# BIOLOGY 12
## EXPERIMENTAL DESIGN QUESTIONS

The K–12 Science Curriculum implicitly assumes that most modern scientific knowledge has been obtained through empirical experimentation. The scientific method assumes the following sequential steps:

1. Observing natural phenomena which leads to the clear statement of a question.
2. Researching information related to the question.
3. Using knowledge, experience, insight and imagination to formulate a hypothesis to serve a testable answer to the question.
4. Designing and carrying out a controlled, repeatable experiment to test the hypothesis.
5. Determining whether the data obtained support or reject the hypothesis.
6. Reporting the results to others.

In order to demonstrate the ability to devise an experiment using the "scientific method," students should be able to:

1. Indicate how the above steps are applied to a scientific inquiry.
2. Design a controlled experiment where:
   - a hypothesis is produced (given a question)
   - procedures are implemented to test the hypothesis
   - a control is included which will serve as a known comparison to the resulting data.

Below is an example of an experimental design item. It covers a number of curricular areas. It is an "understanding" level item and appears as five written-response questions. These questions cover all of the expectations of experimental design, only some of which may be examined on any specific examination as a multiple-choice or written-response question. Students who practice this example should be successful on similar questions.

1. State a hypothesis that could be used to design an experiment determining whether trypsin is the enzyme responsible for protein hydrolysis in the small intestine.

**Response:**

- **Trypsin is more effective at hydrolyzing proteins than other enzymes found in the small intestine.**

2. Using any of the materials listed below, design an experimental procedure that could be used to test the hypothesis.

   - Seven bottles each containing a different enzyme. The enzymes trypsin, pancreatic amylase, maltase, peptidase, lipase, nuclease and nucleosidase are at the same concentration and at a basic pH.
   - A bottle containing a protein solution of known concentration.
   - Test tubes and a test tube rack.
   - A device capable of measuring the concentration of protein in a solution.
   - A water bath capable of maintaining the bottles and test tubes at a constant temperature.

**Response:**

- **Fill seven of the test tubes with an equal amount of protein solution.**
- **Add a different enzyme to each of the test tubes.**
- **Maintain the test tubes at 37°C for one hour (times may vary).**
- **Measure the resulting concentrations of protein in each of the tubes.**

3. In order for the hypothesis to be supported, what substance should be found in the tube containing trypsin but not in the other tubes at the conclusion of the experiment?

**Response:**

- **peptide molecules**

4. What could be used as a control in this experiment?

**Response:**

- **Apply the procedure above to a second set of seven tubes without the enzymes.**

5. What is the purpose of the control?

**Response:**

- **to provide a baseline to compare with the activity of the enzymes**
- **to make sure no other variables are responsible for the hydrolysis of the protein**