Biological Science 8th edition Freeman Test Bank

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Chapter 1 Biology: The Study of Life

1) Which of the following is NOT related to the five fundamental characteristics of life?

   A) A bacterial cell divides to produce two cells.

   B) Sugars are transported on carrier proteins into cells across the plasma membrane.

   C) Sugars are broken down inside cells to produce energy.

   D) The gene that specifies skin color in frogs is expressed during its development from a tadpole into an adult frog.

   E) Giraffes have longer necks so that they can reach food sources unavailable to other animals.

   Answer: E

   Bloom's Taxonomy: Applying/Analyzing

   V&C Core Concept: EM

   V&C Core Comp: PS

   LO/EO: 1.1, 1.2; 1.1.1

   Section: 1.1

2) Which of the following statements best describes a characteristic that may be associated with both living organisms and nonliving matter?

   A) Reproduction by passing on genetic information to future generations.

   B) Composed of cells.

   C) Capable of evolution.

   D) Able to produce heat as a byproduct of chemical reactions.

   Answer: D

   Bloom's Taxonomy: Remembering/Understanding

   V&C Core Concept: EM

   V&C Core Comp: PS

   LO/EO: 1.1; 1.1.1

   Section: 1.1.1

3) Which of the following statements is an inaccurate example of how the living organism in the scenario exemplifies a characteristic feature of living organisms?

   A) Photosynthetic bacteria meet the energy requirement, as they are able to convert energy from sunlight into the chemical energy they store in sugars.

   B) As humans, we meet the cell requirement because even though we are made of tissues and organs, all of those components are made of specialized types of cells.

C) English bulldogs would meet both the information and ability to replicate requirements because when they have a litter of puppies, we would expect the progeny to be English bulldogs due to their DNA from the parents.

D) Monarch butterflies meet the evolution requirement because each of them will look different as adults (butterflies) than they do as juveniles (caterpillars) which demonstrate their ability to change over time.

E) All of the statements are proper examples of how that organism exemplifies particular characteristics of life.

Answer: D

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: EM

V&C Core Comp: PS

LO/EO: 1.1, 1.4; 1.1.1

Section: 1.1.1, 1.4.1

4) Pasteur's experiments demonstrated that _____.

A) cells cannot survive in swan-necked flasks

B) in order to grow, cells need to be supplied with oxygen

C) spontaneous generation can only occur if nutrient broth is left open to the environment

D) sterilizing nutrient broth prevents spontaneous generation

E) preexisting cells present in the air can grow in sterilized nutrient broth

Answer: E

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: EM

V&C Core Comp: PS

LO/EO: 1.2; 1.2.2

Section: 1.2

5) Recall Pasteur's experiment on spontaneous generation. If he had just warmed the nutrient-rich broth, rather than boiled it, what would have been the likely outcome of his experiment? Cells would _____.

A) not have appeared in either flask

B) have appeared in both flasks

C) have appeared in the swan-neck but not the straight-neck flask

D) have appeared in the straight-neck but not the swan-neck flask

Answer: B

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: EM

V&C Core Comp: PS

LO/EO: 1.2; 1.2.2

Section: 1.2

6) Spontaneous generation _____.

A) was demonstrated to occur under normal laboratory conditions by Pasteur

B) apparently occurred at least once–when life on Earth began

C) occurs every time a new species evolves from a preexisting species

D) addresses the formation of new cells from existing cells

Answer: B

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: EM

V&C Core Comp: PS

LO/EO: 1.2; 1.2.3

Section: 1.2

7) Recall Pasteur's experiment on spontaneous generation. What would the expected results have been if Pasteur's swan-neck experiment hypothesis were incorrect?

A) Cells would not have appeared in either flask.

B) Cells would have appeared in both flasks.

C) Cells would have appeared in the swan-neck but not the straight-neck flask.

D) Cells would have appeared in the straight-neck but not the swan-neck flask.

Answer: B

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: EM

V&C Core Comp: PS

LO/EO: 1.2; 1.2.2

Section: 1.2.1

8) Algae in the genus *Caulerpa* typically grow to a length of over half a meter and have structure similar to stems, leaves, and roots. Reproduction occurs when adults produce sperm and eggs that fuse to form offspring. Each adult *Caulerpa* consists of just a single cell, however. Which of the following statements is TRUE?

A) *Caulerpa* violate the pattern component of the cell theory that all organisms consist of cells.

B) *Caulerpa* violate the process component of the cell theory that all cells come from preexisting cells.

C) *Caulerpa* violate both the pattern and process components of the cell theory.

D) The existence of *Caulerpa* is consistent with the cell theory.

Answer: D

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: SF

V&C Core Comp: PS

LO/EO: 1.2; 1.2.1

Section: 1.2

9) Cells are _____.

A) only found in pairs because single cells cannot exist independently

B) limited in size to 200 and 500 micrometers in diameter

C) characteristic of eukaryotic but not prokaryotic organisms

D) characteristic of prokaryotic and eukaryotic organisms

Answer: D

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: SF

V&C Core Comp: PS

LO/EO: 1.2; 1.2.1

Section: 1.2

10) The cell theory states that all cells come from preexisting cells. If this is the case, why are the cells in a multicellular organism so different from one another?

A) Cells in a multicellular organism are exposed to different energy sources allowing them to develop different features.

B) During cell division, the genetic information that is replicated and passed onto the daughter cells is different from the original cell.

C) The genetic information of each cell is copied and passed on to the daughter cells and the molecular machinery that reads that genetic information is different in each cell.

