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Correct Answers are located at the end of each chapter.

TRUE/FALSE - Write 'T' if the statement is true and 'F' if the statement is false.

1) The kingdom is the most all-inclusive taxonomic category.
   - ◎ true
   - ◎ false

2) The cell is the basic unit of life.
   - ◎ true
   - ◎ false

3) The smallest scale of biological organization is represented by organelles.
   - ◎ true
   - ◎ false

4) Decomposers are a special group of primary producers.
   - ◎ true
   - ◎ false

5) In an experiment designed to determine if a fertilizer increased crop yield in tomato plants, the number of tomatoes produced by each plant would be the independent variable.
   - ◎ true
   - ◎ false

6) In an experiment designed to determine if a fertilizer increased crop yield in tomato plants, the number of tomatoes produced by each plant would be the dependent variable.
   - ◎ true
   - ◎ false

7) In an experiment designed to determine if a fertilizer increased crop yield in tomato plants, the amount of sunlight and water the plants received would be standardized variables.
   - ◎ true
   - ◎ false

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8) A theory is an advanced hypothesis that has been proven to be true.
   ◎ true
   ◎ false

9) Researchers can readily extract DNA from one organism and merge that DNA into another organism, applying genetic engineering as a possible cure to cancer or muscular dystrophy and other diseases. The scientific method can test a hypothesis to determine if this approach is morally right or wrong.
   ◎ true
   ◎ false

MULTIPLE CHOICE - Choose the one alternative that best completes the statement or answers the question.

10) Thinking about life's organizational hierarchy in a biological system, which of the following is the correct sequence from the smallest unit to the largest unit?
   A) atom - molecule - organelle - cell - tissue
   B) molecule - atom - organelle - tissue - cell
   C) cell - organelle - atom - tissue - molecule
   D) organelle - molecule - atom - tissue - cell
   E) atom - organelle - molecule - cell - tissue

11) The hierarchy of life extends past individual organisms. Which of the following is the correct sequence, from least inclusive to most inclusive, following an individual organism?
   A) population - ecosystem - community - biosphere
   B) community - population - ecosystem - biosphere
   C) community - population - biosphere - ecosystem
   D) population - community - ecosystem - biosphere
   E) ecosystem - population - biosphere - community

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12) In living organisms, emergent properties
   A) are functions that arise from interactions between a system's components.
   B) evolve new properties from other similar organisms.
   C) are produced in a new generation of offspring that will show the properties.
   D) are qualities of cells that disappear when in the presence of other cells.
   E) functionally arise from larger successful parts working together for a stronger organism.

13) To be considered living, an organism must minimally consist of
   A) DNA and proteins.
   B) one or more cells.
   C) RNA and proteins.
   D) atoms and molecules.
   E) DNA and RNA.

14) Which of these is not a required characteristic of life?
   A) homeostasis
   B) locomotion
   C) structural organization
   D) evolution
   E) energy use

15) Organisms that make their own food by capturing energy from nonliving resources (solar energy) are called
   A) decomposers.
   B) parasites.
   C) primary producers.
   D) consumers.
   E) detritivores.

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16) Organisms that obtain energy and nutrients by eating either living or dead organisms are called
A) primary producers.
B) plants.
C) consumers.
D) autotrophs.
E) All of the answer choices are correct.

17) Which of the following is an example of a characteristic of life?
A) Energy is needed to build, regulate, and conduct processes of life.
B) Organisms are composed of atoms that make up cells.
C) Organisms have the ability to reproduce, grow, and develop.
D) Organisms maintain internal constancy.
E) All of the answer choices are correct.

18) The basic unit of classification in the taxonomic hierarchy, designating the organism "type," is the
A) species.
B) domain.
C) genus.
D) family.
E) kingdom.

19) The four kingdoms included in the domain Eukarya are
A) Bacteria, Fungi, Archaea, and Animalia.
B) Bacteria, Protista, Plantae, and Animalia.
C) Protista, Fungi, Plantae, and Animalia.
D) Archaea, Bacteria, Protista, and Animalia.
E) Archaea, Fungi, Plantae, and Animalia.

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20) A major difference between prokaryotes and eukaryotes is that whereas prokaryotes
A) have cell walls, eukaryotes do not.
B) do not have a nucleus, eukaryotes have a nucleus in their cells.
C) have DNA, eukaryotes only have RNA.
D) have chloropasts for photosynthesis, eukaryotes do not.
E) have mitochondria, eukaryotes do not.

21) Until the late 1970s, there was no "Domain" as the broadest category in taxonomy. Instead, there were five kingdoms: Protista, Plantae, Fungi, Animalia, and Monera, which included all bacteria-like organisms. Researchers proposed the domains to distinguish between the bacteria-like organisms. Which information supported placing bacteria and archaea in separate domains?
A) Differences in DNA among the existing kingdoms showed a need for a broader naming category.
B) More complex emergent properties developed after organisms were originally categorized into kingdoms.
C) Cell shapes of bacteria and archaea were found to be more distinct, after microscope technology improved.
D) Evolution led to new adaptations and diversity of organisms.
E) Organisms in the Bacteria and Archaea domains have a nucleus, whereas eukaryotes do not.

