Test Bank to accompany Jay Phelan’s What Is Life? A Guide to Biology with Physiology, Third Edition

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Chapter 1

Scientific Thinking

Multiple-Choice Questions

1. Biology is to science as \_\_\_\_\_\_\_\_ is to \_\_\_\_\_\_\_\_.

a) baseball; tennis

b) basketball; sports

c) American soccer; European football

d) college baseball; professional baseball

e) the home team; the visiting team

Answer: b

Section: 1.1

Bloom’s level: 4

2. Biology is \_\_\_\_\_\_\_\_.

a) mostly a collection of facts that can be ordered and memorized

b) the study of living things

c) always used responsibly in advertising claims

d) a separate branch of science from the study of how organisms interact with each other and with their environment

e) Both a and b.

Answer: b

Section: 1.1

Bloom’s level: 2

3. Biological literacy is the ability to:

a) use the process of scientific inquiry to think creatively about real-world issues that have a biological component.

b) communicate ideas about biology to others.

c) integrate ideas about biology into your decision-making.

d) All of the above are components of biological literacy.

e) Only b and c are components of biological literacy.

Answer: d

Section: 1.2

Bloom’s level: 3

4. All of the following are elements of biological literacy EXCEPT the ability to:

a) use the process of scientific inquiry to think creatively about real-world issues having a biological component.

b) communicate with others about issues having a biological component.

c) integrate thoughts about issues having a biological component into your decision-making.

d) write clearly and precisely about your observations, data gathering, and conclusions.

e) All of the above are elements of biological literacy.

Answer: e

Section: 1.2

Bloom’s level: 2

5. Thinking scientifically relies on which of the following?

a) intuition

b) objective observation and experimentation

c) statements from authorities

d) learning a list of facts

e) applying your preconceptions

Answer: b

Section: 1.3

Bloom’s level: 1

6. Superstitions are:

a) irrational beliefs that actions not logically related to a course of events influence its outcome.

b) held by some humans but not by any non-human species.

c) true beliefs that have yet to be fully understood.

d) proof that the scientific method is not perfect.

e) just one of many possible forms of scientific thinking.

Answer: a

Section: 1.3

Bloom’s level: 1

7. Science is self-correcting. This means that:

a) science actively seeks to disprove its own theories and hypotheses.

b) science is incapable of producing mistaken beliefs if its studies are carefully done.

c) scientists correct their own biases before engaging in scientific study.

d) when scientists make mistakes in their statistical analyses, their statistical software always catches those mistakes.

e) scientists have impeccable manners.

Answer: a

Section: 1.3

Bloom’s level: 4

8.



Using the graphic above as a guide, what is Step 4 in the scientific process?

a) Make observations.

b) Formulate a hypothesis.

c) Devise a testable prediction.

d) Conduct a critical experiment.

e) Draw conclusions and make revisions.

Answer: d

Section: 1.4

Bloom’s level: 3

9. What should you do when something you believe turns out to be wrong?

a) Change your mind.

b) Feel ashamed.

c) Blame the government.

d) Hold to your beliefs.

e) Doubt your ability to properly perceive the sensory stimuli of the world.

Answer: a

Section: 1.4

Bloom’s level: 3

10. In a recent study, patients treated with a genetically engineered heart drug were able to walk on a treadmill for 26 seconds longer than those not receiving the drug and showed no side effects. Can we conclude that this drug is an effective treatment for heart disease?

a) Yes.

b) No. It is not clear that the proper controls were made.

c) No. It is not clear that the drug is not a placebo.

d) No. It is not clear how many subjects were in the study.

e) No. Genetically engineered drugs cannot be tested via the scientific method. They require comparative observations.

Answer: b

Section: 1.4

Bloom’s level: 6

11. You note a fuzzy growth on some of the gels in your incubator. What is the name given to this step of the scientific method?

a) observation

b) hypothesis

c) law

d) theory

e) confirmation

Answer: a

Section: 1.5

Bloom’s level: 2

12. Scientific study always begins with:

a) observations.

b) conclusions.

c) hypotheses.

d) predictions.

e) experiments.

