EXERCISE 2-1

EARLY EXPERIMENTS IN SPONTANEOUS GENERATION

Even though Leeuwenhoek discovered microorganisms (yeasts, bacteria, and other one-celled organisms) in the latter half of the seventeenth century, it was nearly two hundred years before the study of microorganisms and their activities received much attention from the scientific world. The delay was due in part to the lack of adequate methods of observation and study. With the development and use of the optical microscope there was a growing belief that microorganisms were connected with the putrefaction (rotting) of meat and the fermentation of fruit juices. Scientists and philosophers speculated on the causes of putrefaction and fermentation. Likewise, there was speculation on the origin of the microorganisms observed in fermenting juices and putrefying infusions. Chapter 2 in the textbook discusses the question about the origin of life through **spontaneous generation** and should be read before doing this exercise.

Do microorganisms cause fermentation and putrefaction, or are they the result of these processes?

Do microorganisms arise from the nonliving materials; that is, do they appear spontaneously? Or do they come from pre-existing microorganisms? And if so, how? Such questions led scientists into a heated controversy about the spontaneous generation of yeasts, bacteria, and other microorganisms. This battle was raging when Louis Pasteur was doing his work on fermentation a century ago. Because microorganisms are so small that they cannot be seen individually, with the unaided eye, it is difficult to answer these questions by simple observation.

At the time of the American Revolution, an Italian, Lazzaro Spallanzani, had conducted many experiments with hay infusions in an attempt to answer these questions—specifically, to test the popular theory of spontaneous generation. But his results and his interpretation of them failed to convince those who believed in spontaneous generation. Later, Louis Pasteur, seeking the answers, carried out carefully designed experiments with yeast and sugar which he performed in connection with his public lectures. His experiments provided more decisive answers.

■ **The purpose of this demonstration is to visualize the work of Spallanzani and Pasteur.**

MATERIALS

500 ml nutrient broth of beef bouillon
Seven flasks (250 ml)
Straight glass tube (7-8 mm diameter) 8-10 cm long
C-shaped glass tube (7-8 mm diameter) 14-16 cm long
S-shaped glass tube (7-8 mm diameter) 18-20 cm long
Five cork stoppers for flasks, three with holes to receive glass tubes
Screen or gauze
Sealing wax or paraffin
Graduated cylinder (100 ml)

PROCEDURE

Put 70 milliliters (ml) of the broth into each flask.

Treat the flasks as follows:

Flask 1: Overall control
Plug with cork stopper and seal the cork to the flask with warm wax or paraffin. Do not heat.

Flask 2: Spallanzani's control
Boil gently for 15 minutes. Leave open.

Flask 3: Spallanzani's experiment
Boil gently for 15 minutes. After heating, close with a cork. Seal with wax or paraffin.

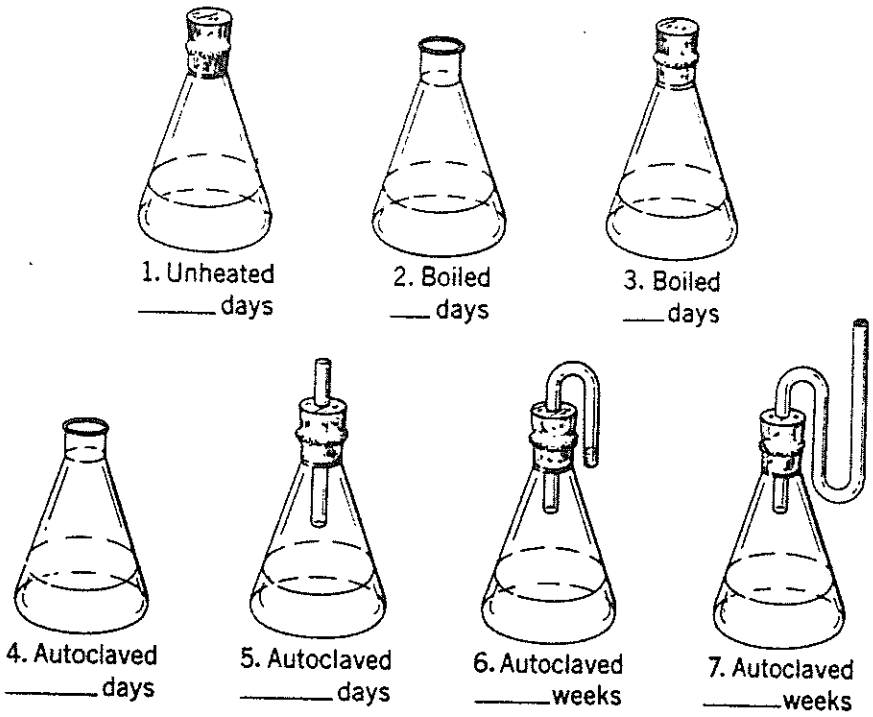

Figure 2-1-1 **Spontaneous generation.**

Flask 4: Pasteur's control

Heat in the pressure cooker or autoclave for 15 minutes at 15 lbs pressure. Leave unplugged.

Flask 5: Modified Pasteur's control

Plug with a cork stopper through which an open, straight glass tube has been inserted. Heat in the pressure cooker or autoclave as for Flask 4. Then seal cork with wax or paraffin.

Flask 6: Pasteur's first experiment

Plug with a cork stopper through which the C-shaped glass tube has been inserted. Heat in pressure cooker or autoclave as for Flask 4. To seal the exposed end of the C-tube, heat gently and plug with wax or paraffin. Also seal the cork to the flask.

Flask 7: Pasteur's final experiment

Plug with a cork stopper through which the S-shaped tube has been inserted. Heat in the pressure cooker or autoclave as for Flask 4. Seal the cork to the flask with warm wax or paraffin.

Put all the flasks on a laboratory table (not in direct sunlight or over a radiator).

Look for changes in the flasks, at first from day to day, later on from week to week. When any changes in the appearance of the flasks have occurred, record them and also note whether any odor is present in those which are open. Do not remove any corks, however, as that would, of course, spoil the experiment.

Record your observations in your notebook in a list numbered to correspond to the entries in Figure 2-1-1. Show changes by describing the contents of the flask and stating the number of days or weeks before each of the described changes appears. (1)

From the observations you have made on the contents of the flasks, what are your conclusions about the origin and sources of microorganisms in nutrient broth? (2)

Why is it important to leave Flasks 2 and 4 unplugged? (3)

What is the purpose of the S-shaped tube in Flask 7? (4)

Why was Pasteur's experiment more successful than Spallanzani's? (5)

What argument might be brought by an abiogenist against sealing Flask 6? (6)

What practical aspects of this experiment can you suggest? (7)