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Name:_____ Class:_____ Date:_____

Chapter 1

1. A hypothesis is a statement that:
   a. can be changed throughout the experiment.
   b. can be avidly accepted by scientists.
   c. can be tested and proven true.
   d. can be tested and proven false.
   e. precedes a theory.

ANSWER: d

2. Where are the most reliable scientific results published?
   a. in the daily news
   b. in science magazines
   c. in science journals
   d. on scientific websites
   e. in peer-reviewed scientific journals

ANSWER: e

3. The scientific process from beginning to end can be outlined as:
   a. hypothesize, test, analyze, and conclude.
   b. observe, hypothesize, test, analyze, and conclude.
   c. observe, question, test, analyze, and conclude.
   d. hypothesize, test, analyze, and conclude.
   e. observe, test, hypothesize, analyze, and conclude.

ANSWER: b

4. Which sequence places the steps of the scientific process in the correct order?
   a. experiment□questions□hypothesis□read literature□conclusions
   b. questions□experiment□read literature□hypothesis□conclusions
   c. read literature□experiment□questions□conclusion□hypothesis
   d. questions□read literature□hypothesis□experiment□conclusions
   e. read literature□questions□experiment□hypothesis□conclusions

ANSWER: d

5. In approaching a scientific problem or question, scientists will often first:
   a. design an experiment.
   b. choose test subjects.
   c. peer review a study.
   d. review existing literature on the topic.
   e. formulate a hypothesis.

ANSWER: d

6. What is the importance of peer review in the scientific process?

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a. It helps a scientist formulate a hypothesis.
b. It helps a scientist choose test subjects.
c. It ensures that a study has been appropriately designed and correctly interpreted.
d. It helps the scientist collect data.
e. It is the first step in any scientific study.

ANSWER: c

7. What are the criteria for a good hypothesis?
a. It must be realistic and have only one possible result.
b. It must have only one possible result and be peer reviewed.
c. It must be based on anecdotal evidence and be testable.
d. It must be based on peer-reviewed journal articles and be realistic.
e. It must be testable and falsifiable.

ANSWER: e

8. Based on previous published data and some preliminary experiments done in my lab, I hypothesize that a drug called “shrinkase” will inhibit the growth of a particular type of cancerous tumor. What is my next step in the scientific process?
a. find people with that kind of tumor
b. obtain a large supply of shrinkase
c. determine what my control and experimental groups will be
d. submit my hypothesis for peer review
e. analyze the results of my experiments

ANSWER: c

9. If the results of an experiment contradict the hypothesis, you have _____ the hypothesis.
a. supported
b. falsified
c. proved
d. failed
e. verified

ANSWER: b

10. Scientific journals send out potential articles to other scientists who are working in the same research area, and those scientists make comments regarding the research. This is known as:
a. jurisprudence.
b. peer rebuttal.
c. journalistic integrity.
d. journalistic license.
e. peer review.

ANSWER: e

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11. You have the following known facts: Smoking causes accumulation of materials in the lungs, thereby decreasing the oxygen-absorbing capability of the lungs. Long-term smoking causes more accumulation of materials in the lungs. Decreased lung capacity increases the workload of the heart. Which hypothesis can you formulate from these observations?

a. People who never smoke will never develop lung problems.
b. Long-term smokers have poorer heart health than nonsmokers.
c. New smokers have poorer heart health than long-term smokers.
d. Stopping smoking eliminates lung problems within two years.
e. Stopping smoking eliminates heart problems within two years.

ANSWER: b

12. I notice that all the students in my class seem very drowsy 45 minutes into my class period. Knowing that it could not possibly be my lecture putting them to sleep, I consider other factors such as the fact that my class is at 5 P.M. and the sun is usually setting at that time of the day, which I think may make people drowsy. What type of evidence am I collecting in making this observation?

a. experimental
b. anecdotal
c. peer reviewed
d. coincidental
e. untestable

ANSWER: b

13. Evidence that is not based on systematic scientific study is known as _____ evidence.

a. empirical
b. causational
c. anecdotal
d. logical
e. statistical

ANSWER: c

14. A controlled experiment describes the use of:

a. separate control and experimental groups.
b. precise measurements.
c. accurate and careful measurements.
d. more than one variable changing separately.
e. careful testing of the hypothesis.

ANSWER: a

15. In a controlled experiment, the control and experimental groups differ in the:

a. environmental variable.
b. controlled variable.

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c. independent variable.
d. dependent variable.
e. result.

ANSWER: c

16. A placebo is given to the:
a. dependent group.
b. control group.
c. independent group.
d. experimental group.
e. variable group.

ANSWER: b

17. In a controlled experiment, usually only one factor is changed, which is the:
a. placebo.
b. controlled variable.
c. coordinate variable.
d. independent variable.
e. dependent variable.

ANSWER: d

18. A study is conducted to determine if walking reduces joint stiffness in people suffering from arthritis of the knee. Half the participants are instructed to walk an additional 1 mile every day, whereas the other half are told to go about their normal daily routines with no additional exercise. In this study, the group that walks an extra mile every day is referred to as the:
a. control group.
b. experimental group.
c. placebo group.
d. dependent group.
e. independent group.

ANSWER: b

19. A study was conducted to determine if the growth rate of babies differs between babies who are bottle-fed and babies who are breast-fed. In this experiment, growth rate is referred to as the:
a. controlled variable.
b. experimental variable.
c. dependent variable.
d. independent variable.
e. placebo variable.