22) Which of the following is not a true statement about the scientific method?
A) It is a general way of organizing an investigation.
B) It requires testing a hypothesis.
C) It begins with observations.
D) It does not apply to problems encountered in everyday life.
E) It is a framework to consider evidence in a repeatable way.

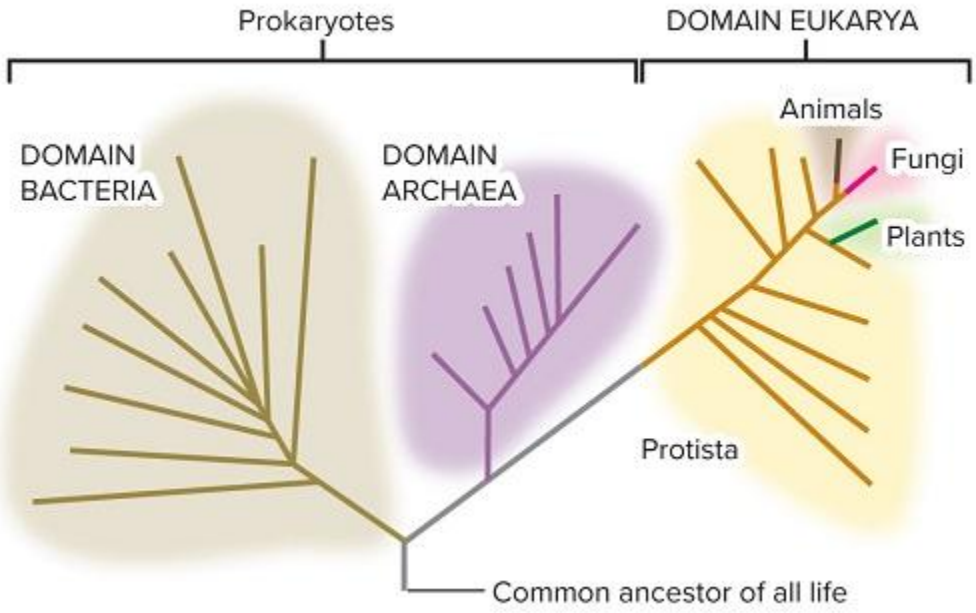
23) Which of the following is not true about a hypothesis?
A) It can be proven to be true.
B) It can be rejected.
C) It is a tentative explanation.
D) Previous knowledge can help support it.
E) It must be testable to be useful.

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24) In an experimental procedure, the researcher has established multiple levels of a chemical, or amounts of light, or some other factor at the beginning of the experiment, in order to determine if and how much the biological system responds. The manipulated factor at varying levels is the

A) standardized variable.
B) control group.
C) dependent variable.
D) independent variable.
E) Both control group and standardized variable are correct.

25) Examine this diagram. Note the structure of branches connecting groups of organisms. Called a phylogenetic tree, the branches propose relationships among organisms to each other, related to common ancestors. Although the proposed relationships can be described in sentences, the diagram summarizes them visually. Which of the following statements is true based on this diagram?



A) The organisms in domain Archaea are more closely related to the organisms in domain Eukarya than those in domain Bacteria.
B) All the organisms in this phylogenetic tree are equally related to one another.
C) The organisms in domain Bacteria are more closely related to the organisms in domain Eukarya than those in domain Archaea.
D) The organisms in kingdom Protista are part of domain Bacteria.
E) All of the answer choices are correct.

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26) In an experimental procedure, the researcher measures changes, such as cell growth rates, numbers of patients with a disease, etc. in response to factors manipulated at the beginning of the experiment. This measure of change in response to the initial conditions is the
A) independent variable.
B) dependent variable.
C) control group.
D) standardized variable.
E) Both dependent variable and standardized variable are correct.

27) Which of the following would not be a "control" in an experimental procedure?
A) a placebo group
B) a known standard of comparison
C) a normal (untreated) group
D) an experimental group
E) a "zero-value" group

28) A theory differs from a hypothesis in that a theory
A) has more supportive research evidence than a hypothesis.
B) is broader in scope than a hypothesis.
C) has predictive power for similar phenomena that haven't been observed yet.
D) ties together many existing observations.
E) All of the answer choices are correct.

29) A structure, such as a flower in plants, or a liver in animals, consisting of tissues organized to carry out a specific function is a(n)
A) organ.
B) cell.
C) population.
D) molecule.
E) organelle.

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30) An ecosystem would include all of the following except
A) a community that may include primary producers, consumers, and decomposers.
B) the biosphere, with its resources and functioning systems.
C) populations of organisms in the same species.
D) nonliving air, water, soil, and other components in an area.
E) None of the answer choices are correct.