D) The genetic information of each cell is copied and passed on to the daughter cells and the molecular machinery makes copies of particular genes in different cells to generate different features in those cells.

Answer: D

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: I

V&C Core Comp: PS

LO/EO: 1.3; 1.3.1

Section: 1.3

11) The discovery of the structure of DNA was useful because _____.

A) it helped scientists understand how the information in DNA could be used to acquire ATP for the cell

B) it inferred that genetic information flowed from messenger RNA to DNA to protein

C) it suggested a mechanism for copying and preserving the genetic material

D) it revealed how mRNA was used to make proteins

Answer: C

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: SF

V&C Core Comp: PS

LO/EO: 1.3; 1.3.1

Section: 1.3

12) Double helical DNA _____.

A) serves as a template for protein synthesis

B) is used to synthesize messenger RNA

C) contains two identical single strands of DNA

D) must be accurately copied to ensure variation in organisms

Answer: B

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: I

V&C Core Comp: PS

LO/EO: 1.3; 1.3.1

Section: 1.3

13) In comparison to eukaryotes, prokaryotes _____.

A) do not require ATP for energy while eukaryotes do require ATP

B) are more closely related to archaea than eukaryotes

C) lack a nucleus, while eukaryotes have a nucleus

D) are always single-celled while eukaryotes are always multicellular

E) have chromosomes composed of single-stranded DNA, while eukaryotes have chromosomes composed of double-stranded DNA

Answer: C

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: SF, E

V&C Core Comp: PS

LO/EO: 1.5; 1.5.2

Section: 1.5

14) Which of these provides evidence of the common ancestry of all life?

A) Ubiquitous use of catalysts by living systems

B) Near universality of the genetic code

C) Structure of the nucleus

D) The flow of genetic information from DNA to RNA to protein

E) The directionality of protein synthesis

Answer: B

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: SF, E, I

V&C Core Comp: PS

LO/EO: 1.5; 1.5.1

Section: 1.5

15) Cotton-topped tamarins are small primates with tufts of long white hair on their heads. While studying these creatures, you notice that males with longer hair get more opportunities to mate and father more offspring. To test the hypothesis that having longer hair is adaptive in these males, you should _____.

A) test whether other traits in these males are also adaptive

B) look for evidence of hair in ancestors of tamarins

C) determine if hair length is heritable

D) test whether males with shaved heads are still able to mate

Answer: C

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: E

V&C Core Comp: PS

LO/EO: 1.4; 1.4.2

Section: 1.4

The following experiment is used for the corresponding question(s).

A researcher discovered a species of moth that lays its eggs on oak trees. Eggs are laid at two distinct times of the year: early in spring when the oak trees are flowering and in midsummer when flowering is past. Caterpillars from eggs that hatch in spring feed on oak flowers and look like oak flowers. But caterpillars that hatch in summer feed on oak leaves and look like oak twigs.

How does the same population of moths produce such different-looking caterpillars on the

same trees? To answer this question, the biologist caught many female moths from the same population and collected their eggs. He put at least one egg from each female into eight identical cups. The eggs hatched, and at least two larvae from each female were maintained in one of the four temperature and light conditions listed below.

Temperature	Day Length
Springlike	Springlike
Springlike	Summerlike
Summerlike	Springlike
Summerlike	Summerlike

In each of the four environments, one of the caterpillars was fed oak flowers; the other, oak leaves. Thus, there were a total of eight treatment groups (4 environments × 2 diets).

16) Refer to the figure above. Which one of the following is NOT a plausible hypothesis to explain the differences in caterpillar appearance observed in this population?

A) The longer day lengths of summer trigger the development of twiglike caterpillars.

B) The cooler temperatures of spring trigger the development of flowerlike caterpillars.

C) Differences in air pressure, due to differences in elevation, trigger the development of different types of caterpillars.

D) Differences in diet trigger the development of different types of caterpillars.

Answer: C

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: SF, E

V&C Core Comp: PS

LO/EO: 1.4; 1.4.2

Section: 1.4

17) Refer to the figure above. In every case, caterpillars that feed on oak flowers looked like oak flowers. In every case, caterpillars that were raised on oak leaves looked like twigs. These results support which of the following hypotheses?

A) The longer day lengths of summer trigger the development of twiglike caterpillars.

B) Differences in air pressure, due to elevation, trigger the development of different types of caterpillars.

C) Differences in diet trigger the development of different types of caterpillars.

D) The differences are genetic. A female will produce either all flowerlike caterpillars or all twiglike caterpillars.

Answer: C

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: SF, E

V&C Core Comp: PS

LO/EO: 1.4; 1.4.2

Section: 1.4

18) Refer to the figure above. Recall that eggs from the same female were exposed to each of the eight treatments used. This aspect of the experimental design tested which of the following hypotheses?

A) The longer day lengths of summer trigger the development of twiglike caterpillars.

B) Differences in air pressure, due to elevation, trigger the development of different types of caterpillars.

C) Differences in diet trigger the development of different types of caterpillars.

D) The differences are genetic. A female will produce either all flowerlike caterpillars or all twiglike caterpillars.

Answer: D

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: SF, E

V&C Core Comp: PS

LO/EO: 1.4; 1.4.2

Section: 1.4

19) Recall the caterpillar experiment in which caterpillars born in the spring looked like flowers, and caterpillars born in the summer looked like twigs. What is the most likely selective advantage for this difference in body shape?

A) Looking like their food sources allows the caterpillars to move through their environment more efficiently.

B) Development into the adult moth form is faster for caterpillars shaped like twigs than like flowers.

C) Looking like their food source lets the caterpillars blend into their surroundings, reducing predation.