Answer: a

Section: 1.5

Bloom’s level: 3

13. Which of the following is usually employed before the others by an investigator using the scientific method?

a) Make observations.

b) Formulate a hypothesis.

c) Devise a testable prediction.

d) Conduct a critical experiment.

e) Analyze data.

Answer: a

Section: 1.5

Bloom’s level: 3

14. The raw materials of science are:

a) observations.

b) hunches.

c) predictions.

d) theories.

e) hypotheses.

Answer: a

Section: 1.5

Bloom’s level: 3

15. “Engaging in aerobic activity three times each week will reduce cholesterol levels” is a:

a) control group.

b) testable hypothesis.

c) scientific control.

d) critical experiment.

e) All of the above are correct.

Answer: b

Section: 1.6

Bloom’s level: 3

16. Scientific data:

a) must be collected in laboratories.

b) are used to support or refute a hypothesis.

c) cannot be collected in a completely unbiased way.

d) are always true.

e) All of the above are true.

Answer: b

Section: 1.6

Bloom’s level: 1

17. If your hypothesis is “Estrogens in sewage runoff turn fish into hermaphrodites,” what is your null hypothesis?

a) Estrogens in sewage runoff have no effect in turning fish into hermaphrodites.

b) Estrogens in sewage runoff turn turtles into hermaphrodites.

c) Estrogens in sewage runoff turn hermaphroditic fish into unisexual fish.

d) Testosterones in sewage runoff turn fish into hermaphrodites.

e) Testosterones in sewage runoff have no effect in turning fish into hermaphrodites.

Answer: a

Section: 1.6

Bloom’s level: 6

18. In a well-designed experiment, the:

a) prediction will be highly probable if the explanation is correct.

b) prediction will be highly improbable if the explanation is incorrect.

c) prediction will most likely be true.

d) null hypothesis will not be tested.

e) Both a and b.

Answer: e

Section: 1.6

Bloom’s level: 2

19. Which of the following statements is CORRECT?

a) The scientific method can be used only to understand scientific phenomena.

b) Common sense is usually a good substitute for the scientific method when trying to understand the world.

c) A hypothesis that does not generate a testable prediction is not useful.

d) It is not necessary to make observations as part of the scientific method.

e) All of the above are correct.

Answer: c

Section: 1.6

Bloom’s level: 2

20. The proposed explanation for a phenomenon is BEST described as:

a) an observation.

b) a hypothesis.

c) a testable prediction.

d) an experiment.

e) a theory.

Answer: b

Section: 1.6

Bloom’s level: 3

21. A null hypothesis:

a) is the premise that no difference exists between a treatment and control group.

b) is the premise that treatment groups were not adequately controlled.

c) results from an improperly controlled experiment.

d) cannot be rejected.

e) is a hypothesis that the experimenter hopes will be falsified.

Answer: a

Section: 1.6

Bloom’s level: 2

22. Which of the following is MOST correct?

a) You can accept or reject a hypothesis, but never prove it to be true.

b) You can prove a hypothesis to be true.

c) You can prove a hypothesis to be false.

d) Accepting or rejecting a hypothesis is the same as proving whether or not the hypothesis is true.

e) By rejecting a hypothesis, you also reject any theory that was correlated with that hypothesis.