31) A researcher collected a single-celled organism from birdbath water and grew the organism in a laboratory. The researcher observed the organism reproducing by cell division, which resulted in identical offspring generations. This organism exhibits a form of
A) asexual reproduction.
B) reproduction that produces enormous genetic diversity among offspring
C) reproduction occurring only in bacteria.
D) sexual reproduction, mixing genetic material from the parent cells.
E) sexual reproduction of fungi.

32) Homeostasis means that
A) a population changes over time.
B) environmental conditions are held constant and do not change.
C) cells have enough water.
D) all organisms require an energy source.
E) conditions inside a cell or organism remain within a constant range.

33) The correct sequence going from smallest to largest is
A) tissue - cell - organelle - molecule - atom.
B) molecule - atom - organelle - tissue - cell.
C) atom - molecule - organelle - cell - tissue.
D) cell - tissue - organelle - molecule - atom.
E) cell - molecule - tissue - organelle - atom.

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34) All ecosystems
A) need a source of external energy.
B) stay exactly the same once mature.
C) are entirely self-sufficient.
D) consist of only living organisms.
E) None of the answer choices are correct.

35) Which is the correct sequence of steps in the scientific method?
A) make an observation - analyze results - form hypothesis - draw conclusions - design an experiment
B) make an observation - analyze results - draw conclusion - design an experiment - form hypothesis
C) make an observation - form hypothesis - design an experiment - collect data - analyze results
D) form hypothesis - make an observation - design an experiment - collect data - analyze results
E) form hypothesis - make an observation - collect data - analyze results - design an experiment

36) A college student has a new job, and must balance classes and commute times to work. The student takes two weeks to drive from campus to the workplace by several routes, including a direct route through town, a highway route, and a route through a city park. Comparing the drive times affected by the route is possible. The dependent variable is the
A) average time in minutes it takes to drive from campus to workplace.
B) distance in miles of each possible driving route from campus to workplace.
C) the number of cars in the same route.
D) the time in minutes between walking from class to their vehicle.
E) the type of vehicle the student is driving.

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37) A golfer wants a new set of clubs to improve their game. In an experiment, the golfer tests different drivers made from different materials. They compare the drivers to the distance of their shot. In this simple experiment, the independent variable is the

A) wind direction when the experiment took place.
B) distance the golf ball traveled.
C) type of material used to make the golf ball.
D) swing speed of the golf club prior to striking the golf ball.
E) type of material used to make the drivers.

38) A golfer wants a new set of clubs to improve their game. In an experiment, the golfer goes to the driving range and compares the distance they hit a bucket of golf balls with drivers of different materials in the clubs before making their purchase decision. In this simple experiment, the standardized variable is the

A) wind direction when the experiment took place.
B) force generated by her swing, when hitting the ball.
C) type of material used to make the golf ball.
D) all of these except the type of material used to make the club.
E) angle the ball was hit by the head surface of the club.

39) Scientists have developed an ointment to decrease muscle inflammation after intense workouts or trainings. To test the product, 99 weight lifters are divided into three equal groups. Group 1 is given the actual ointment, Group 2 is given an inactive ointment that looks and smells like the active ointment, and Group 3 is not allowed to use any treatment. Group 2 has been given

A) a placebo.
B) an independent variable.
C) a standardized variable.
D) the active ointment.
E) a control variable.

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40) In an experiment, which of the following is not generally a true statement?
A) The larger the sample size the more reliable the results.
B) The smaller the sample size the more reliable the results.
C) Without the proper control an experiment is not valid.
D) It is important to standardize aspects of an experiment that might affect the outcome, other than the independent variable.
E) None of the answer choices are correct.

41) What did Charles Darwin propose after observing the 11-inch-long nectaries of the *Angraecum sesquipedale* orchid in Madagascar?
A) the existence of a pollinator moth with a proboscis of 10–11 inches
B) the presence of very small bees that can fit into a long nectar tube
C) that the orchid must reproduce asexually
D) that the orchid was an evolutionary dead end and could no longer reproduce
E) that the orchid was a self-pollinator and required no assistance from an organism

42) After observing variability among plant and animal species in various locations, Charles Darwin proposed an explanation for what he saw. The broad proposal included reasons that species could be modified through genetic variation, leading to measurable similarity and difference. Evidence for the proposal came from biological, geographic, and geological observations. His proposal allowed for the prediction of new species that might be found in new settings, based on environmental conditions. Darwin's proposal is an example of
A) a standardized variable.
B) a theory.
C) an independent variable.
D) a dependent variable.
E) a hypothesis.

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43) Charles Darwin observed an orchid flower with very long, thin tubes that prevent many species from feeding on the flower nectar and pollinating the flower. He offered a prediction that some species of pollinators would eventually be found that can feed and pollinate through the small tube.
You decide to test Charles Darwin's proposal by placing nets over some orchids that allow small pollinators to enter, but prevent the large sphinx moth from entering. You then compare the number of seeds produced by plants with and without the nets. The seed production is

A) a dependent variable.
B) a hypothesis.
C) a theory.
D) an independent variable.
E) a standardized variable.