D) Looking like their food source will increase the caterpillars' feeding efficiency; this would increase their growth rate and survival rate.

Answer: C

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: SF, E

V&C Core Comp: PS

LO/EO: 1.4; 1.4.2

Section: 1.4

20) Protists and bacteria are grouped into different domains because _____.

A) protists eat bacteria

B) bacteria cannot generate their own ATP; protists can

C) protists have a membrane-bounded nucleus, which bacterial cells lack

D) bacteria decompose protists

E) protists lack the genetic diversity that bacteria have

Answer: C

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: SF, E

V&C Core Comp: PS

LO/EO: 1.5; 1.5.2

Section: 1.5

21) You have isolated and purified a new species of cells from the rain forest, and you want to place this new species in the appropriate branch of the tree of life. You sequence the ribosomal RNA genes from these cells and discover that for one particular region of the ribosomal RNA gene (the rRNA) the RNA sequence is AAUGAAGG. You have sequences from the same region of the ribosomal genes (the rRNA) from each of these species: bacteria, eukaryote, and archaea, which are listed below.

bacteria AUAGAUGG

eukaryote AAAGAAGG

archaea AAUGGAGU

Based on these sequence results, to which branch of the tree of life should you assign this new species?

A) Archaea

B) Bacteria

C) Eukaryote

D) Bacteria and archaea

E) There is not enough information.

Answer: C

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: E

V&C Core Comp: PS

LO/EO: 1.5; 1.5.1

Section: 1.5

22) You have isolated and purified a new species of cells from the rain forest, and you want to place this new species in the appropriate branch of the tree of life. You sequence the ribosomal RNA genes from these cells and discover that for one particular region of the ribosomal RNA gene (the rRNA) the RNA sequence is AAUGAAGG. You have sequences from the same region of the ribosomal genes (the rRNA) from each of these species: bacteria, eukaryote, and archaea, which are listed below.

bacteria AUAGAUGG

eukaryote AAAGAAGG

archaea AAUGGAGU

Based on these sequence results, which reasonable expectation could be made about the new species?

A) It is composed of cells that contain a membrane-bound nucleus.

B) It is an animal, likely one that has a spinal cord.

C) It is composed of cells that do not contain a membrane-bound nucleus.

D) It is a single-celled organism.

E) There is not enough information.

Answer: A

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: E

V&C Core Comp: PS

LO/EO: 1.5; 1.5.1, 1.5.2

Section: 1.5

23) How does a scientific theory differ from a scientific hypothesis?

A) Theories are proposed to test scientific hypotheses.

B) Theories are usually an explanation for a more general phenomenon; hypotheses typically address more specific issues.

C) Hypotheses are usually an explanation for a more general phenomenon; theories typically address more specific issues.

D) Confirmed theories become scientific laws; hypotheses become theories.

Answer: B

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.6; 1.6.2

Section: 1.6

24) Louis Pasteur's experiment was designed well because _____.

A) simple equipment was used

B) a major question, spontaneous generation, was tested

C) the possible outcomes led to distinct, unambiguous conclusions

D) the experiment was a success

Answer: C

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.6; 1.6.3

Section: 1.6

25) Recall the experiment on ant navigation. To run a controlled experiment, what parameters were held constant for the test group of 75 ants?

A) Stride number

B) Leg length

C) Stride number, leg length, and environmental temperature

D) All variables except leg length

Answer: D

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.6; 1.6.3

Section: 1.6

26) Your colleague proposes to test the mechanism of ant navigation by placing a food source 7 meters (m) from the nest. She then takes ants from the nest and places them in a spot that is 4 m from the nest and 3 m from the food source. Based on the previous data, where do you expect the ants to start searching for their nest on their return trip?

A) After they have traveled 3 m from the food source

B) After they have traveled 4 m from the food source

C) After they have traveled 7 m from the food source

D) As soon as they leave the food source

Answer: A

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: S

V&C Core Comp: PS, QR

LO/EO: 1.6; 1.6.2

Section: 1.6

27) For many years, no one bothered to test the food-competition hypothesis for why giraffes have long necks. Why?

A) It had been much too difficult to test.

B) The hypothesis was so plausible that no one thought to question it.

C) They tried, but the results were inconclusive.

D) The hypothesis did not make clear predictions that could be tested.

Answer: B

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: E

V&C Core Comp: PS

LO/EO: 1.6; 1.6.2

Section: 1.6

28) A friend of yours calls to say that his car would not start this morning. He asks for your help. You say that you think the battery must be dead. If so, then jump-starting the car from a good battery will solve the problem. In doing so, you are _____.

A) testing a theory for why the car will not start

B) making observations to inspire a theory for why the car will not start

C) stating a hypothesis and using that hypothesis to make a testable prediction

D) comparing multiple hypotheses for why the car will not start

Answer: C

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.6; 1.6.2

Section: 1.6

29) *Agrobacterium* infects plants and causes them to form tumors. You are asked to determine how long a plant must be exposed to these bacteria to become infected. Which of the following experiments will provide the best data to address that question?

A) Measure the number of tumors formed on plants, which are exposed to different concentrations of *Agrobacterium* for different lengths of time.

B) Measure the number of tumors formed on a plant when exposed to various concentrations of *Agrobacterium*.

C) Measure the concentration of *Agrobacterium* in different soil environments where the plants grow.

D) Measure the number of tumors formed on plants, which are exposed to a known concentration of *Agrobacterium* for different lengths of time.

Answer: D

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.6; 1.6.3

Section: 1.6

30) *Agrobacterium* infects plants and causes them to form tumors. You determine that tumor formation requires a large amount of the plant's energy for tissue formation. How might this change the number of offspring a plant produces, and what is the most likely explanation for this change?

