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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) If the control group in an experiment shows the same results as the test group, the treatment was successful.
   - ◎ true
   - ◎ false

2) An important part of scientific research is repeatability.
   - ◎ true
   - ◎ false

3) The general public needs to have an understanding of science in order to make informed decisions about our futures and our world.
   - ◎ true
   - ◎ false

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

4) The scientific study of life is called
   - A) biology.
   - B) ecology.
   - C) anatomy.
   - D) biochemistry.
   - E) limnology.

5) A complex individual that consists of organ systems is known as a(n)
   - A) community.
   - B) population.
   - C) organism.
   - D) tissue.
   - E) species.

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6) All of the ecosystems on the planet together are called the
   A) atmosphere.
   B) hydrosphere.
   C) biosphere.
   D) lithosphere.
   E) stratosphere.

7) In a swamp, all of the alligators would represent a(n)
   A) organism.
   B) population.
   C) community.
   D) ecosystem.
   E) biosphere.

8) The region in which populations interact with each other and with the physical environment is called a(n)
   A) entity.
   B) ecosystem.
   C) biosystem.
   D) community.
   E) biosphere.

9) All of the changes that occur starting from the time an egg is fertilized and continuing through childhood, adolescence, and adulthood are called
   A) metabolism.
   B) evolution.
   C) homeostasis.
   D) reproduction.
   E) development.

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10) Which of the following statements most correctly defines homeostasis?
   A) All living organisms are alike.
   B) Living organisms do not change much over time.
   C) Human beings and other animals acquire materials and energy when they eat food.
   D) It takes energy to maintain the organization of the cell.
   E) Cells and organisms maintain a fairly constant internal environment.

11) The face of a sunflower turns to follow the sun as it moves across the sky. This is an example of
   A) metabolism.
   B) homeostasis.
   C) response to stimuli.
   D) development.
   E) reproduction.

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12) Choose the correct order (1–5) of increasing complexity/organization.

A)
1. (1) tissues,
2. (2) organ systems,
3. (3) cells,
4. (4) organs,
5. (5) organism

A)
1. (1) cells,
2. (2) organ systems,
3. (3) tissues,
4. (4) organs,
5. (5) organism

A)
1. (1) tissues,
2. (2) organs,
3. (3) organ systems,
4. (4) cells,
5. (5) organism

A)
1. (1) cells,
2. (2) tissues,
3. (3) organs,
4. (4) organ systems,
5. (5) organism

A)
1. (1) organism,
2. (2) organ systems,
3. (3) organs,
4. (4) tissues,
5. (5) cells

13) Fish have scales that enable them to live in a water environment. This is an example of

A) homeostasis.
B) adaptation.
C) metabolism.
D) development.
E) cellular organization.

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14) The domain Eukarya contains_____ kingdom(s).
A) one
B) two
C) three
D) four
E) five

15) Traditions, beliefs, and values are considered what aspect of human life?
A) communicative
B) cultural
C) instructional
D) biological
E) chemical

16) The cell you are examining under the microscope appears to contain a nucleus. This organism belongs to the domain
A) Bacteria.
B) Archaea.
C) Eukarya.
D) Animalia.
E) Fungi.

17) Which organisms are most closely related to humans?
A) spiders
B) earthworms
C) parakeets
D) meerkats
E) snakes

18) Which group of primates are humans most closely related to?
A) monkeys
B) apes
C) prosimians
D) lemurs

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19) Which feature makes humans unique among animals?
A) We walk on two legs.
B) We have a large brain.
C) We have a language that allows for the communication of information and experiences symbolically.
D) We are omnivores and can eat a wide diversity of foods.

20) Humans clear forests to grow crops, and they build houses and cities. What are these an example of?
A) how humans modify the biosphere
B) how humans preserve ecosystems
C) the high value humans place on biodiversity
D) the positive impact of humans on life on Earth
E) how humans do not need the rest of life on Earth

21) _____observations are supported by factual information, while _____observations involve personal judgment.
A) Subjective; analytical
B) Objective; analytical
C) Objective; subjective
D) Objective; hypothetical
E) Subjective; theoretical

22) Which of the following statements is an objective observation?
A) This milk tastes funny.
B) This package is larger than that one.
C) I like this picture.
D) This mattress feels hard to me.
E) I think I am going to be sick.