44) Darwin observed an orchid flower with petals arranged in very long, thin tubes, rather than broad and flat, as we might see in other common flowers. What is the advantage to the orchid having an 11-inch-long nectar tube arrangement of the petals?

A) The flower can produce nectar more easily spread over a larger area to attract more pollinators.
B) The flower nectar tube can collect more rainwater to maintain health of the flower.
C) The flower can only be pollinated by a specifically adapted pollinator, reducing cross-fertilization among orchid species.
D) The flower can collect more sunlight for photosynthesis.
E) The long tube can trap insects as a source of nutrients.

45) What is the advantage to the sphinx moth *Xanthopan morgani* by having an 8-inch-long tongue?

A) It is used to attract mates through sexual selection.
B) It can only pollinate one type of flower.
C) It makes flying more efficient.
D) It can be used to capture other flying insects for food.
E) It can reach nectar that no other pollinator can reach.

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46) Given basic information from observations of the orchid with a long nectary, and the moth with the long proboscis, what is the advantage to a plant like an orchid producing nectar over a plant like a pine tree that does not produce nectar?

A) Nectar helps disperse pollen by wind.
B) Nectar attracts animals that perform pollination.
C) Nectar provides food for the pollen and growing fruit.
D) Nectar helps disperse pollen by water.
E) Nectar provides a sticky surface for pollen to attach to, promoting fertilization.

47) You are feeling ill, so you visit a physician. The physician takes your temperature, blood pressure, and pulse and orders blood tests and urine analysis to determine more about your condition. The results of all of these observations and tests will help the physician assess why your body is temporarily out of "normal" conditions, or when the body is not adequately

A) maintaining homeostasis.
B) evolving.
C) adapting.
D) reproducing.
E) organized.

48) Before biologists discovered the role of DNA and chromosomes, Gregor Mendel, a scientific researcher, studied the genetics of pea plants related to flower colors, pea colors, pea pod shapes, and other features of the plant.
He numerically modeled the results he observed and published results, which eventually led to our basic understanding of how biological traits are passed to new generations of organisms.
His work, however, was largely rejected for over 30 years, partly for minor record-keeping errors, and partly for the new approach of defining reproduction of organisms in terms of numerical probabilities. This demonstrates that

A) scientific evidence is harder to accept because of cultural biases and misunderstandings on the topic.
B) Gregor Mendel's work wasn't valid until researchers later identified chromosomes and their role in reproduction.
C) a unique, new way to propose a theory discredits the research until someone else proves findings to be true.
D) only the most recent scientific investigations on a topic are useful in understanding biological conditions or processes.
E) the color and shape of peas was not important to the scientific community.

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49) Viruses are not considered an organism because they don't have cell membranes, organelles, and do not carry out vital life functions, although they do have a form of DNA (or similar RNA). A researcher proposing to categorize viruses in the tree of life would need to

A) propose a genetic relationship to living organisms and test how viruses lost life characteristics over time.
B) establish any virus as a control group for experimentation with established domains of organisms.
C) apply his/her proposal to any newly discovered virus, since others aren't currently considered organisms.
D) remember that the scientific method will prevent any changes to the current taxonomy and tree of life.
E) show the importance of genetic information as a characteristic of life.

50) Health care and fitness professionals claim moderate exercise yields heart health.
In an attempt to study the effect of moderate exercise on heart health, you track four groups of fellow students through a semester. One group is a control, who are not to change their exercise patterns. The three other groups are assigned to a 30-minute exercise once, twice, or three times a week.
Results at the end of the semester show that average blood pressure and pulse rates are nearly the same for the control group as the once-a-week exercisers. Average blood pressure and pulse were slightly lower for the two groups that exercised more often, but not every student showed any difference, and some actually had increased blood pressure and pulse rates.
What conclusions can be drawn from the data collected?

A) Measured differences in the average blood pressure and pulse of the three experimental groups will not likely show a statistically significant difference from the control group.
B) Measured differences in the average blood pressure and pulse of the once-a-week exercise group and the control group will likely show a statistically significant difference from the groups exercising more often.
C) The individual student data variability and even increased blood pressure and pulse in the two groups exercising more often will not change the fact that the average data values will prove to be statistically significant in difference from the control group.
D) The measured blood pressure and pulse data values of the control group and three exercising groups in this study prove that moderate exercise does not have any beneficial impact on heart health.
E) A conclusion cannot be drawn based on the information provided.

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SECTION BREAK. Answer all the part questions.

51) You perform an experiment in which you take 16 pots of strawberry plants and give half of them 1 gram of ammonium nitrate per liter of water and the other half just gets water. Each group is then split in half again, and exposed to either 8 or 16 hours of light each day. You monitor the height of the plants for four weeks. You observe that increasing ammonium nitrate and light both increase plant height.

51.1) Which of the following is/are an independent variable(s) in this experiment?