ANSWER: c

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20. Two groups of people are given a drug that they are told will make them drowsy. However, only one group actually receives this drug, whereas the other group secretly receives a sugar pill. Strangely, both groups report feeling very tired 30 minutes later. The group receiving the sugar pill is said to be experiencing the:

a. control effect.
b. experimental effect.
c. dependent effect.
d. independent effect.
e. placebo effect.

ANSWER: e

21. What is the importance of a placebo?

a. It allows the researcher to treat control and experimental groups differently, while allowing them to believe they are being treated the same.
b. It allows the researcher to treat control and experimental groups the same, while allowing them to believe they are being treated differently.
c. It allows the researcher to use an experimental drug on more people.
d. It removes the need for a control group.
e. All of these statements are correct.

ANSWER: a

22. In a well-designed experiment, the independent variable:

a. does not depend on another factor or condition.
b. changes from subject to subject randomly.
c. can never be manipulated by the researcher.
d. will depend on the dependent variable.
e. none of these

ANSWER: a

23. A scientific study evaluated the effect of tanning beds on DNA damage. The scientists took skin cells and exposed them to UV radiation (the type used in indoor tanning beds) for different lengths of time: some for 1 minute, some for 5 minutes, some for 15 minutes, and some for 30 minutes. They then looked for signs of DNA damage and compared the results to cells that had never been exposed to UV light.
What is the independent variable in this experiment?

a. the number of skin cells
b. the type of light
c. the length of time the cells are exposed to UV light
d. the untreated cells
e. the amount of DNA damage in the cells

ANSWER: c

24. A scientific study evaluated the effect of tanning beds on DNA damage. The scientists took skin cells and exposed them to UV radiation (the type used in indoor tanning beds) for different lengths of time: some for 1

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minute, some for 5 minutes, some for 15 minutes, and some for 30 minutes. They then looked for signs of DNA damage and compared the results to cells that had never been exposed to UV light.
What is the control in this experiment?

a. the number of skin cells
b. the type of light
c. the length of time the cells are exposed to UV light
d. the untreated cells
e. the amount of DNA damage in the cells

ANSWER: d

25. A scientific study evaluated the effect of tanning beds on DNA damage. The scientists took skin cells and exposed them to UV radiation (the type used in indoor tanning beds) for different lengths of time: some for 1 minute, some for 5 minutes, some for 15 minutes, and some for 30 minutes. They then looked for signs of DNA damage and compared the results to cells that had never been exposed to UV light.
What is a reasonable hypothesis for this study?

a. The greater the number of skin cells that are exposed to UV radiation, the greater the potential for DNA damage.
b. The longer skin cells are exposed to UV radiation from tanning beds, the more DNA damage will occur.
c. If skin cells are exposed to UV radiation, then they will have DNA damage.
d. If people are allowed to use tanning beds, then they will have more DNA damage.
e. If a person is exposed to UV radiation from tanning beds, they will have more DNA damage compared to UV radiation from the sun.

ANSWER: b

26. You finish a research project and submit your findings to a journal for peer review. The reviewers decide that they do not think your experimental results were convincing enough to support or disprove your hypothesis. What is your next step?

a. cry
b. formulate a new hypothesis that better fits your data
c. design and carry out more experiments to support or disprove your hypothesis
d. reanalyze your data
e. fix your results so that they better fit your hypothesis

ANSWER: c

27. In a scientific study evaluating the beneficial effects of caffeine on the elderly, who would be the best subjects to test?

a. elderly men and women
b. elderly women
c. pregnant women
d. elderly men
e. teenagers

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ANSWER: a

28. Two studies were carried out to determine if children in day care developed more ear infections than children who stayed at home. The first study compared ear infection rates in 50 Canadian girls ages 1 to 2, half of whom attended day care and half of whom stayed home. The second study compared ear infection rates in 1,000 Swedish boys ages 3 to 4, half of whom attended day care and half of whom stayed home. The results of these two studies differed greatly.
Which of the following is LEAST likely to be the cause of such differences?

a. different genders
b. different mothers
c. different ages
d. different sample sizes
e. different countries

ANSWER: b

29. Would it be possible for a scientist to bias a scientific study?

a. No, there are so many checks and balances outside of the scientist's control that it is impossible to show bias in a scientific study.
b. No, because all scientific experiments are designed to be fair.
c. Yes, if the scientist used a large number of test subjects.
d. Yes, if the scientist chose specific individuals to include in the study.
e. Yes, if it was a randomized double-blind study.

ANSWER: d

30. An experiment was performed using 1,000 nonsmoking males ages 18 to 22. Which experimental group would most likely produce the most similar results?

a. 800 nonsmoking females ages 30 to 45
b. 800 smoking males ages 30 to 45
c. 1,000 smoking females ages 25 to 40
d. 1,000 nonsmoking males ages 30 to 55
e. 800 nonsmoking males ages 20 to 25

ANSWER: e

31. You conduct an experiment to test the effectiveness of a new drug in controlling blood sugar levels in people with diabetes. Unfortunately, half the participants experienced nausea. Nausea would be considered a(n):

a. control effect.
b. experimental effect.
c. tangential effect.
d. side effect.
e. placebo effect.

ANSWER: d

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32. All of these statements are true of side effects EXCEPT:
    a. Side effects may make data interpretation difficult.
    b. Side effects are unintended results.
    c. Side effects are usually considered problematic.
    d. Side effects always invalidate the results of the study.
    e. Side effects may vary from person to person.