A) The number of offspring should increase because in general, illness increases the reproductive output of organisms.

B) The number of offspring should increase because the bacteria will provide energy for the plant.

C) The number of offspring should decrease because the plant will divert energy from reproduction to tumor formation.

D) There should be no effect of infection on offspring production because energy for reproduction is independent of infection.

Answer: C

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.6; 1.6.3

Section: 1.6

Use the following information when answering the corresponding question(s).

In 1668, Francesco Redi performed a series of experiments on spontaneous generation. He began by putting similar pieces of meat into eight identical jars. Four jars were left open to the air, and four were sealed. He then did the same experiment with one variation: Instead of sealing four of the jars completely, he covered them with gauze (the gauze excluded the flies while allowing the meat to be exposed to air). In both experiments, he monitored the jars and recorded whether or not maggots (young flies) appeared in the meat.

31) Refer to the paragraph on Redi's experiments. What hypothesis was being tested in the initial experiment with open versus sealed jars?

A) Spontaneous generation is more likely during the long days of summer.

B) The type of meat used affects the likelihood of spontaneous generation.

C) Maggots do not arise spontaneously, but from eggs laid by adult flies.

D) Spontaneous generation can occur only if meat is exposed to air.

Answer: C

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.2, 1.6; 1.2.2, 1.6.2

Section: 1.2, 1.6

32) Refer to the paragraph on Redi's experiments. In both experiments, flies appeared in all of the open jars and only in the open jars. Which one of the following statements is correct?

A) The experiment was inconclusive because Redi used only one kind of meat.

B) The experiment was inconclusive because it did not run long enough.

C) The experiment supports the hypothesis that spontaneous generation occurs in rotting meat.

D) The experiment supports the hypothesis that maggots arise only from eggs laid by adult flies.

Answer: D

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.2, 1.6; 1.2.2, 1.6.2

Section: 1.2, 1.6

33) The best experimental design _____.

A) includes a large sample size for each condition

B) includes a control

C) alters only one condition between the controls and the experimental condition

D) includes a large sample size and a control and alters only one condition between the controls and the experimental condition

Answer: D

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.6; 1.6.3

Section: 1.6

34) In the process of science, which of these is NOT used to test a hypothesis?

A) A theory

B) A result

C) An observation

D) A control group

Answer: A

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.6; 1.6.2

Section: 1.6

35) A controlled experiment _____.

A) is repeated many times to ensure that the results are accurate

B) proceeds at a slow pace to guarantee that the scientist can carefully observe all reactions and process all experimental data

C) includes at least two groups, one of which does not receive the experimental treatment

D) includes at least two groups, one differing from the other by two or more variables

E) includes one group for which the scientist controls all variables

Answer: C

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.6; 1.6.3

Section: 1.6

36) Which of the following are qualities of any good scientific hypothesis?

I. It is testable.

II. It is falsifiable.

III. It produces quantitative data.

IV. It produces results that can be replicated.

A) I only

B) II only

C) III only

D) I and II

E) III and IV

Answer: D

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.6; 1.6.3

Section: 1.6

37) In an attempt to examine the idea of spontaneous generation, Pasteur conducted experiments utilizing different shaped flasks. Upon designing the study, he noted "that if cells come only from preexisting cells, then the different shapes of flasks would produce different growth observations," which served as the _____ of the study.

A) fact

B) hypothesis

C) theory

D) proof

E) process

Answer: B

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.6; 1.6.2

Section: 1.6

38) In presenting data that result from an experiment, a group of students show that most of their measurements fall on a straight diagonal line on their graph. However, two of their data points are "outliers" and fall far to one side of the expected relationship. What should they do?

A) Change their experiment so that the outlier data points are eliminated.

B) Average several trials, rule out the improbable results, and do not show them in the final work.

C) Show all results obtained and then try to explore the reason(s) for these outliers.

D) Redesign the experiment using a different hypothesis.

E) Change the values on the graph so that only the straight diagonal line is produced.

Answer: C

Bloom's Taxonomy: Evaluating/Creating

V&C Core Concept: S

V&C Core Comp: PS, QR

LO/EO: 1.6; 1.6.3

Section: 1.6

39) Which of the following is the best description of a control for an experiment?

A) The control group is kept in an unchanging environment.

B) The control group is left alone by the experimenters.

C) The control group is matched with the experimental group, except for one experimental variable.

D) The control group is exposed to only one variable rather than several.

E) Only the experimental group is tested or measured.

Answer: C

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.6; 1.6.3

Section: 1.6

40) Why is a scientific topic best discussed by people of varying points of view, from different subdisciplines, and representing diverse cultures?

A) They can correct each other's approach to make it scientific.

B) Robust and critical discussion between diverse groups improves scientific thinking.

C) Scientists can coordinate with others to conduct experiments in similar ways.

D) This is a way of ensuring that everyone gets the same results.

E) People need to exchange their ideas with other disciplines and cultures because everyone has a right to an opinion in science.

Answer: B

Bloom's Taxonomy: Evaluating/Creating

V&C Core Concept: S

V&C Core Comp: PS, I, CC, SS

LO/EO: 1.6; 1.6.3

Section: 1.6

41) A controlled experiment is one that _____.

A) proceeds slowly enough that a scientist can make careful records of the results

B) tests experimental and control groups in parallel

C) is repeated many times to make sure the results are accurate

D) controls all variables

E) is supervised by an experienced scientist

Answer: B

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.6; 1.6.3

Section: 1.6

42) Which of the following statements best distinguishes scientific hypotheses from scientific theories?

