How-To-Do-It

Magnetotactic Bacteria in the Classroom

Patrick Guilfoile

Magnetotactic bacteria are a widespread group of microorganisms that are able to orient in the earth's magnetic field using biosynthesized magnetite (Blakemore 1982). They are found in the bottom sediment of nearly any aquatic environment including marshes, swamps, rivers, lakes, and estuaries (Blakemore 1982).

First described by Richard Blakemore in 1975, magnetotactic bacteria have been of great interest to researchers during the past decade (Blakemore and Frankel 1981). This paper presents information on how these fascinating microorganisms can be used in high school and college biology classrooms using simple equipment and techniques. Equipment includes: depression slides; cover slips; vaseline; droppers; beaker with culture; darkfield microscope (Fig. 1).

Why Use Magnetotactic Bacteria?

Magnetotactic bacteria are large, rapidly motile, and demonstrate a novel tactic response. Further, they are easy to collect, easy to maintain, and easy to isolate in nearly pure culture, making them useful organisms for classroom study.

Culturing Magnetotactic Bacteria

To culture these bacteria, gather bottom sediment from an aquatic environment. Sediment from swamps seems to be particularly rich in magnetotactic bacteria.

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A 13-min. videotape, produced by Guilfoile, shows the collection, culture, and movement of magnetotactic bacteria. This tape is available from Sherry Severson, Media Development Center, Univ. of Wisconsin-Eau Claire, Eau Claire, WI 57401. (716)836-2651.

Place the sediment in 1-2 liter jars or beakers. Good growth of these bacteria occurs when the jars are half full of sediment, topped with a column of marsh or distilled water about 6 cm high. The jars should be loosely covered with food wrap to slow evaporation, and swathed in brown paper or aluminum foil to inhibit the growth of algae. The jars should be allowed to sit undisturbed for a period of 1-2 months in a dimly lit or dark room. After this incubation period, the jars should contain detectable populations of magnetotactic bacteria. Their numbers usually remain high for 1-2 years with only the occasional addition of water.

Isolating the Bacteria

Once enriched, magnetotactic bacteria can be easily isolated from the sediments by taking advantage of their unique method of navigation. Place the south ends of a bar magnet on either side of a jar containing concentrations of these microorganisms. After 15-45 minutes, a concentration of bacteria will appear as a white dot at the focus of the magnets (Fig. 2). The bacteria can be removed by using an eyedropper or Pasteur pipette, placed in the region of bacterial concentration. (See diagram for a step-by-step description of the culturing and isolation process. See Fig. 3)

Observing the Bacteria

Once removed from the culture, the bacteria are best observed when placed in a hanging drop slide. Dark-field or phase-contrast microscopes should be used for observing these bacteria. If standard dark-field micro-

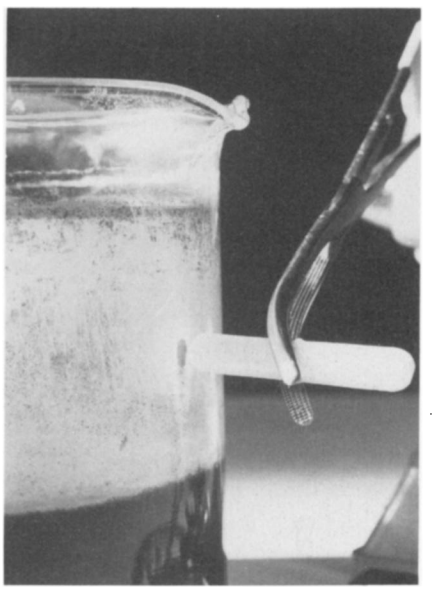

FIGURE 2. Magnetotactic bacteria can be collected by placing the south end of a bar magnet at the side of a jar containing these microorganisms. An aggregation of bacteria appears as the large spot at the focus of the magnet.

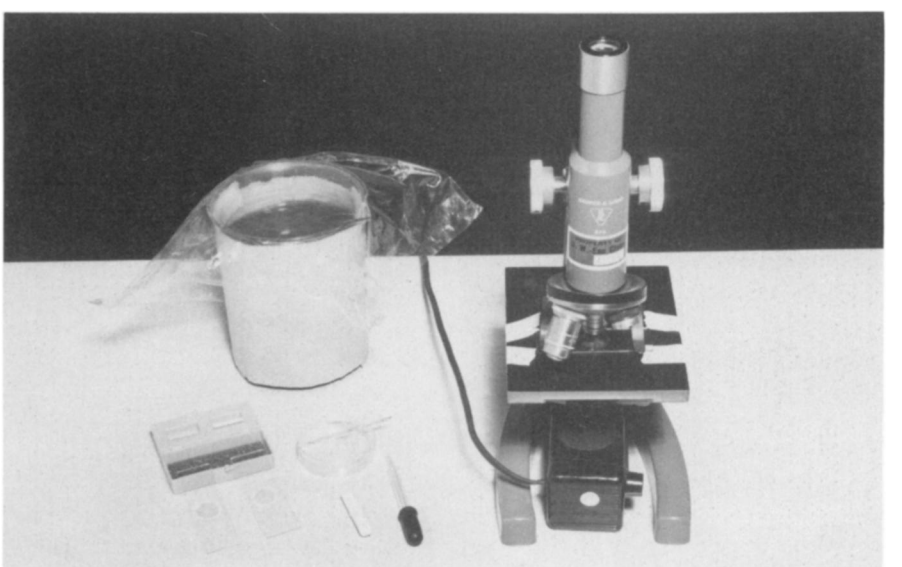

FIGURE 1. Equipment needed for observing magnetotactic bacteria: coverslips and depression slides, bar magnet, vaseline and toothpick, beaker with sediment, microscope with dark-field illumination.

scopes are unavailable, student microscopes can be easily converted to dark-field illumination, using techniques described by Sundberg (1984). These bacteria are normally fairly large, and can be easily observed using 100x magnification (Fig. 4).