ANSWER: d

33. Many chemicals can cause positive reactions in the human system, but they may also cause a variety of negative effects. These negative effects are called:
    a. side effects.
    b. causal effects.
    c. peripheral effects.
    d. homeopathic effects.
    e. indirect effects.

ANSWER: a

34. Scientific studies within a single ethnic population:
    a. demonstrate cause and effect for that population only.
    b. may miss correlations in other ethnicities.
    c. are usually done to determine cause and effect for all populations.
    d. can be extrapolated to other ethnicities.
    e. show links between multivariables in that population.

ANSWER: b

35. Increasing a sample size:
    a. provides more reliable data.
    b. increases the likelihood of getting a positive result.
    c. increases the likelihood of getting a negative result.
    d. provides better variables.
    e. provides better controls.

ANSWER: a

36. In a clinical trial with 400 subjects, the most reliable results would be obtained if _____ subjects were in the experimental group and _____ in the control.
    a. 200; 200
    b. 300; 100
    c. 100; 300
    d. 350; 50
    e. 50; 350

ANSWER: a

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37. Statistical significance:
    a. indicates a high likelihood that your results are due to your treatment versus due to chance.
    b. is more likely to be reliable if you have a small sample size versus a large sample size.
    c. is a requirement of the data from a scientific experiment.
    d. indicates that the hypothesis should be rejected.
    e. depends on large data sets.

ANSWER: a

38. Increasing sample size increases:
    a. the control group.
    b. the experimental group.
    c. randomness.
    d. the reliability of the data.
    e. variation.

ANSWER: d

39. A significant result from a scientific study indicates:
    a. a statistical error.
    b. it occurred by chance.
    c. a positive result.
    d. a negative result.
    e. a nonrandom result.

ANSWER: e

40. Which sample group would give the most statistically significant data?
    a. 10 individual mice each tested once
    b. 1 mouse tested 10 times
    c. one pig
    d. five pigs each tested five times
    e. 1 mouse tested 100 times

ANSWER: a

41. A small sample size:
    a. will likely yield a high degree of statistical significance.
    b. is unacceptable in scientific studies.
    c. is usually a benefit to researchers.
    d. does not allow the use of dependent and independent variables.
    e. none of these

ANSWER: e

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42. I carried out a series of experiments to test the effect of caffeine on mice. I used two mice. I fed one mouse caffeinated water and fed the other plain water. I then measured the ability of each mouse to find its way through a maze. I timed their progress. My results were exciting and conclusive, the caffeinated mouse found his way through the maze much more rapidly and accurately than the noncaffeinated mouse. I sent my results to the editors of a peer-reviewed journal, but they rejected my paper. They said the results were not valid. Why?

a. I should have let the mice go through the maze at different times.
b. I should have given the mouse different amounts of caffeine.
c. I did not use the right form of caffeine.
d. I did not have enough mice in the study.
e. None of these statements are correct.

ANSWER: d

43. You are reviewing the results of five similar experiments, but each had a different sample size. Which experiment would have the most reliable results?

a. the experiment with a sample size of 10
b. the experiment with a sample size of 100
c. the experiment with a sample size of 1,000
d. the experiment with a sample size of 10,000
e. the experiment with a sample size of 100,000

ANSWER: e

44. Which statement is an example of an everyday (nonscientific) theory?

a. Objects are attracted to one another by gravity.
b. Broccoli tastes better than cauliflower.
c. All life forms are related to each other through common ancestry.
d. All living things are made of cells.
e. The universe was created from a large cosmic explosion.

ANSWER: b

45. Which statement is NOT a scientific theory?

a. Cells come from pre-existing cells.
b. Objects are attracted to one another by gravity.
c. A hypothesis supported by results from an experiment with 3,000 subjects.
d. All life forms are related to each other through common ancestry.
e. The universe was created from a large cosmic explosion.

ANSWER: c

46. A scientific theory:

a. is a hypothesis that has been upheld by many experiments.
b. is an uneducated guess.
c. has not been tested.

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d. is an educated guess.
e. can never be proven wrong.

ANSWER: a

47. I observe that squirrels that live in the southeastern United States are much thinner than squirrels that live in the northeastern part of the country. I theorize that this is because the squirrels that live in the northeast have greater fat reserves for the winter months when food is scarce. Is this a scientific theory?
a. Yes, it is a good educated guess.
b. Yes, I am taking into consideration physiological reasons for their larger size, so it is scientific.
c. No, it is just a hypothesis; it has not been proven to be true through extensive experimentation or quantification.
d. No, it cannot be proven true.
e. Yes, I theorized it, so it qualifies as a theory.

ANSWER: c

48. In the field of science, an idea that has been examined numerous times and has never been falsified may be called a:
a. theory.
b. hypothesis.
c. conclusion.
d. conundrum.
e. ideology.

ANSWER: a

49. In everyday usage, the word “theory” is used to mean an untested idea. Which scientific term is most similar to the everyday usage of “theory”?
a. concept
b. conclusion
c. observation
d. hypothesis
e. theory

ANSWER: d

50. Although the term radiation can be scary for many people, not all radiation is equal. Cell phone radiation is not considered to be harmful because there is no valid scientific evidence that it:
a. is high energy.
b. can damage molecules in cells, such as DNA.
c. is high frequency.
d. can promote cell repair.
e. stimulates cell division.

ANSWER: b

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51. Although the term radiation can be scary for many people, not all radiation is equal. Ionizing radiation refers to radiation that:
    a. can alternate between low and high energy states.
    b. is low frequency, thus not known to be harmful to DNA.
    c. causes melanoma (a type of skin cancer), regardless of the source of radiation.
    d. promotes cellular division and repair due to its low-energy state.
    e. is powerful enough to directly damage molecules in cells, including the DNA.