A) Hypotheses describe and theories explain.

B) Hypotheses explain and theories describe.

C) Hypotheses are usually narrower in scope; theories have broader explanatory power.

D) Hypotheses are used in experiments. Theories are not tested.

E) Hypotheses are generally supported by more evidence than theories.

Answer: C

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.6; 1.6.2

Section: 1.6

43) Which of the following best describes the logic of scientific inquiry?

A) If I generate a testable hypothesis, tests and observations will support it.

B) If my prediction is correct, it will lead to a testable hypothesis.

C) If my observations are accurate, they will support my hypothesis.

D) If my hypothesis is correct, I can expect certain test results.

E) If my experiments are set up right, they will lead to a testable hypothesis.

Answer: D

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.6; 1.6.2

Section: 1.6

44) The formulation of a model for a structure or for a process serves which of the following purposes?

A) It asks a scientific question.

B) It functions as a testable hypothesis.

C) It records observations.

D) It serves as a data point among results.

E) It can be arrived at only after years of experimentation.

Answer: B

Bloom's Taxonomy: Evaluating/Creating

V&C Core Concept: S

V&C Core Comp: PS, MS

LO/EO: 1.6; 1.6.2

Section: 1.6

45) An African savanna elephant has the scientific name *Loxodonta africana*. Based upon Linnaean classification, we can conclude that *Loxodonta* is the _____ designation and *africana* is the _____ designation of an African savanna elephant.

A) genus; species

B) family; species

C) species; genus

D) kingdom; order

E) phylum; class

Answer: A

Bloom's Taxonomy: Remembering/Understanding

V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.5; 1.5.2

Section: 1.5

46) African savanna elephant taxonomic classifications:

Kingdom: Animalia Phylum: Chordata Class: Mammalia

Order: Proboscidea Family: Elephantidae Genus: Loxodonta

Species: Africana

Using the Linnaean classification system, _____ is the scientific name of an African savanna elephant.

A) *Animalia Mammalia Elephantidae Africana*

B) *Loxodonta africana*

C) *Proboscidea africana*

D) *Elephantidae loxodonta*

E) *Africana loxodonta*

Answer: B

Bloom's Taxonomy: Remembering/Understanding

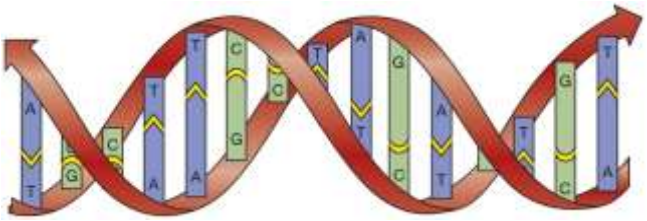
V&C Core Concept: S

V&C Core Comp: PS

LO/EO: 1.5; 1.5.2

Section: 1.5

47) Models of the double helix are good at showing the three-dimensional shape of DNA, but they are not the best type of model to use for comparing DNA sequences. Use the double helix model shown as a reference to finish the easier-to-read DNA sequence model.



A)

A-C-G-A-A-G-C-A-T-C-A-G-A-C-A

B)

A-C-G-A-T-C-C-T-A-G-A-G-A-C-A

C)

A-C-G-A-T-C-G-A-T-C-A-G-A-C-A

D)

A-C-G-A-A-G-C-T-A-G-A-G-A-C-A

Answer: D

LO/EO: 1.3; 1.3.1

Examine the student-drawn models.

-T-A-A-G-T-C-T-C-T-G-T-A-T-T-G- Maria

48) All three models represent DNA.

Answer: TRUE

LO/EO: 1.3; 1.3.1

49) Models must always include all available information to be useful.

Answer: FALSE

LO/EO: 1.3; 1.3.1

50) If the goal was to compare the three-dimensional shape of DNA to other molecules, Umberto's model would be the most helpful.

Answer: TRUE

LO/EO: 1.3; 1.3.1

51) If the goal was to show how information is stored in double-stranded DNA, Chandra's model would be the most helpful.

Answer: TRUE

LO/EO: 1.3; 1.3.1

52) If the goal was to compare the DNA sequences of several species, Maria's model would be the most helpful.

Answer: TRUE

LO/EO: 1.3; 1.3.1

Four students have used different circling strategies to show the differences in DNA sequence between Atlantic salmon and three other species.

53) Refer to the figure above. Whose approach do you think is most helpful in this analysis?

A) Ahmed's approach

B) David's approach

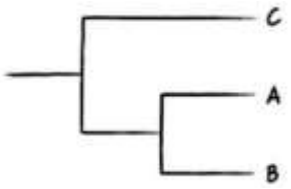
C) Tania's approach

D) Breya's approach

Answer: C

LO/EO: 1.3; 1.3.1

54) Based upon the rRNA sequences provided, where should species 2 be placed on the phylogenetic tree provided for the three species?



Species 1: A U G U C C A A U G

Species 2: U G G U C A G A U G

Species 3: A C G U C C A A U G

A) A

B) B

C) C

D) Either A or B

E) Either B or C

Answer: C

Bloom's Taxonomy: Applying/Analyzing

V&C Core Concept: E

V&C Core Comp: PS

LO/EO: 1.5; 1.5.1, 1.5.2

Section: 1.5

CHAPTER

1 Biology: The Study of Life

Learning Objectives: *Students should be able to...*

1.1 Explain what it means to say that an organism is "alive."
- 1.1.1 List five traits shared by all living organisms.
- 1.1.2 List three unifying theories related to the characteristics of living organisms.