A) the amount of ammonium nitrate and light
B) the amount of ammonium nitrate
C) the amount of light
D) the height of the plants and amount of light
E) the height of the plants

51.2) Which of the following is/are a dependent variable(s) in this experiment?

A) the amount of ammonium nitrate and light
B) the amount of ammonium nitrate
C) the amount of light
D) the height of the plants
E) the height of the plants and amount of light

51.3) In this experiment, you are working with available planter pots from the laboratory. You have choices of clay pots of different sizes, as well as biodegradable peat pots and others within lab equipment provided. To establish a standardized variable, you would

A) choose clay pots for the fertilized plants, and biodegradable pots for the unfertilized plants.
B) monitor the strawberry growth rates and determine a mathematical correction to account for the type and size of pot used.
C) select all sixteen pots to be of the same material and size for the experiment.
D) report the pot type used, though recognizing the pot is not as important as fertilizer and light to the strawberries.
E) select a variety of sizes based on the initial strawberry plant size.

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51.4) A plant takes up nutrients like ammonium nitrate to maintain
A) asexual reproduction.
B) sexual reproduction.
C) natural selection.
D) evolution.
E) homeostasis.

51.5) The leaf of a plant is
A) an organ.
B) a molecule.
C) an organelle.
D) a cell.
E) an organism.

51.6) A plant is a
A) consumer.
B) decomposer.
C) primary producer.
D) consumer and decomposer.
E) consumer and producer.

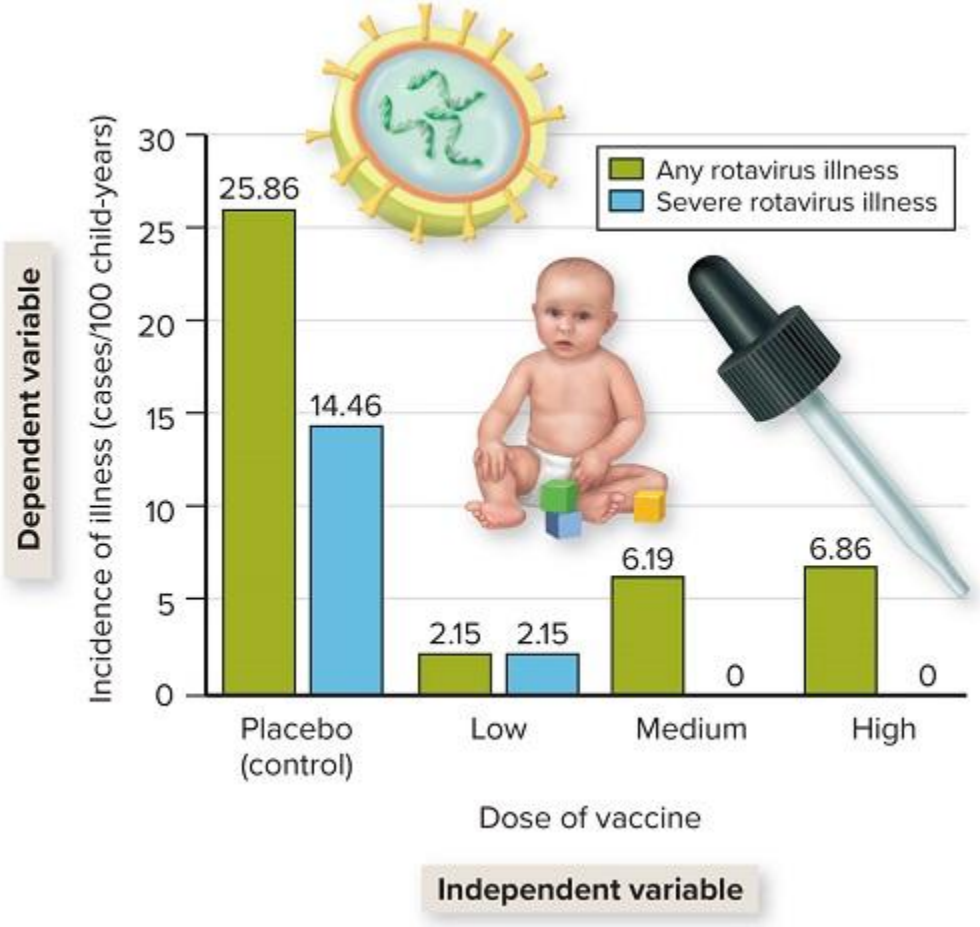
51.7) Organisms require energy to function. What is the energy source for the plants in your experiment?
A) ammonium nitrate
B) light
C) water
D) soil
E) carbon dioxide

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51.8) As part of observation in your scientific method, you discover that your strawberry plants are producing plantlets that are identical to the parent plant. This demonstrates that they reproduce by

A) asexual reproduction.
B) sexual reproduction.
C) development and adaptation.
D) development and maturation.
E) fragmentation.