ANSWER: e

52. A correlation in a scientific study indicates:
    a. insufficient data.
    b. a cause and effect between variables.
    c. a clear link between two variables.
    d. a possible link between two variables.
    e. the necessity for a new hypothesis.

ANSWER: d

53. A negative correlation in a scientific study means:
    a. one variable causes a change in another variable.
    b. one variable is linked to another variable.
    c. one variable increases, while the other decreases.
    d. there is no link between the variables studied.
    e. both variables decrease proportionately.

ANSWER: c

54. Correlation is:
    a. a problem encountered when the drug under study causes many different reactions.
    b. a type of study in which researchers examine what happens to a group of people over time.
    c. when one variable causes an observed result.
    d. when two variables are related to one another in a predictable manner.
    e. when the effect of one variable hides the effect of the other variable.

ANSWER: d

55. A positive correlation between a memory test score and drinking coffee would show:
    a. decreasing coffee consumption correlates with increasing memory test score.
    b. increasing coffee consumption correlates with increasing memory test score.
    c. decreasing coffee consumption has no relationship to memory test score.
    d. increasing coffee consumption correlates with decreasing memory test score.
    e. no change on memory test score, with or without coffee.

ANSWER: b

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56. You are a researcher studying alcohol intake and smoking. You find that as alcohol intake increases, the number of cigarettes smoked also increases. Which statement is an appropriate conclusion?

a. Alcohol consumption causes smoking.
b. Smoking causes alcohol consumption.
c. Alcohol consumption and smoking are not related.
d. Alcohol consumption and smoking are correlated.
e. No appropriate conclusions can be drawn from this study.

ANSWER: d

57. An epidemiologist looks at a compilation of studies conducted at a medical center in which they have catalogued the lifestyles and habits of thousands of women. When she looks at the women in this group who have contracted breast cancer versus those who are healthy, she finds that women who have breast cancer drink more milk than those who do not have cancer. Does this mean that drinking milk causes breast cancer?

a. Yes, if there is a correlation between the two, then milk causes cancer.
b. Yes, an epidemiologist uses statistics to look at populations, so it is not a coincidence.
c. No, just because there is a correlation, it does not mean that milk is the cause of the cancer.
d. No, it is just a coincidence; correlations never indicate a cause-and-effect relationship.
e. None of these statements are correct.

ANSWER: c

58. Which of these issues plays a factor in misrepresentation of research data in the media?

a. lack of understanding of the topic by the reporter
b. overstating the importance of the study results by the researcher
c. misinterpretation of the scientific terminology when trying to disseminate it to the public
d. time and space limitations by the media
e. all of these.

ANSWER: e

59. Some of the issues faced by media personnel when reporting the latest scientific findings include all of the following EXCEPT:

a. simplifying complex issues.
b. conveying information clearly.
c. avoiding misunderstandings.
d. determining what is most important about a study.
e. communicating the researcher's opinion about the study.

ANSWER: e

60. Choose the list that depicts the correct order of MOST reliable to LEAST reliable sources of information.

a. scientific journal→magazine article written by scientist→magazine article written by journalist→public opinion
b. scientific journal→magazine article written by journalist→magazine article written by

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scientist→public opinion

c. magazine article written by scientist→scientific journal→magazine article written by journalist→public opinion

d. magazine article written by scientist→scientific journal→public opinion→magazine article written by journalist

e. magazine article written by scientist→magazine article written by journalist→scientific journal→public opinion

ANSWER: a

61. Why do some media reports about scientific discoveries end up being exaggerations?

a. Findings can be misunderstood and misinterpreted.

b. Some studies are not conducted with the proper controls or scientific method, so they are unreliable; however, journalists often do not realize the distinction.

c. Media reports can come from sources that are not peer reviewed.

d. Media agencies may sensationalize news to draw more attention.

e. All of these statements are correct.

ANSWER: e

62. If you read about several studies on the effectiveness of a new drug to treat diabetes, which of these would give you the most confidence in the results?

a. one study with 50 people

b. one study with 500 people

c. one study with 1,000 people

d. three studies conducted the same way, each with 50 people

e. three studies conducted the same way, each with 1,000 people

ANSWER: e

63. Which news source is the most reliable source of scientific advances?

a. Wikipedia

b. a peer-reviewed scientific journal

c. a newspaper

d. a popular science news website

e. the evening television news

ANSWER: b

64. Which published scientific data would be most reliable?

a. a local daily newspaper

b. a website

c. a drug company's clinical trial results

d. a popular scientific magazine

e. a peer-reviewed scientific journal

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ANSWER: e

65. Peer review means what in relation to scientific journals?
    a. review by specialists in the field
    b. review by the editor
    c. review by top scientists
    d. review by an editorial board
    e. review by people of the same age, gender, and ethnicity

ANSWER: a

66. Epidemiologists:
    a. study the incidence of diseases and risk factors in populations.
    b. investigate skin diseases.
    c. perform clinical trials on health issues.
    d. examine autopsy data.
    e. assess cancer treatments and survival outcomes.

ANSWER: a

67. Pitfall(s) to avoid from the analysis of data from single epidemiological studies is(are):
    a. nonrandomized subjects.
    b. too small of a sample size.
    c. disease complexity.
    d. lack of proper controls.
    e. all of these

ANSWER: e

68. Epidemiological studies:
    a. are the least common form of human health study.
    b. have a small number of participants.
    c. are used when manipulating people is unethical.
    d. make conclusions based on laboratory studies.
    e. are usually very expensive to conduct.