1.2 Explain what organisms are made of and how cells come to be.
- 1.2.1 Explain the concept of the cell theory.
- 1.2.2 Describe the two original hypotheses for how cells arise.
- 1.2.3 Explain the significance of cell division.

1.3 Explain how organisms process hereditary information and acquire and use energy.
- 1.3.1 Describe the relationship between the chromosome theory of inheritance and the central dogma.
- 1.3.2 Explain the relationship between life and energy.

1.4 Explain the relationships between species and how evolution occurs.
- 1.4.1 Define the theory of evolution.
- 1.4.2 List two conditions of natural selection.

1.5 Describe the significance of the tree of life.
- 1.5.1 Explain how genetic sequences are used to study the tree of life.
- 1.5.2 Explain how branches on the tree of life are named.

1.6 Explain the scientific process.
- 1.6.1 Describe what type of questions biologists can answer.
- 1.6.2 Describe the process of hypothesis testing.
- 1.6.3 List three important characteristics of experimental design.

Lecture Outline

A. Biology is the study of life.

B. Life shows great diversity with clear underlying unity.

I. What Does It Mean to Say That Something Is Alive?

A. All living organisms share five fundamental traits:

1. Organisms are made up of membrane-bound cells.

2. Organisms can replicate/reproduce.

3. Organisms have hereditary information encoded in genes.

4. Organisms acquire and use energy.

5. Populations of organisms evolve.

II. Life Is Cellular and Replicates through Cell Division

A. Are *all* organisms made of cells?

1. Cells were first described and identified in cork tissue (Hooke, 1665) and in water and a variety of living tissues (van Leeuwenhoek). **(Fig. 1.1)**
2. Scientists have examined thousands of plant and animal samples and have concluded that all organisms are composed of cells.
3. A cell is an organized compartment bounded by a thin, flexible plasma membrane and contains concentrated chemicals in an aqueous solution.
4. Most chemical reactions important to life occur inside cells.
5. Cells reproduce via cell division.

B. Where do cells come from?

1. Two components of theories: observable pattern and the mechanism or process that creates the pattern
2. Spontaneous generation hypothesis (Virchow) versus all-cells-from-cells (Pasteur) hypothesis
   a. Pasteur's experiment supported the all-cells-from-cells hypothesis. **(Fig. 1.2)**
3. All individuals in a population of organisms are related by ancestry.
4. All cells in a multicellular organism are descended from the same ancestral cell.

C. Statement of the cell theory: All organisms are made of cells, and all cells come from preexisting cells.

1. Theories are explanations for phenomena or observations supported by evidence.
2. Chemical evolution: Biologists have evidence that life arose from non-life early in life's history through this process.

D. Life replicates through cell division.

1. New cells arise when preexisting cells split.
2. All species are connected by common ancestry was also a founding idea published in the same year as all-cells-from-cells hypothesis.

III. Life Processes Information and Requires Energy

A. Chromosome theory of inheritance (1902): Inside cells, hereditary or genetic information is encoded in genes, the units located on chromosomes.

1. Chromosomes consist of a molecule of deoxyribonucleic acid (DNA).

B. The central dogma (DNA → RNA → Protein) **(Fig. 1.4)**

1. Watson/Crick double-stranded helix. **(Fig. 1.3)**
2. DNA encodes a message in the sequence of its building blocks: A, T, C, and G.
3. A pairs with T, and C pairs with G.
4. DNA is made into RNA (ribonucleic acid), messenger RNA is read to make a protein.

C. Life requires energy.

1. Two fundamental nutritional needs are required by organisms: ATP (adenosine triphosphate) and obtaining molecules that can be used as building blocks for the synthesis of complex functions of the cell.

2. Energy is acquired in a variety of ways. (**Fig. 1.5)**

IV. Life Evolves

A. What is evolution?

1. Species are related by common ancestry (pattern component).

2. The characteristics of a species can be modified from generation to generation (process component).

a. Darwin and Wallace (1858) proposed that this happens by natural selection (descent with modification, Darwin). (**Fig. 1.6**)

3. Evolution is a change in heritable characteristics of a population over time.

4. Population is a group of individuals of the same species living in the same area at the same time.

B. What is natural selection?

1. Natural selection occurs whenever two conditions are met:

a. Individuals within a population vary in characteristics that are heritable.

b. Certain heritable traits help individuals survive and produce offspring.

2. How do these two conditions lead to evolution?

a. If certain heritable traits help individuals produce more offspring, then those traits become more common (more frequent) in the population over time.

3. Natural selection acts on individuals, but evolutionary change affects populations as a whole.

4. Speciation: In recent decades, natural selection has caused populations of one species to diverge and form new species.

5. Fitness is the ability to produce offspring.

6. Adaptation is a trait that increases an individual's fitness in a particular environment.

V. The "Tree of Life" Depicts Evolutionary History

A. Evolution leads to speciation, the generation of new species.

1. This implies that all species come from preexisting species and that their ancestry can be traced back to a single common ancestor.

2. Therefore, we should be able to reconstruct the tree of life—a family tree of all organisms.

B. How can we use molecules to understand the tree of life?

1. Evolutionary relatedness should be reflected in molecular similarities.

2. Woese and colleagues proposed using RNA to assess the relatedness (phylogeny) of all living groups of organisms.

C. What does it mean to analyze genetic variation?

1. Looking at genetic variation means looking at the DNA or RNA of that organism and its close relationship to related species. (**Making Models 1.1** and plant/algae example)

2. The goal in analysis is to then produce a diagram, a phylogenetic tree, that describes those organisms being compared. **(Fig. 1.7)**

D. How is the tree of life estimated from genetic data?

1. Construction of a phylogenetic tree is done using computer programs to find the arrangement of branches that is most consistent with the similarities and differences observed in the genetic data.