Answer: a

Section: 1.6

Bloom’s level: 4

23. When conducting a scientific experiment, which of the following is tested?

a) an observation

b) a prediction

c) a result

d) a question

e) the null variable

Answer: b

Section: 1.7

Bloom’s level: 2

24. If your hypothesis is “Echinacea reduces the duration and severity of the common cold,” which of the following is the BEST testable prediction for this hypothesis?

a) If echinacea reduces the duration and severity of the symptoms of the common cold, then individuals taking echinacea should get sick less frequently than those not taking it, and when they do get sick, their illness should not last as long.

b) If echinacea reduces the duration and severity of the symptoms of the common cold, then individuals taking echinacea should get sick less frequently than those not taking it.

c) If echinacea reduces the duration and severity of the symptoms of the common cold, then individuals taking echinacea who get sick should have illness that does not last as long.

d) If echinacea reduces the duration and severity of the symptoms of the common cold, then individuals taking echinacea should get sick more frequently than those not taking it, and when they do get sick, their illness should last longer.

e) None of the above is a reasonable testable prediction for this hypothesis.

Answer: a

Section: 1.7

Bloom’s level: 6

25. After generating a hypothesis, a scientist next:

a) makes a prediction.

b) does an experiment.

c) formulates a theory.

d) writes a grant proposal.

e) designs a series of tests.

Answer: a

Section: 1.7

Bloom’s level: 2

26. A \_\_\_\_\_\_\_\_\_\_\_\_\_ is a pill that looks identical to a pill that contains the active ingredient in a scientific trial, but contains no active ingredient itself.

a) placebo

b) treatment

c) barbiturate

d) capsule

e) tablet

Answer: a

Section: 1.8

Bloom’s level: 1

27. Once a scientist has formulated a hypothesis that generates a testable prediction, she will:

a) conduct a critical experiment.

b) formulate a second hypothesis.

c) make observations.

d) draw conclusions.

e) make revisions.

Answer: a

Section: 1.8

Bloom’s level: 3

28. If the results of an experiment turn out differently from what you expected, then:

a) your experiment was a failure.

b) you should explore the reasons for this in the “conclusions” section of your experimental write-up.

c) you need to redo your experiment until you get the expected result.

d) you didn’t follow the scientific method.

e) your instruments were probably at fault.

Answer: b

Section: 1.9

Bloom’s level: 5

29. Which of the following is the BEST way to state the relationship between “data” and “results”?

a) “Data” and “results” are two names for the same thing.

b) “Data” are the facts you collect from your experiment, while “results” are your interpretation of what the data mean.

c) Any two scientists examining the same “data” would draw the same “results.”

d) The “data” section should always come before the “results” section in a scientific paper.

e) Any two scientists reporting the same “results” must have been using the same “data.”

Answer: b

Section: 1.9

Bloom’s level: 4

30. Some have claimed that the herb echinacea reduces the likelihood of catching the common cold. In many hundreds of studies, this claim has been refuted. Assuming these studies were properly conducted, which of the following is a scientifically responsible claim that an echinacea advocate could make in support of further research on this subject.

a) The effective dosage of echinacea was outside the range of the dosages given in the scientific studies.

b) The investigators were paid off by the drug companies.

c) The effective length of time needed for taking echinacea is longer than that provided in any of the scientific studies.

d) All of the above are scientifically responsible claims that an echinacea advocate could make in support of further research on this subject.

e) Only a and c are scientifically responsible claims that an echinacea advocate could make in support of further research on this subject.

Answer: e

Section: 1.9

Bloom’s level: 3

31. If your hypothesis is rejected, then:

a) your experiment was a success.

b) your experiment was poorly designed.

c) your experiment was a failure.

d) you should change the level of statistical significance until your hypothesis is accepted.

e) you may still have learned something important about the system you were testing.

Answer: e

Section: 1.9

Bloom’s level: 4

32. If you conduct an experiment that rejects your hypothesis, then:

a) your experiment was poorly designed.

b) your experiment was a failure.

c) you should publish your results anyway.

d) the null hypothesis was a better fit to your data.

e) you should become an English major.

Answer: d

Section: 1.9

Bloom’s level: 4

33. Which of the following is NOT an example of a theory?

a) Species evolve through natural selection.

b) Molecules are composed of atoms.

c) Organisms are composed of cells.

d) Diseases are caused by germs.

e) All of the above are considered to be theories.