ANSWER: c

69. All of these are true of a clinical trial EXCEPT:
    a. participants are randomly assigned to different treatment groups.
    b. it can often be conducted with a large survey.
    c. it can be very expensive.
    d. it can be difficult to get participants to adhere to the treatment regime.
    e. it can be unethical if the treatment group can cause serious harm.

ANSWER: b

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70. The study of the incidence of disease in a population that cannot be directly manipulated is called:
    a. an experiment.
    b. population biology.
    c. evolutionary biology.
    d. epidemiology.
    e. systemic biology.

ANSWER: d

71. Do epidemiologists perform planned scientific experiments with rigorous controlled experimentation?
    a. Yes, they work in labs and perform lab experiments to prove their hypotheses.
    b. Yes, they use the standard scientific method.
    c. No, they only form a hypothesis but do not analyze or compile any data.
    d. No, they examine data that have already been compiled and look for patterns.
    e. No, they only do uncontrolled experiments.

ANSWER: d

72. You should not use just one epidemiological study to make policy decisions because:
    a. diseases are complex.
    b. all variables cannot be controlled in one study.
    c. sample size can affect accuracy.
    d. one population may not accurately represent the entire population.
    e. all of these

ANSWER: e

73. A scientific hypothesis must have two very important features. What are they?
    a. testable
    b. provable
    c. adaptable
    d. correctable
    e. falsifiable

ANSWER: a, e

74. What conclusions can be drawn from a hypothesis?
    a. If evidence supports the hypothesis, then the hypothesis is considered scientific theory.
    b. If evidence rejects the hypothesis, then it can be removed from the list of possible answers to the original question.
    c. If data support the hypothesis, then it is accepted and further testing is not warranted.
    d. If there is data to support the hypothesis, then it is accepted until further testing suggests otherwise.
    e. If the data collected do not support the hypothesis, then it was a poor hypothesis.

ANSWER: b, d

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75. Information that can be used as valid scientific evidence includes:
    a. peer-reviewed scientific literature.
    b. previous data generated.
    c. observations about past work.
    d. anecdotal evidence.
    e. other people's data.

ANSWER: a, b, c, e

76. Characteristics of a scientific hypothesis include:
    a. it is an opinion.
    b. it is an educated guess to explain an observation.
    c. there must be a way to test the hypothesis.
    d. there must exist a possibility of obtaining a result that could prove the hypothesis wrong.
    e. there must exist a possibility of obtaining a result that could support the hypothesis.

ANSWER: b, c, d, e

77. A controlled experiment must:
    a. have a dependent variable.
    b. have an independent variable.
    c. be falsifiable.
    d. be repeatable.
    e. not have been previously tested.

ANSWER: a, b, c, d

78. Studies involving the benefits or risks of drinking coffee may be obscured by:
    a. the side effects of caffeine.
    b. where the coffee was purchased.
    c. other chemicals in coffee.
    d. how the coffee was roasted or processed.
    e. the brand of the machine used to brew the coffee.

ANSWER: a, c, d

79. In designing a scientific research project, the ideal control group should:
    a. be identical to the dependent variable.
    b. be identical to the experimental group.
    c. not be present in a good scientific project.
    d. receive no experimental manipulation or receive the placebo.
    e. be identical to the independent variable.

ANSWER: b, d

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Chapter 1

80. Scientific studies involving a subjectively assessed benefit (i.e., caffeine and enhanced memory recall) can be complicated by:
    a. too few observations.
    b. improper controls.
    c. poor subject selection.
    d. side effects from the substance.
    e. too many observations.

ANSWER: a, b, c, d

81. A large sample size is important for which of these reasons? Large sample sizes:
    a. reduce the possibility that results are due to chance alone.
    b. increase the likelihood of finding a statistically significant result.
    c. make the results more reliable.
    d. increase the accuracy of the results.
    e. increase the likelihood that a very rare result will be noticed.

ANSWER: a, b, c, d

82. What is(are) the major factor(s) affecting the strength of a conclusion?
    a. sample size
    b. independent variable
    c. dependent variable
    d. the type of study conducted
    e. where the study was conducted

ANSWER: a, d

83. Which of these are examples of scientific theories?
    a. If you carry an umbrella, it will not rain.
    b. Evolution occurs by natural selection.
    c. The freezer is the best place for valuables.
    d. All cells come from pre-existing cells
    e. 3,000 subjects perform better after a full night's sleep.

ANSWER: b, d

84. A scientific theory is a(n):
    a. hypothesis that has been rigorously tested and never been disproven.
    b. opinion.
    c. hypothesis that has never been disproven.
    d. hypothesis that has been tested at least five times.
    e. idea based on a person's experience or knowledge.

ANSWER: a, c

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85. In valid scientific studies, an important difference between cell phones, which have not been linked to increased brain cancer rates, and x-rays and UVA/B rays, which have been linked to certain types of cancers, is that cell phones utilize electromagnetic radiation that is characterized by:

a. low frequency.
b. high frequency.
c. shorter wavelength.
d. longer wavelength.
e. lower energy.