52) This figure shows graphed medical research results from a study on a new vaccine. The research was done in an effort to determine if a new vaccine would be effective in preventing potentially dangerous rotavirus infections in infants. Green data bars represent occurrence of infant cases that had normal rotavirus strains that aren't critically dangerous. Blue data bars represent occurrence of infant cases that had more dangerous rotavirus strains that can hospitalize or lead to fatality of infants.



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52.1) In this diagram, the vertical axis of the graph shows values of "Incidence of Illness" in infants. The varying numbers of infants getting sick with rotavirus represents the

A) dependent variable of this medical study.
B) independent variable of this medical study.
C) standardized variable of this medical study.
D) control group of infants in this medical study.
E) normal infant baseline for reference to results from this medical study.

52.2) In the graph, interpret the data that are shown regarding the response of a large number of infants to vaccination from dangerous rotavirus infection. Which of the hypotheses is NOT supported by these data results?

A) The new vaccine is ineffective in protecting infants from any rotavirus infection.
B) The high dose of the new vaccine does not offer any stronger protection from any rotavirus infection than the medium dose.
C) The low dose of the vaccine reduces incidence of illness from any rotavirus in general, and also severe rotavirus.
D) Medium and high doses of the vaccine are more effective at reducing severe rotavirus illnesses than reducing any rotavirus.
E) Hypotheses about the vaccine doses can't be evaluated because the placebo group is biased, with high incidence of illness in those infants.

52.3) In the graph, the horizontal axis is showing different doses of vaccine, including "placebo," "low," "medium," and "high." These levels of vaccine were applied to different groups of babies to test if and how much the vaccination helped reduce the incidence of rotavirus, an illness that can quickly dehydrate infants to critical or fatal levels. These dosages in this medical study represent

A) the independent variable.
B) the standardized variable.
C) the dependent variable.
D) the control group.
E) the placebo.

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52.4) In this experiment, if the scientists administering the treatments (low, medium, or high vaccine doses, as well as the placebo) did not know which dose they were administering, then this would be an example of a double-blind experiment.

- ◎ true
- ◎ false

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Answer Key

Test name: Chapter 01

1) FALSE
2) TRUE
3) FALSE
4) FALSE
5) FALSE
6) TRUE
7) TRUE
8) FALSE
9) FALSE
10) A
11) D
12) A
13) B
14) B
15) C
16) C
17) E
18) A
19) C
20) B
21) A
22) D
23) A
24) D
25) A
26) B
27) D
28) E
29) A
30) B
31) A
32) E
33) C
34) A
35) C
36) A
37) E

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38) D
39) A
40) B
41) A
42) B
43) A
44) C
45) E
46) B
47) A
48) A
49) A
50) A
51) Section Break
51.1) A
51.2) D
51.3) C
51.4) E
51.5) A
51.6) C
51.7) B
51.8) A
52) Section Break
52.1) A
52.2) A
52.3) A
52.4) TRUE

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Hoefnagels—Biology: Concepts and Investigations

CHAPTER 1—The Scientific Study of Life

WHERE DOES IT ALL FIT IN?

Chapter 1 introduces the fundamental principles that scientists use to understand the scope of biological knowledge. Stress to students that the concepts of evolution, life's organizational hierarchy, properties of living things, and scientific method are essential for understanding the other chapter topics covered throughout the semester. It may be fitting to refer to chapter 1 when discussing the different levels of organismic complexity covered in the following chapters. The hierarchical levels of the organization of life provide a framework for the study of biology, which starts with the chemical composition of life, proceeds through the organization of cells, and continues to the structure of populations and biological communities. It is also important to stress to students that the information covered throughout the remaining chapters was derived from careful scientific inquiry using the principles of scientific method presented in this chapter. Students should regularly be reminded about how the information in this chapter relates to what is covered throughout the semester.

SYNOPSIS

This chapter provides students with two fundamental ideas needed to understand biology: (1) the modern scientific interpretation of life, and (2) the methodology used to create a scientific understanding of biological systems. A full appreciation of living properties cannot be formed unless students are asked to compare and contrast animate and inanimate entities. It is also important to assess how the major characteristics of living organisms explain the full diversity of life and differentiate life versus dead or diseased organisms. A very important principle to stress is that these living properties evolve with an organism to ensure survival from one generation to the next. The hierarchical organization of living organisms is introduced at this time to give a better understanding of organismic complexity and the roles of each level in the biosphere. Chapter 1 also uses taxonomy to show how biologists classify the biodiversity into rational categories that provide a better understanding of each organism.

An introduction to scientific methodology is critical for students to understand the process by which biological information is acquired and refined. This chapter presents the scientific method as a dynamic human process that involves peer review and statistical evaluation. The

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terminology about variables and experimental design is described in simple terms without compromising accuracy. It provides detailed examples of properly designed controlled experiments, which encourage hypothesis generation and conclusion formation. The chapter also stresses the importance of understanding the inherent limitations of carrying out scientific inquiry and the fact that science is a human endeavor and data may be subject to errors in interpretation.