Answer: e

Section: 1.10

Bloom’s level: 1

34. Scientific theories do not represent speculations or guesses about the natural world. Instead, they are hypotheses—proposed explanations for natural phenomena—that have been:

a) so strongly and persuasively supported by empirical observation that the scientific community views them as unlikely to be altered by new evidence.

b) verified by at least one critical experiment.

c) validated by the International Board of Scientific Theories.

d) used to support the political stances of the scientists who have developed them.

e) found to be statistically significant.

Answer: a

Section: 1.10

Bloom’s level: 6

35. A scientific theory is one that:

a) perfectly sums up many years of accumulated experimental results.

b) is based on hunches with no actual supporting evidence.

c) changes each time a different observation is made.

d) is the foundation of all scientific experiments.

e) sounds the most plausible.

Answer: d

Section: 1.10

Bloom’s level: 2

36. In science, theories tend to be \_\_\_\_\_\_\_\_\_\_\_ than hypotheses.

a) more speculative

b) less scientific

c) broader in scope

d) more experimental

e) more empirical

Answer: c

Section: 1.10

Bloom’s level: 2

37. In a randomized, controlled, double-blind study:

a) neither the experimenter nor the subject know whether the subject is in a control group or an experimental group.

b) individuals will be assigned to an experimental or control group depending on whether or not they took part in a pilot study.

c) experimental subjects are blindfolded when given the experimental treatment.

d) all experimental variables are held constant.

e) All of the above.

Answer: a

Section: 1.11

Bloom’s level: 1

38. Which of the following is the BEST description of a control group in an experiment?

a) The control group is identical to each test group, except for one variable.

b) The control group and the test groups may have several differences between them.

c) There can be more than one difference between the control group and test groups, but not several differences or else the experiment is invalid.

d) There should be more than one control group in any experiment.

e) The control group is a test group that is chosen at random.

Answer: a

Section: 1.11

Bloom’s level: 4. Analysis

39. In controlled experiments:

a) all variables are held constant.

b) one variable is manipulated, while others are held constant.

c) all critical variables are manipulated.

d) all variables are dependent on each other.

e) all variables are independent of each other.

Answer: b

Section: 1.11

Bloom’s level: 1

40. The placebo effect:

a) is the frequently observed, poorly understood, phenomenon that people tend to respond favorably to any treatment.

b) reveals that sugar pills are generally as effective as actual medications in fighting illness.

c) is an urban legend.

d) reveals that experimental treatments cannot be proven as effective.

e) demonstrates that most scientific studies cannot be replicated.

Answer: a

Section: 1.11

Bloom’s level: 2

41. An experimental condition applied to research subjects is called a:

a) treatment.

b) control.

c) randomization.

d) placebo.

e) variable.

Answer: a

Section: 1.11

Bloom’s level: 1

42. In a scientific experiment, a control group:

a) is less important than an experimental group.

b) makes the experiment better, but is not essential.

c) can be compared with an experimental group to assess whether one particular variable is causing a change in the experimental group.

d) must be kept in a laboratory.

e) All of the above are correct.

Answer: c

Section: 1.13

Bloom’s level: 2

43. Which of the following is an important feature of the scientific method?

a) A good hypothesis does not necessarily need to be tested.

b) If research results are not conclusive, the opinion of experts should be relied upon.

c) Anyone should be able to repeat an experiment.

d) A researcher’s methods should not be described once desired results have been obtained.

e) Once demonstrated, conclusions cannot be changed.

Answer: c

Section: 1.13

Bloom’s level: 2

44. A powerful way to demonstrate that observed differences between a treatment group and a control group truly reflect the effect of the treatment is for researchers to:

a) conduct the experiment over and over again.

b) get their study published in a scientific journal.

c) use a variety of statistical tests until they find one that shows statistical significance.

d) formulate as many hypotheses as they can.

e) make more observations.