2. The tree of life contains a diverse array of species with a main node that extends to the last universal common ancestor (LUCA).

a. There are three major lineages in the tree of life: Bacteria, Archaea (barely known prior to this analysis), and Eukarya. **(Figs. 1.7, 1.8)**

b. Fungi are more closely related to animals than to plants.

c. The data did not support older models, such as the five-kingdom model.

3. Organisms are placed in taxa, formally named groups.

E. The tree of life is a work in progress.

a. ***Students should understand that the lines in the tree of life, specifically the length of the lines between species, reflect the variation in nucleotide sequences between species.*** **(BioSkills 13)**

F. How should we name branches on the tree of life? **(BioSkills 15)**

1. The three major lineages of life—Bacteria, Archaea, and Eukarya—are called domains.

2. A phylum (plural: phyla) is a major lineage within one of the three domains.

3. Several (or more) distinct phyla per domain are each represented by distinct major branches on the tree of life.

4. Each species has a unique, formal, two-part (*Genus species*) scientific name. This system was developed by Linnaeus (1735) and is still used today.

VI. Doing Biology

A. What is the nature of science?

1. Biologists test the predictions made by alternative hypotheses, either by making observations or by setting up carefully designed experiments.

2. Biologists explore only those types of questions that can be tested by collecting data from the observable world.

3. Are science and religion compatible?

a. Science explores the what (patterns) and how (processes) questions of life.

b. Religion explores why we exist and how we should live.

B. Why do giraffes have long necks? An introduction to hypothesis testing

1. State the hypothesis as precisely as possible, and list the predictions that it makes. (Example: Giraffes have long necks for food competition.)

a. Remember to search for alternative hypotheses, too. (Example: Giraffes have long necks to compete for mates.)

2. Design an observational or experimental study that can test the predictions. (Where do giraffes feed? Prediction for food competition would be high in trees.)
3. Interpret the results.
   a. If the predictions are accurate, the hypothesis is supported.
   b. If the predictions are not accurate, the hypothesis as originally stated is not correct. **(Fig. 1.9)** It may need to be modified or discarded altogether in favor of an alternative hypothesis.
4. Example: Why do giraffes have long necks?
   a. ***Students should be able to state whether the giraffe study was an observational or experimental study. Students should also be able to develop hypotheses, generate ideas for studies, and interpret hypothetical data for similar questions, such as, "Why do zebras have stripes?"***

C. Let's look at an introduction to experimental design.

1. Experiments allow researchers to test the effect of a single, well-defined factor on a particular phenomenon.
2. Example: Navigation by Saharan desert ants—How do ants find their way back to their nest? **(Fig. 1.10)**
   a. Hypothesis: Ants know the distance back based on number of steps taken and stride length.
   b. Variable tested—stride length (shortened, typical, and lengthened) **(Figs. 1.11, 1.12)**
3. Important features of experimental design:
   a. It is critical to include control groups to rule out the effect of other factors. (Control with typical ants to ensure that manipulating ants doesn't alter ability to attain an accurate distance.)
   b. Control groups and experimental groups are exposed to exactly the same conditions.
   c. Repeating the test is essential; larger sample sizes reduce the effect of "noise" in the data.
4. ***Students should be able to explain: (1) What you would conclude if in the first test the normal individual had not walked 10 m on the return trip before looking for the nest; and (2) What you would conclude if the lengthened and shortened ants had not navigated normally during the second test.***

Chapter Vocabulary

This vocabulary list may be used in several ways, such as to:

- Add or modify terms to customize the list to your lectures.
- Remind yourself about concepts to emphasize or clarify during lectures.
- Easily determine which terms or topics are discussed in a chapter, and why.
- Distribute the list to students to use as a study aid for exams.

This list includes terms other than those highlighted in bold type in the chapter text.

adaptation
Archaea
ATP (adenosine triphosphate)
cell
cell theory
central dogma
chemical evolution
chromosome
chromosome theory of inheritance
control group
DNA
domain
double helix
energy
eukaryote
evolution
experiment
experimental study
fitness
genes
genus (s.), genera (pl.)
heritable trait
hypothesis
hypothesis testing
inheritance
kingdom
LUCA
microscope
natural selection
null hypothesis
observational study
organism
phylogenetic tree
phylogeny
phylum
population
prediction
prokaryote
protein
replication
RNA
scientific name
speciation
species
spontaneous generation
taxon (s.), taxa (pl.)
taxonomy
theory
tree of life

Lecture Activities

Most instructors of introductory college biology classes struggle to find a balance between covering the large volume of material required and engaging the students. These lecture activities are suggestions for ways to engage the students while reinforcing a concept that is foundational to their understanding of the subject at hand. We recognize that class sizes for introductory courses vary depending on the size of the institution. For this reason, we frequently provide different suggestions for both large and small class sizes. Sometimes, the activity ideas are completely different; at other times, we include suggestions on how to modify an activity to make it work with a large class. Following each set of lecture activities is a discussion idea that may help you to engage the students in a simpler way that takes up less class time than an activity does.

Developing Hypotheses

Estimated duration of activity: 5 to 15 minutes (depending on the depth of discussion)

Present students with a set of observations (or ask them to make some observations), and instruct them to develop one or more hypotheses that might explain the observed phenomena. The observations do not necessarily have to be biological. The goal is first to show students that they make observations, hypotheses, and predictions every day and then to get them to think about how a scientist would formally approach a question to test the hypothesis.