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23) What is the unifying principle of the biological sciences?

A) technology
B) anatomy
C) biochemistry
D) taxonomy
E) evolution

24) Where on a graph can you find the information that the graph pertains to?

A) The x-axis only
B) The y-axis only
C) The dot points that are connected by the lines of the graph
D) The top of each bar in a bar graph
E) The x-axis and y-axis

25) The tentative explanation to be tested is called

A) a theory.
B) a hunch.
C) a hypothesis.
D) the data.
E) the conclusion.

26) Which type of graph can be used to depict the relationship between two quantities?

A) circle
B) pillar
C) line
D) point

27) The information collected during the experiment or observation is called

A) a theory.
B) a hunch.
C) the hypothesis.
D) the data.
E) the conclusion.

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28) Which topic is not supported by a general understanding of science?
A) climate change
B) biodiversity
C) emerging diseases
D) culture

29) The cause of stomach ulcers appears to be
A) excess stomach acid.
B) the bacterium *Helicobacter pylori.*
C) drinking too much coffee.
D) extreme stress.
E) diets rich in meat products.

30) Which of the following statements is a hypothesis?
A) If a student buys a meal plan, they will eat more vegetables.
B) The student gained 5 lbs during their first year at college.
C) The student failed the test.
D) I like my biology class better than my other classes.

31) A controlled study in which neither the patient nor the examiner is aware of whether the patient is receiving a treatment, is called a(n)
A) statistical study.
B) double-blind study.
C) variable study.
D) adaptive study.
E) blind study.

32) In an experiment designed to test the effect of temperature on goldfish respiration, the temperatures that were changed represent what type of variable?
A) control
B) responding
C) experimental
D) correlative
E) placebo

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33) To make all subjects think they are receiving the same treatment, what are patients in the control group given?

A) a placebo
B) the full dose of the drug
C) a 50% dose of the drug
D) a 75% dose of the drug

34) One of the difficulties with publication of research in scientific journals is that it

A) is technical and may be difficult for the general person to read.
B) is often out of context or misunderstood.
C) is unverified and usually not referenced.
D) displays bias.
E) is designed to convince readers to purchase a product.

35) Which of the following URLs would you trust least in writing a scientific paper?

A) .com
B) .gov
C) .edu
D) .org
E) both .edu and .gov

36) The standard error tells

A) how often the examiner made an error.
B) how often the experimental variable was tested.
C) the relationship between the control and test groups.
D) whether or not the research has been published in a scientific journal.
E) how uncertain a particular value is.

37) To be accepted scientifically, what does the probability value need to be less than?

A) 5%
B) 8%
C) 10%
D) 15%

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38) Which of the following is an example of correlation without causation?
A) HPV can cause cervical cancer.
B) Illegal drug use causes an increase in crime.
C) *Helicobacter pylori*can cause ulcers.
D) People who commit crimes also consume bread.
E) Parents have children.

39) In a graph, the experimental variable is plotted on the
A) x-axis.
B) y-axis.
C) x- and y-axis.
D) z-axis.
E) x- and z-axis.

40) Choose the interest group that should be held most responsible for the future roles of new scientific technologies.
A) scientists
B) politicians
C) clergy
D) educators
E) everyone

41) In conducting a review of the literature on the internet, which of the following sources would be the least reliable?
A) The Centers of Disease Control
B) The Cystic Fibrosis Foundation
C) The National Institute of Health
D) The Pasteur Institute
E) Astrology and Medicine

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42) After studying biology, you should
A) become an animal rights activist.
B) be better able to make wise decisions regarding your own well-being and the Earth's.
C) get a high paying job as a biologist.
D) understand all there is to know about humans and biology.
E) dislike anything to do with biology.

43) The application of scientific knowledge to the interests of humans is known as
A) science.
B) technology.
C) research.
D) invention.

44) Scientists who have a financial stake in a company are now required to state that when they do research. This is an example of
A) ethics in science.
B) financial planning.
C) a new business model.
D) a biotechnology revolution.
E) statistical significance.

45) Which of the following statements is most correct when considering the atomic bomb and the use of radiation in cancer therapy?
A) Science and technology are not risk-free.
B) Science and technology are wrong.
C) Science and technology are good for humanity.
D) Science and technology always provide value to people.