To demonstrate the tactic response of these microorganisms, a bar magnet is placed on the microscope stage (Fig. 5). Changing the pole of the magnet causes the bacteria to move from one end of the water droplet to the other. These bacteria (in the Northern Hemisphere), are attracted to the south end of a bar magnet and repelled from the north pole of a bar magnet.

Summary

Magnetotactic bacteria provide students with excellent demonstrations of bacterial motility, a unique form of taxis (magnetotaxis), and they are also fascinating creatures to observe. Due to the relative ease of collection and maintenance of cultures, these bacteria seem well-suited for use in high school and college biology laboratories.

References

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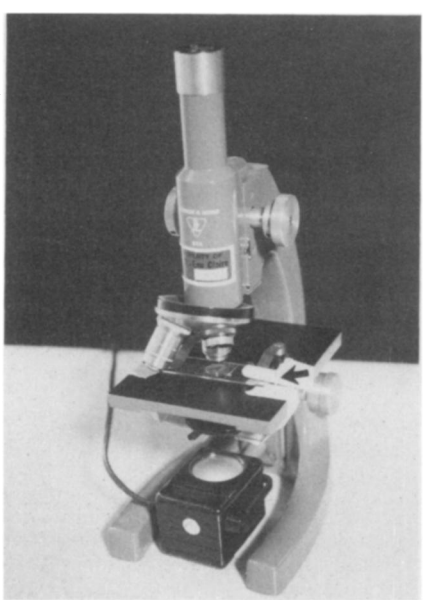

FIGURE 4. Tactic response of these microorganisms can best be seen when a bar magnet is placed on the microscope stage (arrow). The bacteria move rapidly when the pole of the magnet is reversed or moved to another area of the slide.

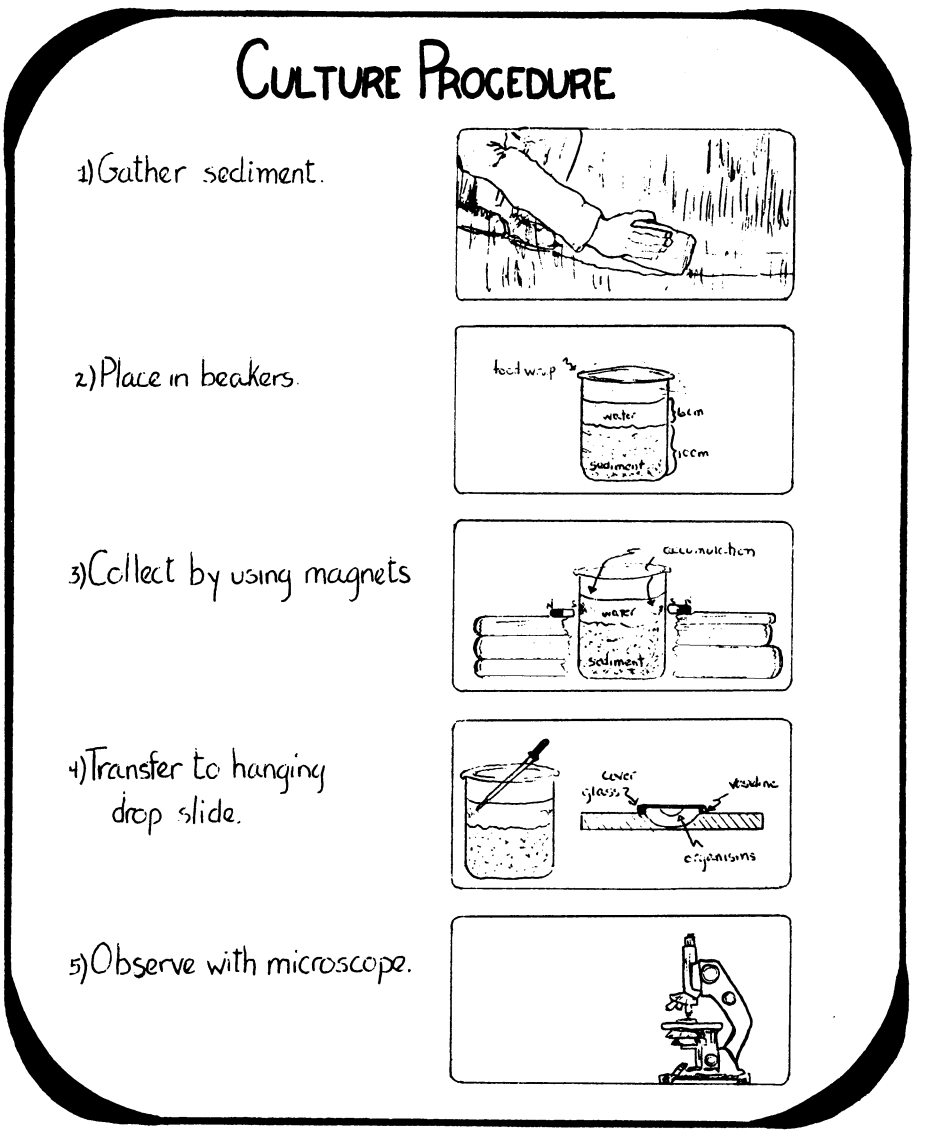

FIGURE 3. Capsule summary of procedure for collecting, maintaining, and observing magnetotactic bacteria.