Answer: a

Section: 1.13

Bloom’s level: 6

45. If a researcher uses the same experimental setup as another study to collect data, but uses different research subjects, it is considered:

a) exploration.

b) a two-tailed test of the hypothesis.

c) inductive reasoning.

d) replication.

e) extrapolation.

Answer: d

Section: 1.13

Bloom’s level: 1

46. Alon claimed that a tincture of a local herb was effective in lowering anxiety and was planning to invest in the product. As evidence of his claim, Alon, who had anxiety over his financial situation, said that he felt much better after the treatment, was much more relaxed, and no longer worried about his finances. Which of the following combinations of methodological flaws BEST characterizes Alon’s investigation?

a) lack of an appropriate outcome measure

b) lack of appropriate controls and lack of an appropriate outcome measure

c) lack of randomization, lack of replication, and lack of an appropriate outcome measure

d) lack of replication and lack of appropriate controls

e) lack of an appropriate outcome measure, replication, randomization, and controls

Answer: e

Section: 1.13

Bloom’s level: 4

47. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ may have biases that affect their abilities to perform in an objective fashion.

a) Scientists

b) Research assistants

c) Politicians

d) Authors of test questions

e) All of the above are correct.

Answer: e

Section: 1.14

Bloom’s level: 2

48. What is the best way for a scientist to address his/her own biases?

a) Make sure that no biases influence his/her work.

b) Use careful controls to minimize them.

c) Understand his/her biases and interpret the data differently as a result.

d) Never be involved in any kind of scientific study where his/her possible biases might impact the study.

e) None of the above is correct; there is no way a scientist can deal with biases.

Answer: b

Section: 1.14

Bloom’s level: 2

49. The set of analytical and mathematical tools designed to help researchers gain understanding from the data they gather is called:

a) geometry.

b) biology.

c) statistics.

d) genetics.

e) experimentation.

Answer: c

Section: 1.16

Bloom’s level: 2

50. If you toss a coin and it comes up tails on eight consecutive tosses, what is the likelihood it will come up heads on the ninth toss?

a) 1/2

b) 4/9

c) 5/9

d) 1

e) 0

Answer: a

Section: 1.16

Bloom’s level: 3

51. Suppose you measure the height of two people. One is a woman who is 5 feet 10 inches tall. The other is a man who is 5 feet 6 inches tall. Which of the following is an appropriate conclusion to draw from these measurements?

a) Women are taller than men.

b) Some men are taller than some women.

c) Some women are taller than some men.

d) Men are taller than women.

e) The tallest woman is 5 feet 10 inches tall.

Answer: c

Section: 1.16

Bloom’s level: 3

52. Statistical methods make it possible to:

a) determine how likely it is that certain results may have occurred by chance.

b) choose the best answer to value-based questions.

c) reject any hypothesis.

d) unambiguously learn the truth.

e) test non-falsifiable hypotheses.

Answer: a

Section: 1.16

Bloom’s level: 2

53. When comparing two groups, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_, the more confident we are of the conclusion that a significant difference exists in the groups.

a) larger the variation in each group

b) smaller the difference between the two groups

c) fewer the number of individuals in each group

d) smaller the variation in each group

e) more variables we measure

Answer: d

Section: 1.16

Bloom’s level: 6

54. In a series of studies, researchers found a statistically significant positive correlation between the number of firefighters present at a fire and the amount of damage that the fire does. Which of the following is the BEST conclusion to be drawn from these studies?

a) Firefighters make fires worse.

b) Firefighters are effective in fighting fires.

c) Causation is not correlation.

d) Statistical data must be put in its proper context to be understood.

e) To more accurately estimate the effect of the number of firefighters on the amount of damage, we would need to compare the amount of damage from fires of different sizes that are fought by similar numbers of firefighters.