46) Which of the following kingdoms is not classified under the domain Eukarya?
A) Fungi
B) Animalia
C) Protista
D) Archaea

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47) Which characteristic is not found among all living organisms?
A) breathe oxygen
B) are organized
C) have the ability to acquire materials and energy
D) can reproduce and grow

48) Identify the first step of the scientific method.
A) Make an observation.
B) Develop a hypothesis.
C) Design an experiment.
D) Analyze the results and draw a conclusion.

49) Which of the following statements correctly describes the conditions affecting biodiversity?
A) Habitat loss and climate change are accelerating species extinction.
B) Humans are preventing the loss of biodiversity.
C) The Earth's biodiversity is increasing every year.
D) Climate change is helping a large number of species adapt to new environments.

50) Which of the following is considered the greatest challenge facing science and society?
A) pollution
B) habitat loss
C) loss of biodiversity
D) climate change

51) A new taxonomic group, called the supergroup, was developed to explain the evolutionary relationships among the____; there are____ supergroups in domain Eukarya.
A) protists; 6
B) animals; 4
C) fungi; 6
D) plants; 4

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Answer Key

Test name: Chapter 01

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

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38) D
39) A
40) E
41) E
42) B
43) B
44) A
45) A
46) D
47) A
48) A
49) A
50) D
51) A

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CHAPTER 1
EXPLORING LIFE AND SCIENCE

LEARNING OUTCOMES

1.1 The Characteristics of Life

1. Explain the basic characteristics common to all living organisms.
2. Describe the levels of organization of life.
3. Explain why the study of evolution is important in understanding life.

1.2 Humans Are Related to Other Animals

1. Summarize the place of humans in the overall classification of living organisms.
2. Understand that humans have a cultural heritage.
3. Describe the relationship between humans and the biosphere.

1.3 Science as a Process

1. Describe the general process of the scientific method.
2. Distinguish between a control group and an experimental group in a scientific test.
3. Recognize the importance of scientific journals in the reporting of scientific information.
4. Recognize the importance of statistical analysis to the study of science.

1.4 Challenges Facing Science

1. Distinguish between science and technology.
2. Summarize some of the major challenges facing science.

EXTENDED LECTURE OUTLINE

1.1 The Characteristics of Life

The science of biology is the study of living organisms and their environments. All living organisms share several basic characteristics.

Life Is Organized

Atoms join together to form molecules that make up cells. A cell is the smallest structural and functional unit of an organism. Some organisms are single-celled, while other more complex living things are multicellular. Cells joined together form tissues, which form organs, which form organ systems, which then form individual organisms. Biological organization extends beyond the individual to populations, communities, ecosystems, and, finally, the biosphere.

Life Requires Materials and Energy

Energy is the capacity to do work. Human beings require an outside source of materials and energy to carry on life's activities. Humans and other animals get these materials when they eat food. Metabolism is the sum of all chemical reactions of all cells within an organism. The ultimate source of energy for the majority of life on Earth is the sun. Plants, algae, and some bacteria use photosynthesis to create sugars, which are the basis of the food chain.

Living Organisms Maintain an Internal Environment

The ability of a cell or an organism to maintain a constant balance of the internal environment under specific conditions is called homeostasis. Organ systems work to maintain homeostasis, but it is also partially dependent on the external environment. Regulation of body temperature within a normal range is an example.

Living Organisms Respond

Living things respond to external stimuli, often by moving toward or away from a stimulus. There are two types of stimuli: external (removing your hand from a hot stove) and internal (response of your brain and blood vessels to dilate when blood pressure is too high). Organisms use a variety of mechanisms to move. Movement of humans depends on musculoskeletal and nervous systems.

Living Organisms Reproduce and Develop

When organisms reproduce, they pass on genetic information to the next generation. Following fertilization of the egg by the sperm cell, the zygote that results undergoes growth and development. Growth is an increase in size and number of cells and is a part of development. In humans, development includes all the changes that occur from the time the egg is fertilized until death, as well as repair that takes place following an injury. DNA is genetic information of all life and is contained within genes. Genes enable living organisms to pass on hereditary information

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from parent to child. Before an organism reproduces, DNA is replicated so that copies of genes are passed to offspring. Mutation is an alteration in the DNA sequence that results in evolutionary change. This can result in an organism being better suited for the environment.

