

## **Nine: Appropriate technology is used for gathering and analyzing data as student teams design experiments following their own experimental pathways**

To investigate temperature effects, students can use thermometers or temperature probes interfaced to graphing calculators or computers. Have students monitor temperatures in controlled-temperature water baths set up in styrofoam coolers with ice or ice packs for lower temperatures, and hot water for higher temperatures.

Students measuring pH effects can use: indicator solutions, pH paper, pH meters, and/or pH probes interfaced to graphing calculators or computers. Students can make solutions of varying pH using vinegar and baking soda, or, more experienced students could prepare buffer solutions at varying pH levels. Students can use the pH probe to monitor pH changes in the yeast suspension.

Students testing catalase from plant materials can make water or buffer homogenates of the tissues using blenders or mortar and pestle sets. To maintain enzyme activity, the homogenate must be kept on ice. See tips for handling enzymes in **Resources**. The homogenates can be filtered through layers of cheesecloth. Students can begin to quantify activity by weighing tissue samples and keeping careful records of volumes of liquid added.

Students can use microscopes and hemocytometers to count cells in the yeast suspension. They could use pressure probes interfaced to graphing calculators or computers as another way of measuring yeast catalase activity.

Statistical analysis can be performed using TI-84 or Excel spreadsheet functions, graphical analysis curve fitting in Excel, or using, for example, Vernier graphical analysis software.

Before designing their experiments, students may need instruction in working with new equipment and using new techniques. They will need time to practice these techniques and to do initial explorations, just as they did with the floating disc assay. They will need to try out procedures and techniques in order to design a realistic experiment and to anticipate how much they will be able to accomplish in the time allotted. For example, before students decide to test yeast catalase activity at 10 different temperatures, they need to experience the difficulties inherent in setting up and maintaining constant temperature bath. Then they can plan how many different temperatures to test in the available time.

This experimentation will lead to many more good research questions:

- What is the effect of varying temperature of the yeast suspension? What is the optimal temperature?
- What is the effect of varying the age of the yeast suspension on catalase activity? What is the optimal age?
- What is the effect of varying the sugar in the yeast suspension?
- What is the relationship between yeast viability and catalase activity?
- What is the relationship between yeast population density and catalase activity?
- How does the pH in the yeast suspension change as a function of time? What pH is optimal for yeast population growth? For catalase activity?
- Which potato tissue has greater catalase activity, the skin, eyes or the center tissue?
- Which has greater catalase activity, fresh or wilted lettuce? Which type of lettuce has the greatest catalase activity?