Answer: d

Section: 1.16

Bloom’s level: 6

55. If a report states, “The female subjects in the study are 5 feet 6 inches ± 3 inches,” this indicates that:

a) two-thirds of the women are between 5 feet 3 inches and 5 feet 9 inches.

b) all of the women are between 5 feet 3 inches and 5 feet 9 inches.

c) 90% of the women are between 5 feet 3 inches and 5 feet 9 inches.

d) the variation among women is 3 inches in height.

e) the investigator is unsure of her data.

Answer: a

Section: 1.16

Bloom’s level: 2

56. When a chewing gum manufacturer makes the claim, “Four out of five dentists surveyed recommend sugarless gum for their patients who chew gum,” how many dentists need to have been surveyed for the statement to be factually accurate?

a) at least 500

b) at least 100

c) five

d) four

e) ten

Answer: c

Section: 1.17

Bloom’s level: 3

57. Which of the following statements BEST explains the observation that more autism cases exist now than in the past?

a) Doctors are more aware of the condition and have better techniques for diagnosing and reporting it.

b) More parents neglect their children, which is a cause of autism, now than in the past.

c) The vaccine for measles, mumps, and rubella has been established as a significant cause of autism.

d) Autism has been selected for in recent generations by natural selection.

e) All of the above are equally good explanations for the observation that more autism cases exist now than in the past.

Answer: a

Section: 1.17

Bloom’s level: 2

58. Anecdotal evidence:

a) can appear to reveal links between two phenomena that do not actually exist.

b) tends to be more reliable than data based on observations of large numbers of diverse individuals.

c) is often the only way to prove important causal links between two phenomena.

d) is a more efficient method for understanding the world than the scientific method.

e) is a necessary part of the scientific method.

Answer: a

Section: 1.17

Bloom’s level: 4

59. Pseudoscience capitalizes on the belief shared by most people that:

a) the scientific bases for scientific-sounding claims are often not clear.

b) scientific thinking is a powerful method for learning about the world.

c) scientific thinking is beyond the reach of the average person.

d) science is intimidating.

e) scientific claims can be evaluated through the political process.

Answer: b

Section: 1.17

Bloom’s level: 5

60. How can science best help each of us understand the role of humans in nature?

a) Science can provide us with a set of moral precepts.

b) Science can provide us with a specific political agenda.

c) Science can provide understanding of how the systems of nature work.

d) Science can teach us to love nature.

e) None of the above is correct.

Answer: c

Section: 1.18

Bloom’s level: 2

61. Which of the following questions CANNOT be answered by the scientific method?

a) Does taking echinacea reduce the intensity or duration of the common cold?

b) Does chemical runoff give rise to hermaphrodite fish?

c) Does hair that is shaved grow back coarser?

d) Is eyewitness testimony in criminal proceedings reliable?

e) Which Shakespearean sonnet is the most beautiful?

Answer: e

Section: 1.18

Bloom’s level: 3

62. The scientific method will never prove or disprove:

a) the existence of God.

b) the beauty of Shakespeare’s sonnets.

c) the ability of echinacea to prevent the common cold.

d) All of the above are examples of statements that the scientific method will never prove or disprove.

e) Only a and b are examples of statements that the scientific method will never prove or disprove.

Answer: e

Section: 1.18

Bloom’s level: 3

63. Which of the following questions would be LEAST helped by application of the scientific method?

a) formulating public policy on euthanasia

b) comparing the effectiveness of two potential antibiotics

c) developing more effective high school curricula

d) determining the most effective safety products for automobiles

e) evaluating the relationship between violence in video games and criminal behavior in teens

Answer: a

Section: 1.18

Bloom’s level: 3

64. Why is it that creationism can never be accepted as a scientific explanation of the origin of life?

a) Because the age of the earth, as given in Genesis, can never be determined.

b) Because most scientists are not deeply religious people.

c) Because the ideas of creationism cannot be tested through experiment and observation.

d) Because creationism, similar to evolution, is a theory and therefore cannot be proved.

e) None of the above; creationism can be accepted as a scientific explanation of the origin of life.

