succinate as the carbon source and then uses glucose as the carbon source.

Hornez then tested the ability of the parental strain and the mutant to form nodules within alfalfa roots and fix nitrogen. The results are shown in the following table.

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6. These data indicate that:

a. nitrogen fixation does not occur in nodules formed by the mutant.

b. nitrogen fixation does occurs at the same rate in nodules formed by both the mutant and the parent.

c. nitrogen fixation in nodules formed by the mutant occurs at about 2/3 the rate of the parent.

d. nitrogen fixation and plant dry weight show no correlation.

7. Based on these results, it can be concluded that:

a. organic acids can serve as sole carbon sources for nitrogen fixation.

b. only monosaccharides can serve as carbon sources for nitrogen fixation.

c. monosaccharides are required as carbon sources for nitrogen fixation.

d. only organic acids can serve as carbon sources for nitrogen fixation.

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