Ideas for observations:

- How are students seated in the classroom—clustered, evenly distributed, or some other way? An analogy could be made to population distributions in the wild. Ecologists study these types of population distributions to learn more about a community.
- Why do giraffes have long necks? Use the example in the book for this exercise instead of lecturing on it.
- Do antibacterial soaps really work? Have students discuss how they could test this idea.

- Do low-carbohydrate diets put individuals at higher risk for heart disease?

  This would be a nice example for discussing why most biological questions have to be answered by using experimental species other than humans.

Ask students what observations they might make and what experiments they might do to test these hypotheses. For an experiment, students must determine the controls they would need in order to achieve valid results.

Practicing BioSkills: Reading Graphs (BioSkills 2)

Estimated duration of activity: 10 to 15 minutes (depending on whether time is allotted to have students draw their own versions of the graphs)

One of the challenges for introductory students is learning how to read graphs. **Figure 1.9a** (the giraffe feeding data) shows an interesting type of graph that is essentially a modified histogram. **Figure 1.11** (the ant experiment) shows a box-and-whiskers plot, a type of graph commonly used to show behavioral data. This graph will be new to most students. You can use these two graphs to give students practice at interpreting graphs and to drive home the point that the same data can be displayed in many different ways.

First, explain how to read both types of graphs, using these steps outlined in **BioSkills 2**:

1. What do the axes represent?
2. What do the marks on the graph—the lines and boxes—represent?

   Students may benefit from the following tips:

   - Note that the giraffe graph shows *percentages of feeding bites.*
   - The ant experiment uses box-and-whiskers plots, interpreted as follows:
     - The box always encloses the middle 50 percent of the data (25th to 75th percentile).
     - The line inside the box is always the median, which divides the data into a top half and a bottom half.
     - In this case, the whiskers enclose 80 percent of the data (10th to 90th percentile).
     - Often, outliers are shown as isolated dots, but not in this case.
3. What is the overall trend or message?

After students understand how to read both graphs, ask them to make a brief sketch of what each of these graphs would have looked like if the data had been shown in a simple bar graph. (For the giraffe data, students may use the mode—the peak of the line—for the height of the bars in their bar graphs. For the ant data, tell students to use the median line—the line inside the box—for the height of the bar.) Ask students: Which graph is simpler to read? Which gives a "truer" picture of the overall data? Which is a better way to show the data, and why? Remind students that they can refer to **BioSkills 3** for further practice and for examples of other types of graphs. Encourage students by suggesting that reading and understanding graphs will be included on classroom exams or quizzes.

Practicing Taxonomy

Estimated duration of activity: 10 minutes

To illustrate how biologists classify organisms, take a few minutes to have your students build a classification system of the students in the class. Ask them to start with the largest

classification and work toward more specific distinctions. The criteria they suggest may include some of the following:

- *Appearance:* This criterion is analogous to biologists using structural characteristics to classify organisms.
- *Academic affiliations (like college major):* This criterion is loosely analogous to classifying organisms by looking at the functions of specific appendages or by looking at their ecological roles (terrestrial predator, marine reef-builder, etc.).
- *Ethnicity:* This criterion is loosely analogous to classifying organisms based on their evolutionary relationships.

As you are diagramming the classifications the students are making, you may draw them using a tree or cladogram, explaining that the base category for this example is a trait they all have in common, whereas the base of a phylogenetic tree is a presumed common origin.

Asking Good Scientific Questions

Estimated duration of activity: 10 to 15 minutes

Begin with a discussion on the elements of high-quality scientific questions. Introduce the idea that although scientists may begin their inquiry with general questions, they must focus on one or more specific questions in order to make any progress.

1. Have students discuss the following idea in small groups (2 to 4 students): What are the elements of a good scientific question?
2. After a few minutes, ask some groups to report to the class. Guide the class discussion toward sound principles such as these:
   - Good scientific questions imply specific experiments or observations; in other words, they can be tested.
   - Good questions are focused.
   - Good questions may suggest specific hypotheses.
3. Present a list of potential scientific questions (see below). Have the groups rate the questions in terms of their utility for conducting scientific research. Have them provide the reasons for their ratings.

   Suggested questions: (Note: Some of these examples contain details with which the students may not be familiar. Explain to students that it is not necessary to know all the details in order to be able to judge the quality of the question.)
   - How many species of fish are there in a certain lake?
   - Do embryonic cells differentiate into specialized cells (e.g., liver cells) by the inactivation of genes or by the physical removal of them from chromosomes?
   - What determines the vertical distribution of barnacles on rocks in the intertidal zone?
   - Can infections with HIV be treated with drugs that inhibit the viral enzyme known as reverse transcriptase?
   - What makes cells become cancerous?
   - How do steroid hormones stimulate lymphocytes to die?

- Is the anticancer gene known as p53 activated in response to DNA damage initiated by radiation?
- Can animals distinguish colors?
- Are *Agkistrodon piscivorus* and *Crotalus atrox* so closely related that they should be classified in the same genus?
- Does smoking cause cancer?
- What carbon-based compounds are present on Mars?
- Do the retinas of rats contain the specialized cells (cones) responsible for color vision in humans?
- Do all viruses contain DNA?

Discussion Idea: Virchow and Darwin

In 1858, both Virchow and Darwin introduced their ideas on biological ancestry. How do you think these ideas challenged the popular thought of the day? How are the two ideas related to each other, and how have they shaped the field of biology since then? Why is one idea still socially controversial while the other one is not?