ANSWER: a, d, e

86. Although the term radiation can be scary for many people, not all radiation is equal. Ionizing radiation refers to radiation that _____, whereas non-ionizing radiation refers to radiation that _____.

a. can alternate between low- and high-energy states in cells
b. is powerful enough to directly damage molecules in cells, including the DNA
c. causes melanoma (a type of skin cancer), regardless of the source of radiation
d. promotes cellular division and repair due to its low-energy state
e. is low frequency, thus not known to be harmful to DNA

ANSWER: b, e

87. A positive correlation in a scientific study means:

a. both variables increase proportionately.
b. one variable is linked to another variable.
c. one variable increases, while the other decreases.
d. there is a link between the variables studied.
e. both variables decrease proportionately.

ANSWER: a, e

88. Describe the steps used in the process of a scientific study.

ANSWER: making initial observations that generate questions, studying the literature, generating hypotheses that are both testable and falsifiable, testing the hypothesis with experiments and analyzing the data, and making conclusions that are supported by data

89. Imagine that you read a study of the effects of exercise on the prevalence of heart disease in women ages 35 to 65. Although you believe the experiment was carried out in an appropriate manner, you still do not believe the results. You decide to conduct your own study to see for yourself. To determine if the results of the first study are valid, should you do everything the same way as the first study or would it be better if you changed several of the variables, such as studying men, or looking at different age groups? Explain your choice and explain the consequences of the other choice.

ANSWER: To be most comparable, you would conduct your new study in the exact same manner as the previous study. If you were to change any of the variables, then the results might change as well; thus, you would not be able to compare your new results to the first study.

90. Why can't science answer questions about the existence of a supernatural being?

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ANSWER: Science requires a hypothesis that is testable and falsifiable. There is no way to test the existence of a supernatural being, nor is it possible to prove that something does not exist.

91. What does it mean to say that a scientific study has undergone "peer review?" Why is this important?
ANSWER: When a study has undergone peer review, it means that other scientists have examined the study to make sure the experiment was carried out properly and that the conclusions are appropriate. This is important to weed out studies with questionable methods and results to ensure scientific accuracy and reliability.

92. Why do scientists say that a hypothesis is "supported" and never say that a hypothesis has been "proven"?
ANSWER: Because it is impossible to test a hypothesis under every possible scenario; there is no way to "prove" a hypothesis. Thus, a hypothesis can only be supported.

93. A hypothesis is often called an educated guess. Why is it a guess and why is it educated?
ANSWER: It is a guess because it is a possible answer to a question that has been formulated but not yet answered. It is educated because that question and the possible answer are both based on prior knowledge gained from previous observation and research.

94. To test the effectiveness of a new drug designed to improve concentration in children with hyperactivity disorder, a researcher divided 100 children with hyperactivity disorder into two groups of 50 children each. First, both groups received a test to determine the length of time they could study a word list before their attention wandered. Then, group 1 received the new drug, while group 2 received a sugar pill. One hour later, both groups took the concentration test again.
Which group is the experimental group and which is the control group?
ANSWER: Group 1 is the experimental group; group 2 is the control group.

95. To test the effectiveness of a new drug designed to improve concentration in children with hyperactivity disorder, a researcher divided 100 children with hyperactivity disorder into two groups of 50 children each. First, both groups received a test to determine the length of time they could study a word list before their attention wandered. Then, group 1 received the new drug, while group 2 received a sugar pill. One hour later, both groups took the concentration test again.
Why did group 2 receive a sugar pill instead of simply not taking anything at all?
ANSWER: Group 2 received the sugar pill so that as many variables as possible would be the same between the two groups.

96. To test the effectiveness of a new drug designed to improve concentration in children with hyperactivity disorder, a researcher divided 100 children with hyperactivity disorder into two groups of 50 children each. First, both groups received a test to determine the length of time they could study a word list before their attention wandered. Then, group 1 received the new drug, while group 2 received a sugar pill. One hour later, both groups took the concentration test again.
What is the independent variable in this study?
ANSWER: The independent variable is the drug.

97. To test the effectiveness of a new drug designed to improve concentration in children with hyperactivity disorder, a researcher divided 100 children with hyperactivity disorder into two groups of 50 children each. First, both groups received a test to determine the length of time they could study a word list before their

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attention wandered. Then, group 1 received the new drug, while group 2 received a sugar pill. One hour later, both groups took the concentration test again.
What is the dependent variable in this study?
ANSWER: The dependent variable is attention span.

98. Describe the features of an experimental group versus a control group—for example, in an experiment where the hypothesis is "consuming coffee improves memory."
ANSWER: The experimental group will contain subjects who are observed under the conditions being tested. In this case, experimental and control groups would both have their memories tested. The experimental group would consist of individuals who have had caffeinated coffee versus the control group, who would have had decaf coffee (no caffeine).

99. What is a placebo treatment, and why is it important in a properly designed experiment?
ANSWER: A placebo treatment is a fake treatment given to the control group to mimic the experience of the experimental group. It is important to keep as many factors as possible identical between the experimental and control groups, so that only the variable being studied is different. By doing this, you ensure that the result you observe is due to the experimental factor and not to any other unknown factor.

100. You are running an analysis on different food items to test for the presence of the major biological macromolecules of starch, proteins, and lipids. For each test, you examine four food items and distilled water. What is the role of the distilled water?
ANSWER: It is a control.

101. Numerous studies have shown that the more often a person performs a workout routine that increases heart rate, the better their overall heart health is. You have two groups of individuals who are willing to participate in a heart-health experiment. Fifty are nonsmoking males, ages 18 to 22, who work out three times per week. Fifty are nonsmoking males, ages 18 to 22, who do not work out on a regular basis. In the experiment, they will step up and down on an 8-inch-high cinder block 120 times/minute for 3 minutes. Researchers will examine their heart rates before starting, immediately after they finish, and every minute after finishing until their heart rates return to their original rates. Two common measures of heart health are the percentage increase in heart rate caused by exercise and the time the heart rate takes to return to the base rate. Based on these parameters, what is your hypothesis regarding the heart health and test performance of the two groups?
ANSWER: The nonexercising group will have a greater increase in heart rate and a longer recovery time than the exercising group, indicating an overall lower level of heart health in the nonexercising group.