Answer: c

Section: 1.18

Bloom’s level: 3

65. Despite all of the intellectual analyses the scientific method gives rise to and objective conclusions it makes possible, it CANNOT:

a) generate moral statements.

b) aid in technical advances.

c) generate new hypotheses.

d) reject false claims.

e) affect one’s opinions about social issues.

Answer: a

Section: 1.18

Bloom’s level: 6

66. Science as a way of seeking principles of order differs from art, religion, and philosophy in that:

a) science deals exclusively with known facts.

b) science limits its search to the natural world of the physical universe.

c) all scientific knowledge is gained by experimentation.

d) science denies the existence of the supernatural.

e) there is no room for intuition or guessing.

Answer: a

Section: 1.18

Bloom’s level: 2

67. Which of the following terms and phrases best describes the application of scientific knowledge to specific purposes?

a) technology

b) statistics

c) deduction

d) junk science

e) pseudoscience

Answer: a

Section: 1.18

Bloom’s level: 2

68. Which of the following areas is NOT heavily influenced by biology?

a) agriculture

b) environmental issues

c) criminology

d) behavioral issues

e) Biology heavily influences ALL of these areas.

Answer: e

Section: 1.19

Bloom’s level: 1

69. All of the following are branches of biology EXCEPT:

a) geology.

b) genetics.

c) behavior.

d) evolution.

e) ecology.

Answer: a

Section: 1.19

Bloom’s level: 1

Short-Answer Questions

70. What are the key differences between experimental and control groups in any experiment?

**Answer:** An experimental group is any group of subjects who are exposed to a particular treatment. A control group is a group of subjects who are treated identically to the experimental group, with one exception—they are not exposed to the treatment.

71. What is “double-blind experimental design”?

**Answer:** In double-blind experimental design, neither the experimental subjects nor the experimenter know which treatment (if any) that a subject is receiving. This helps to eliminate any bias in experimental design and outcome.

72. Formulate a null hypothesis for the following hypothesis: “Tomato plants exhibit a higher rate of growth when planted in compost instead of in soil.” Why is the null hypothesis useful?

**Answer:** A null hypothesis example would be: “Tomato plants do not exhibit a higher rate of growth when planted in compost instead of in soil.” A null hypothesis is useful because it is easier to disprove; any single new observation that contradicts the null hypothesis allows us to reject it and conclude an alternative hypothesis.

73. Why is the scientific method an effective approach to answering questions about our world?

**Answer:** The scientific method is empirical, rational, testable, repeatable, and self-correcting. Unlike many other approaches to understanding the world, such as superstitions, the scientific method is effective and based in observations and analysis.

74. You take a survey of your classmates to find out what portion of their study time is devoted to biology compared to other subjects. Which type of display of data would you use to represent your findings? Why?

**Answer:** A pie chart would be the best type of visual display of data for this information. Each “slice” is used to represent a portion of the whole. A legend can also be included to identify which information is represented by each pie slice.

75. Give an example of a positive correlation, and explain the phrase “correlation is not causation.”

**Answer:** An example of a positive correlation might be: when more firefighters are at a fire, the fire is larger and causes more damage. This is a positive correlation because when one variable (the number of firefighters) increases, so does the other (the severity of the fire). This does not mean that firefighters make fires worse, however. “Correlation is not causation” refers to this type of scenario. Correlations can reveal relationships between variables but do not tell us how the variables are related, or whether change in one variable actually *causes* change in another.

76. Describe the characteristics of a question that can be addressed through the scientific method, and give some examples.

**Answer:** A good question to address using the scientific method should relate to observed patterns or cause-and-effect relationships. The question should also be one that can be tested through measurement of some kind. The book proposes questions about the effects of echinacea on cold symptoms, and a potential link between chemical runoff and hermaphroditic fish, among others. You may be able to think of other examples.