The use of some lecture or recitation time to discuss the "Burning Questions" box, "Apply It Now" box, and the end-of-chapter reading titled "Investigating Life: The Orchid and the Moth" is encouraged. The information in these three resources encourages students to use the chapter information in critical thinking situations.

LEARNING OUTCOMES

01.00.01 Describe how science is used to study life.

01.01.01 Describe the characteristics that all living organisms share.

01.01.02 Give examples of each level of biological organization.

01.02.01 Compare and contrast the three branches of life.

01.03.01 Apply the scientific method to design experiments and analyze data.

01.03.02 Identify the variables in an experiment.

01.03.03 Differentiate between hypotheses, theories, and facts.

01.03.04 Explain the limitations of the scientific method.

01.04.01 Explain how observations of orchids and moths confirmed a prediction of evolutionary theory.

COMMON STUDENT MISCONCEPTIONS

There is ample evidence in the educational literature that student misconceptions of information will inhibit the learning of concepts related to the misinformation. The following concepts covered in chapter 1 are commonly misunderstood by students. This information on "bioliteracy" was collected from faculty and the science education literature.

- Life is too complex to be explained with scientific reasoning.
- Inanimate objects cannot possess some of the characteristics of living organisms.

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- Acquired characteristics can be inherited.
- All organisms have the same level of hierarchical organization.
- Most organisms on the Earth are either animals or plants.
- There is a single list of steps called “The Scientific Method.”
- Hypotheses are merely a guess about natural phenomena.
- Theories are a scientist’s opinion.
- Theories do not change over time.
- The control is not affected by variables.
- The use of scientific models is not accepted by much of the scientific community.
- Statistics are used to make data fit the hypothesis.
- The independent variable in an experiment is always controlled by the researcher.
- Evolution is a means of disproving the existence of a supernatural being.
- Biological principles can be described without evolutionary theory.
- Evolution only occurs on the individual organism level.
- Evolutionary adaptation occurs during the lifetime of an organism.
- The death of an individual organism can change the whole fate of the Earth.

INSTRUCTIONAL STRATEGY PRESENTATION ASSISTANCE

1. Use a simple activity as a tangible way of introducing the scientific method before a lecture on chapter 1. The scientific method can be portrayed using a nonworking flashlight (have a nonfunctional bulb and dead batteries in it). Guide the class through the process of the scientific method needed to hypothesize and test what is needed to fix the flashlight. It is important to have working spare parts to get the flashlight working again.
2. Many students devalue the scientific method when they see contradictory research studies in the news. Show the students some conflicting news articles related to everyday issues such as the health value of drinking wine or avoiding certain fats. This can then be used as a discussion point about the limitations of science and why certain studies of similar design may yield opposite conclusions.

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3. Use projected images of various types of prokaryotic and eukaryotic organisms to demonstrate biodiversity. Then go to the World Wildlife Fund website to show students how various agencies study and protect global biodiversity.

HIGHER-LEVEL ASSESSMENT

Higher-level assessment measures a student's ability to use terms and concepts learned from the lecture and the textbook. A complete understanding of biology content provides students with the tools to synthesize new hypotheses and knowledge using the facts they have learned. The following table provides examples of assessing a student's ability to apply, analyze, synthesize, and evaluate information from chapter 1.

Application	• Have students design an experiment to investigate the claim that soybean products in the diet of pregnant women may alter the development of children during fetal development. • Have students apply the concept of homeostasis to explain the difference in characteristics between a living and a dead animal. • Ask students to hypothesize an evolutionary explanation for the fact that some people have the genetic ability to control muscles to wiggle their ears.
Analysis	• Ask students to explain how the survival requirements of prokaryotes may differ from those of eukaryotic animals as a result of their level of hierarchical complexity. • Ask students to select two of the most important criteria needed to determine if an unknown specimen collected from another planet is alive or not. • Have the class analyze whether each characteristic of living organisms provided in chapter 1 equally represents animals and plants.
Synthesis	• Ask students to describe how taxonomy would contribute to medical treatments used to control infectious diseases.

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	• Ask students to predict how a physician would treat a disease if the concept of scientific method were not developed.
Evaluation	• Ask students to discuss implications of a disease caused by a purported organism that does not seem to possess any of the characteristics of life discussed in the chapter. • Ask students to come up with some strategies to reduce the number of factors that limit the accuracy of scientific experimentation. • Have students evaluate the pros and cons of using computer models as a substitute for experimentation in gaining an understanding of human diseases.

BIOETHICAL CONSIDERATION

Biological knowledge contributes to the betterment of human society in many ways. However, there are also various ethical concerns that are raised by the applications of this knowledge. Scientific explanations of living processes often conflict with religious views about the nature of life. Many societies end up having to balance the influx of scientific information with explanations and rules founded on religious principles. Facilitate a classroom discussion on the ethical considerations regarding the relationship between scientific thinking and religion.

FUN FACTS

Trivial facts about biology are a fun way to spice up a lecture. They can be read in class or placed at appropriate points in a lecture using the board or a projected presentation. The trivia can be used as a jumping point for students to further investigate the facts.