102. You are performing a bacterial transformation where you are trying to transfer DNA that contains the gene for resistance to the antibiotic ampicillin into the bacterium *E. coli*. Ampicillin normally kills *E. coli*, but if you are successful in your transfer of the DNA, the *E. coli* will now be unaffected by ampicillin. *E. coli* grows best on Luria Broth agar plates. Giving a cold period and then a brief heat shock and a cold period has been shown to help bacteria cells take up pieces of DNA).
You take some cultures of *E. coli*, add cold calcium chloride, keep these on ice for 15 minutes, heat shock them for 90 seconds, and then chill them on ice for 1 minute before putting them onto Luria Broth agar plates with ampicillin and Luria Broth plates without ampicillin. These bacteria should be killed by the plates with ampicillin.
You take some other cultures of *E. coli*, add cold calcium chloride, then add the new DNA, then keep these on

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ice for 15 minutes, heat shock them for 90 seconds, and then chill them on ice for 1 minute before putting them onto Luria Broth agar plates that contain ampicillin and Luria Broth agar plates without ampicillin. If you successfully transferred the DNA, these bacteria should grow on the plates with ampicillin and the ones without ampicillin.
In this experiment, why were the colonies without the added DNA and the colonies with the added DNA treated the same way (15 minutes cold, then heat shock, then cold)?

ANSWER: They were used as a control to show that you handled both types of *E. coli* colonies the same way. Even though there was no DNA to be taken up by the one set of *E. coli*, if you had not handled them the same as the ones with DNA, you might conclude that the cold/heat/cold treatment conferred the ability to resist ampicillin.

103. Two studies were conducted to determine if a new drug was effective at reducing tumor size in patients with lung cancer. One study examined men and found that the drug reduced tumor size by 45%; the other study, conducted on women, concluded that the drug had no effect. Is it possible that the results of both studies are correct? Why or why not?

ANSWER: The results of both studies may be correct because there may be differences in how the drugs affect men compared to women.

104. Two researchers wish to examine the effect of caffeine on alertness. One researcher has the participants drink a cup of coffee with 100 mg of caffeine, whereas the other researcher has the participants take a capsule with 100 mg of caffeine. In all other respects, these two studies are identical. Which method do you think will answer the question best? Why? Are there any complicating factors that could compromise the results of one of the studies?

ANSWER: The study in which participants are given caffeine in pill form will best answer the question about the effect of caffeine on alertness. Even though the amounts of caffeine are equal, there could be other compounds in the coffee that could influence the results.

105. How can two studies on the same topic have conflicting conclusions?

ANSWER: There may be other factors that can influence the outcome of the study that were not considered in the experimental design.

106. Researchers ran three clinical trials, each using a different one of the following populations:
250 nonsmoking men ages 18 to 25
500 smoking and nonsmoking men and women ages 20 to 55
300 smoking women ages 45 to 60
Would you expect the results of these three experiments to be the same? Explain.

ANSWER: No, because the three experimental groups were different in age, gender, and whether or not they smoked, so there are many different factors that may have had an effect on the results of the clinical trial.

107. You have been asked to review and summarize three experiments regarding caffeine consumption and cancer.
A - In experiment A, researchers looked at the incidence of colon cancer among 100 regular tea drinkers and 100 nontea drinkers in Japan, all between the ages of 18 and 38, and found that tea drinkers had less colon cancer than nontea drinkers.
B - In experiment B, researchers looked at the incidence of pancreatic cancer among 300 heavy drinkers of

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yerba mate (*Ilex paraguariensis*, a tree with leaves and stems that contain high levels of caffeine), 300 moderate yerba mate drinkers, and 300 non–yerba mate drinkers in Argentina, all between the ages of 40 and 60. This study showed that heavy yerba mate drinkers had higher levels of pancreatic cancer than moderate yerba mate drinkers, and moderate yerba mate drinkers had higher levels than nondrinkers.
C - In experiment C, researchers looked at the levels of prostate cancer among men ages 40 to 80 in the United States. The study examined 1,000 coffee drinkers and 1,000 non-coffee drinkers and found slightly lower levels of prostate cancer among the coffee-drinking men.
How do you summarize and reconcile these three experiments that have varying results with respect to the relationship between caffeine and cancer? Are some of them wrong?

ANSWER: The three experiments looked at three different types of cancer, three different populations from three different countries, and three different plant sources of caffeine. It would therefore be illogical to think they would have similar results. Although we like to speak of "cancer" as if it was a single disease, it is in fact quite variable. All of these results may be quite accurate, but all are narrow in scope; we can't make any general conclusions regarding caffeine and cancer from these results.

108. You are testing the following hypothesis: left-handed people have better hand-eye coordination than right-handed people. Based on a review of literature, you have learned that one common test of hand-eye coordination is measuring the percentage of times that someone can drop a coin into a small container from a height of 3 feet. To perform this experiment, you use a group of 25 left-handed males, 25 right-handed males, 25 left-handed females, and 25 right-handed females. Design an experiment to test your hypothesis and be sure to define your independent and dependent variables.