77. Is organic produce healthier than non-organic produce? Formulate a hypothesis and testable prediction that address this question as an *if…then* statement.

**Answer:** *If* organic produce is healthier than non-organic produce, *then* people who consume only organic produce over a given time period will be healthier than people who consume non-organic produce.

78. How would you construct control and experimental groups in the experiment listed above? Should you ask for volunteers for each group?

**Answer:** A group of people of the same age and social background would be divided into two groups: one group that eats only organic produce, and one group that eats only non-organic produce. You would study both groups for a finite period of time, let’s say six months. You wouldn’t want your participants to choose which group they participated in because your findings won’t necessarily be representative of the larger group. Instead, people should be placed at random into one of these two groups.

79. People who only consumed organic produce during the six-month period had a range of body mass indices, blood pressures, and blood sugar levels, and people who consumed non-organic produce had an overlapping range of body mass indices, blood pressures, and blood sugar levels. How can one determine whether one group was healthier than the other, given the overlapping nature of these health parameters?

**Answer:** Statistical analysis can compare these two groups, computing differences and determining how reliable and significant these differences are.

80. Does the statement “Evolution is just a theory” have any merit? Explain.

**Answer:** No. This statement incorrectly equates the everyday definition of the term “theory” with an actual scientific theory. A *scientific theory* is supported by a large body of evidence, so much so that it is generally regarded as fact; however, “theory” in the generic sense simply implies a question about a phenomenon. If someone makes as a statement such as, “I have a *theory* about why it always rains more on Saturdays,” what they are really saying is, “I have a *hypothesis* about why it rains more on Saturdays.”

Essay Questions

81. List the basic steps of the scientific method. Explain why the process of using the scientific method is rarely conducted in this linear fashion.

**Answer:** The steps are as follows: 1) make observations; 2) formulate a hypothesis; 3) devise a testable prediction; 4) conduct a critical experiment; and 5) draw conclusions and make revisions. Although the scientific method includes these basic steps, the process of using the scientific method is rarely that rigid. The scientific method is adaptable and can be done effectively in numerous ways. This flexibility is what makes it such a powerful process than can be used to explore a wide variety of thoughts, events, or phenomena—not only in sciences but in all aspects of life.

82. Design an experiment using all the steps of the scientific method.

**Answer:** In answering this question, the student should first be sure to choose a question that can be answered using the scientific method. The answer should include at least the five basic steps of the scientific method: 1) making an observation, 2) formulating a hypothesis, 3) making a testable prediction, 4) detailing a controlled experiment, and 5) drawing a conclusion. The experiment that the student designs should contain an experimental group, a control group, and a description of the experimental and dependent variables and how the experiment would be performed. Finally, the student should explain what he/she would do after the results have been compiled, that is, what changes or revisions he/she would propose for the experiment as well as any ideas for further experimentation on the subject that he/she might later pursue.

83. Give an example of a controlled experiment and an example of one that is not controlled. Explain the differences, and make a judgment about which experiment is more scientifically valid.

**Answer:** The student can give examples of his/her own or describe the examples given in the textbook, making sure to note the importance not only of a control group, but also why it is important that the control and experimental groups be as similar as possible. The placebo effect might also be mentioned as another reason to use treatments that are as identical as possible, in addition to similar demographics in the groups. Experimenter bias and unconscious influence on the results of the experiment may also be mentioned as pitfalls that can be avoided by designing a well-controlled experiment.

84. Give an example of a pseudoscientific claim that you have encountered in your everyday life, and explain why it has no scientific validity.

**Answer:** The answers here will vary greatly, with some students using the examples given in the textbook. The interesting and significant aspect of all of these answers lies in the students’ explanations as to why the claims are invalid. The students may also comment on the value of knowing the scientific method in order to be able to assess critically those claims that are encountered regularly, especially in advertising.