Define the following terms:

1. data: The information gathered from making observations.
2. independent variable: The variable that is deliberately changed by the scientist.
3. dependent variable: The variable observed during the experiment. It is the data collected as a result of changing the independent variable.
4. scientific method: A series of steps used by scientists to solve a problem or answer a question.

Short Answer:

1. List the steps to the scientific method.

   1) Observe / Ask a question.
   2) Form a hypothesis.
   3) Design a controlled experiment.
   4) Record and analyze the results.
   5) Draw a conclusion.

2. How is a theory different from a hypothesis?

   A hypothesis is an “educated guess” that is testable through observations and experimentation. A theory is a broad statement of what is believed to be true based on many experiments and considerable amounts of data.

3. Give two examples of quantitative data.

   There are many possible answers. Any type of answer that is “numerical” should be accepted. Possibilities might include: Number of students who failed a particular test. The amount of weight gain by mice when fed a particular diet.

4. Give two examples of qualitative data.

   There are many possible answers. Any type of answer that is “descriptive” should be accepted. Possibilities might include: Starch turns purple in the presence of iodine. During mating season, male bird plumage becomes bright and colorful.

5. How many variables should an experiment test at a time? Explain your answer.

   Only one variable can be tested at a time. If several variables were changed at the same time, the scientist would not know which variable was responsible for the observed results.

6. Why is it important that scientists communicate and report their findings?

   In order for the findings to be considered “valid”, the experiment must be repeated by other scientists so that the results may be verified and corroborated.
7. A drug company is testing the effectiveness of a new blood pressure medicine using rats as the test subjects.
   a) Describe the experimental group: The experimental group will consist of a set number of rats that will be given the new blood pressure medicine.

   b) Describe the control group: The control group will consist of a set number of rats that will not receive the new blood pressure medicine.

   c) What is the independent variable? The administering or not administering of the blood pressure medicine.

   d) What is the dependent variable? The observed changes in blood pressure of the test subjects.

   e) What are some possible factors that must remain constant during the testing?
      All rats should be fed the same diet and in the same quantity.
      All rats should be kept at the same stress level.
      All rats should be housed in the same type of cages.
      All rats should be kept at the same temperature.
      The rats should be all of one species.

   f) What is the ONE factor that will be different between the experimental group and the control group? Whether or not the rats receive the new blood pressure medicine.

8. What is meant by the term “controlled experiment”?
   In a “controlled experiment” only one variable is changed at a time. All other variables should be unchanged or “controlled.”

9. Why must experiments be repeated many times?
   Experiments are repeated in order to see that the same results are obtained each time. Results cannot be considered “valid” until it is determined that the experiment will always yield the same conclusion.

**Fill in the blanks:**

1. The part of the experiment in which the experimental factor has been removed is referred to as the **control**.

2. The group that shows the effect of the variable being tested is called the **experimental group**.

3. Over time, a hypothesis that is supported by many experiments and much data becomes a **theory**.

4. The purpose of an experiment is to determine if the **hypothesis** is correct or incorrect.
Read each statement and determine if the statement is true or false. If the statement is false, correct the underlined word to make the statement true.

1. A biologist who is measuring the length of salmon as they travel upstream is collecting qualitative data.  False: Correct answer is “quantitative” data.

2. An experiment is a procedure that tests a hypothesis by providing data and observations under controlled conditions.  True

3. In scientific investigations, experimenting usually comes before hypothesizing.  False: Correct answer is “after”.

4. In an experiment, the control group is used to test the effect of the independent variable.  False. Correct answer is “experimental” group.


Multiple Choice:

1. Which of the following would be done last if one is following the scientific method? (a) forming a hypothesis (b) observing a problem (c) performing an experiment (d) reporting the results.  Correct answer: d

2. A hypothesis: (a) can be tested (b) is a prediction about the expected outcome of an experiment (c) must be stated in a form that can be either proven or disproven (d) all of the above are true.  Correct answer: d

3. The factors in an experiment that can be changed are called: (a) variables (b) data (c) the hypothesis (d) the control.  Correct answer: a

Identify the independent variable and the dependent variable in each of the following hypotheses:

1. The process of photosynthesis requires a source of carbon dioxide.  
   HYPOTHESIS: Increasing the concentration of carbon dioxide available to aquatic plants will increase the rate of photosynthesis, as measured by the number of oxygen bubbles produced.

   Independent variable: The various concentrations of carbon dioxide that are to be tested.

   Dependent variable: The number of oxygen bubbles produced at each concentration of carbon dioxide tested.

2. Cell membranes are fragile and can easily be damaged by various substances.  
   HYPOTHESIS: When testing the effect of different alcohols on the cell membrane of red beet cells, the damage to the membrane can be measured by the amount of red dye released into the solution.

   Independent variable: The different alcohols being tested.

   Dependent variable: Amount of red dye released as a result of a particular alcohol.
3. Water is the solvent of life, meaning that many substances can easily dissolve in it. 
**HYPOTHESIS:** Increasing the temperature of a salt water solution will result in a greater amount of salt being dissolved in the solution.

Independent variable: The different temperatures that are tested.

Dependent variable: The amount of salt that will dissolve at a particular temperature.

4. Transpiration is the loss of water from the leaves of plants. The stomata of leaves must open to allow carbon dioxide to enter the leaf for photosynthesis, but when they are open, water vapor escapes into the atmosphere. 
**HYPOTHESIS:** As the intensity of light is increased, the rate of transpiration will increase, as measured in the lab by the loss of mass of the plant.

Independent variable: The different light intensities being tested.

Dependent variable: The mass lost at each light intensity.

5. A catalyst is a substance used to increase the rate of a chemical reaction. Two catalysts are tested to see which will most effectively increase the rate of hydrogen peroxide decomposition. Hydrogen peroxide decomposes into water and oxygen.

**HYPOTHESIS:** Catalyst A will increase the rate of reaction faster than Catalyst B.

Independent variable: The two catalysts being tested and compared.

Dependent variable: The rate of reaction as measured by the amount of oxygen gas given off.

6. Enzymes are biological catalysts. Enzymes are proteins that are found inside cells to increase the rate of chemical reactions within each cell. Enzymes are denatured (destroyed) by various environmental conditions. Amylase is an enzyme in the digestive system that helps to break down complex carbohydrates into simple sugars.

**HYPOTHESIS:** Amylase works best in an environment with a pH level of 7.

Independent variable: The testing of various pH levels, including levels below and above 7.

Dependent variable: The amounts of simple sugars produced at each pH level.