ANSWER: Experimental design may vary but should include a gender and handedness balance. It is important that each individual has multiple attempts to drop the coin into the container. The dependent variable is the number of times each person is successful in getting the coin into the container. The independent variables are gender and handedness. The best experimental designs will also incorporate the concepts of participants' ages and heights.

109. Why does having a large sample size give more reliable results?

ANSWER: The larger the sample size, the less likely the results are due to chance alone.

110. You have two experiments to review. One looks at 1,000 of the 1,000,000 rabbits in an area. The other study looks at 100 of the 100,000 wolves in an area. Is one study more statistically accurate than the other? Why or why not?

ANSWER: Neither, they both looked at 1 out of every 1,000 individuals.

111. Explain the importance of sample size in experiments.

ANSWER: Experiments performed with a small number of participants have a higher probability that their results can be attributed to the nature of the participants. The greater the number of participants, the greater the probability that the results cannot be attributed to chance.

112. Explain why evolution is not dismissed as "just a theory" with reference to the Theory of Evolution.

ANSWER: Evolution has been supported by many experiments in many diverse fields. Fossils, comparative anatomy, biochemical, and biographical data support the theory of evolution by natural selection. Theories in science differ from the mainstream or colloquial interpretations, because scientific theories are based on results and conclusions from many experiments. Over time, supported hypotheses, backed by much data, become recognized as scientific theory.

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Chapter 1

113. What is the difference between a hypothesis and a theory?

ANSWER: A hypothesis is an explanation that may or may not have undergone scientific testing, whereas a theory is a hypothesis that has undergone numerous tests over many years and has accumulated a large body of evidence in support of the explanation.

114. Does science ever prove a hypothesis or theory? Why or why not?

ANSWER: Science never proves anything because no idea can be tested under every possible circumstance. Thus, the best that science can do is rigorously test a hypothesis, and with rigorous testing comes increased support in favor of the hypothesis.

115. Define the meaning of the word "theory" in everyday usage and scientific usage, and give two examples of each type of theory.

ANSWER: In everyday usage, theory means an untested idea, but that is often based on observation; however, it can also be used in the derogatory sense as "just a theory." (Examples will vary.) In scientific usage, theory means an idea that has been rigorously tested and repeatedly supported. (Examples may vary, but may likely include the cell theory and theory of evolution.)

116. In several reported incidents, local school boards have insisted that biology texts have a stamp placed inside stating that "evolution is a theory." To their surprise, most science faculties have not objected to this language. Explain how each group interprets the statement that "evolution is a theory."

ANSWER: In everyday usage, the word theory has come to mean "idea," and it is often used to indicate an idea that is unlikely to be true. Thus, when school board members call evolution a theory, they are implying that it is untrue. However, when a scientist uses the word theory, it means a hypothesis that has been tested numerous times and has never been falsified. It is equivalent to a mathematician using the word "theorem." So, the biology faculty could use the school board's own language to support the theory of evolution when covering that in class, simply by defining the word theory in a scientific context.

117. Differentiate between a simple correlation and causation.

ANSWER: A correlation is a link between two factors that may not indicate causation. An example is the link between coffee drinkers and smokers and the incidence of Parkinson's disease. Both coffee drinkers and smokers have a lower incidence of Parkinson's disease, yet these can be quite different activities. It MAY indicate that something about smoking or drinking coffee plays a role in reducing the incidence level of Parkinson's disease, but no causation is proven. Causation is a definitive link between two factors. Smoking deposits materials into the lungs, decreasing their oxygen-absorbing capacity, causing the heart to work harder. Thus, there is causation between smoking and increased heart rate.

118. You read an article in the newspaper that says people who consume large amounts of red meat show an increased risk of having a heart attack. Is it correct, therefore, to say that red meat causes heart attacks? Why or why not? If not, what would be an appropriate conclusion?

ANSWER: No, you cannot say that red meat causes heart attacks. You can only say that consuming red meat is correlated with an increased risk of heart attack. Correlation does not equal causation.

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Chapter 1

119. To differentiate between a simple correlation and causation, researchers often divide subjects into treatment and control groups and follow them for a number of years to see if one group has a higher incidence of disease than the other group. What is this type of study called?

ANSWER: This type of study is a randomized clinical trial.

120. Why would the media choose to report on one scientific study versus another? Is their decision always based in science?

ANSWER: The media often chooses to report on the most sensational or headline-grabbing scientific studies, without regard to the scientific merit of the work.

121. Imagine you are a journalist whose latest assignment is to write a magazine article on the latest findings about vaccines and autism. What are some of the concerns you might have about how best to convey such a vast amount of information to the general public?

ANSWER: What is the best way to reduce the material down to the essence of what is important? How can complex issues be simplified to make them easily understood by nonscientists? How can the information be conveyed clearly, accurately, and concisely, so as not to mislead the public or cause misunderstandings? How should any limitations of the study be reported?

122. A researcher wishes to determine the quantity of caffeine intake required to improve alertness. The participants are divided into two groups, with one group receiving a low dose of caffeine and the other group receiving a high dose of caffeine. The subjects are all coffee drinkers who regularly consume more than 100 mg of caffeine per day. All participants, however, are required to abstain from caffeine intake for 12 hours before the study. Caffeine is addictive and therefore causes unpleasant side effects when the user stops consuming it. Is the addictiveness of caffeine a potential problem in this study? Why or why not?

ANSWER: The addictiveness of caffeine is a potential problem because the caffeine may simply alleviate the withdrawal symptoms rather than actually increase alertness. Furthermore, the results of this study would not be relevant to people who do not regularly consume caffeine.

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