- The first scientific journals were the French *Journal des Sçavans* and the British *Philosophical Transactions*. Both journals were published in 1665.
- French scientist Antoine-Laurent de Lavoisier supposedly carried out his last experiment by deciding to blink as many times as possible after he was beheaded in the French

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Revolution. It is said that his assistant counted 15 to 20 blinks while watching the beheading.

- An early notion of the emergence of life, called abiogenesis or spontaneous generation, was promoted by Aristotle and led people to believe that snakes formed from horse hairs standing in stagnant water, mice developed from old cheese and bread wrapped in rags, and maggots were born from decaying meat.
- Early scientists followed a doctrine called “vitalism” that states that the processes of life are not entirely due to the laws of chemistry and physics alone, and that life is partially a self-determining vital force.
- Early vitalism proponents believed that the vital force of all living things was composed of four humors or liquids called black bile, blood, phlegm, and yellow bile.
- Linnaeus’s hierarchical classification and binomial nomenclature of organisms has remained a standard model of taxonomy for over 200 years.

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IN-CLASS CONCEPTUAL DEMONSTRATION

Brine shrimp provide a simple living model for investigating some of the properties of organisms. They are simple to view under a microscope and can be clearly projected on a screen using ×100 magnification with a wet mount specimen. This activity demonstrates some of the characteristics of life covered in chapter 1.

Materials

- Small container of large brine shrimp
- One microscope slide
- One small dropper
- One small dropper bottle of trypan blue (dissolve 0.2 g trypan blue in 100 mL distilled)
- One projector microscope or microscope attached to a video projector
- One small bottle of cold water with a dropper
- One small bottle of 50°C water with a dropper
- One small bottle of room temperature 3% hydrogen peroxide with a dropper
- One small bottle of brewed dark coffee
- One small bottle of room temperature pure methanol with a dropper

Procedure and Inquiry

1. Place three or four brine shrimp on a slide. Use just enough water to keep the shrimp immobilized but submerged in water.
2. Place the slide under the microscope and focus the image using ×100 magnification so that a whole brine shrimp can be seen clearly.
3. Ask the students which properties of life and levels of organization are exhibited by the brine shrimp.
4. Add 50°C water to the slide and ask the students to observe what happens. After awhile the shrimp should move faster. Then ask the students what properties of life the exercise demonstrates. (Some may answer metabolism, movement, or response to stimuli.)
5. Add one drop of 3% hydrogen peroxide to the slide and ask the students to observe

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what happens. They should see bubbling due to catalase activity from bacteria on the surface of the shrimp. Then ask the students what properties of life the exercise demonstrates. (Some may answer metabolism or response to stimuli.)

6. Add one drop of strong brewed coffee to the slide and ask the students to observe what happens. Again, ask them to observe and explain. They should see the shrimp speed up kicking activity.
7. Then add the trypan blue to the slide. Let the students observe the shrimp as you add three drops of the methanol. The students should observe some of the cells turning blue as the shrimp cells eventually die outside of the internal environment of the body. Have them make hypotheses about this last observation.

QUICK LABORATORY IDEA

Natural Selection

This laboratory activity has students hypothesizing about the possible survival value of particular human tastes. (Caution: This lab involves the tasting of substances in class.)

1. Provide students with the following materials:
    a. PTC (phenylthiocarbamide) taste paper
    b. Sodium benzoate taste paper
    c. Thiourea taste paper
    d. Clean fresh cabbage
    e. Jar of honey
    f. Strong coffee
    g. Toothpicks for tasting samples
    h. Clean disposable spoons for tasting honey and coffee
    i. Access to the Internet
2. Explain to the class that they will be testing themselves for the presence of certain taste buds based on how the tongue responds to certain molecules.
3. Ask students to determine the number of people in class who can and cannot taste the PTC, sodium benzoate, and thiourea taste papers.

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4. Then ask them to see if the ability to taste or not taste a particular paper is related to a person's like or dislike of the taste of cabbage, coffee, or honey.
5. Let the class know that certain genes determine the ability to taste PTC, sodium benzoate, and thiourea. Then have the students research online to find evidence that the ability to taste these compounds is associated with people from particular regions of the world.

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LEARNING THROUGH SERVICE

Service learning is a strategy of teaching, learning, and reflective assessment that merges the academic curriculum with meaningful community service. As a teaching methodology, it falls under the category of experiential education. It is a way students can carry out volunteer projects in the community for public agencies, nonprofit agencies, civic groups, charitable organizations, and governmental organizations. It encourages critical thinking and reinforces many of the concepts learned in a course.

1. Have students give presentations about life's organizational hierarchy at an area nature center.
2. Have students visit a local elementary school to give a presentation on the properties of life.
3. Have students judge science fairs that focus on projects emphasizing the use of the scientific method.
4. Have students prepare a poster or display on biodiversity for an Earth Day program or another related event.

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