Organisms Have an Evolutionary History

Evolution is the process by which a population changes through time for survival by adapting to the environment. Natural selection is the mechanism of evolution, where organisms that are more suited to the environment survive and reproduce better than those less suited. Over time, the population will consist of organisms that are more adapted to the environment. Evolution explains both the unity and the diversity of life.

1.2 Humans Are Related to Other Animals

All life is now classified into three domains: Bacteria, Archaea, and Eukarya. Bacteria and Archaea are single-celled organisms that do not have a nucleus. Eukarya have a nucleus, are single-celled or multicelled. Historically, domain Eukarya has been divided into one of four kingdoms: Protista, Fungi, Plantae, and Animalia; however, DNA analysis suggests not all of the Protistas share the same evolutionary lineage. In addition, there are subgroups, known as eukaryotic supergroups. Animals are mostly invertebrates (without internal skeletal support), and vertebrates. Humans are mammals (fur or hair and mammary glands) within the vertebrates of the kingdom Animalia (supergroup Opisthokonta) within the domain Eukarya. Humans are primates with apelike ancestors.

Humans Have a Cultural Heritage

Humans' cultural heritage encompasses human activities and products passed on from one generation to the next outside of direct biological inheritance. This includes beliefs, values, and skills.

Humans Are Members of the Biosphere

All living things on Earth are part of the biosphere, a living network that spans the surface of the Earth into the atmosphere and down into the soil and seas.

1.3 Science as a Process

Science is a way of knowing about the natural world and is studied objectively versus subjectively. Objective observations are supported by factual observations while subjective observations involve personal judgment. The process of science involves the scientific method, which includes observations, hypotheses, controlled experiments, conclusions that either support or reject hypotheses, and reformulation of hypotheses.

Start with an Observation

The scientific method begins with observation. Scientists may expand their understanding beyond observation by taking advantage of the knowledge and experiences of other scientists. Observations are made with the senses, instruments, and studying previous research.

Develop a Hypothesis

After making observations and gathering knowledge about a phenomenon, a scientist uses inductive reasoning. A hypothesis is a supposition that is formulated after making an observation. A hypothesis is based on existing knowledge, so it is much more informed than a mere guess. When thinking about how to test a hypothesis, a scientist may make predictions (expected outcomes) based on the knowledge of the factors involved in the observations. A hypothesis is tested by obtaining more data by experimentation.

Test the Hypothesis

A hypothesis is tested by performing experiments. Experiments are a series of procedures and the use of deductive reasoning. An experiment consists of an experimental design, experimental variable, and responding variable. Experiments can take many forms; however, in all experimental designs, the researcher attempts to keep all the conditions constant except for the experimental variable. To ensure that the result of the experiment is meaningful, the experiment should contain test and control groups. One or more test groups are exposed to the experimental variable, but one other group, called the control group, is not. Scientists often use model organisms and model systems to test a hypothesis.

Collect and Analyze the Data

The data obtained from scientific experiments may be presented in various formats such as tables and graphs. These formats show the relationship between two quantities and summarize data.

Statistical Data

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Statistics help scientists evaluate experimental data. In statistics, the standard error (standard deviation) shows how uncertain a particular value is.

Statistical Significance

Statistical significance allows researchers to quantify how likely it is that the results of an experiment resulted from chance alone. Probability (p value) is calculated to determine if results are due to chance or the variable they manipulated.

Scientific Publications

Scientists share their work through publication in peer-reviewed journals through a standardized process that promotes responsibility and reliability within the scientific community. People should be careful about scientific information found on the Internet.

Develop a Conclusion

Scientists must analyze the data to conclude whether a hypothesis is supported or not. In science, the conclusion of one experiment can lead to a hypothesis for another experiment that can be used for different subjects. This is one of the reasons that scientist share their findings in scientific journals, so that methodology and data are available to other scientists.

Scientific Theory

The ultimate goal of science is to understand the natural world in terms of scientific theories, which are accepted explanations for how the world works. Examples of these theories are the cell theory, the gene theory, and the theory of evolution. The theory of evolution is the unifying concept of biology because it generates new testable hypotheses, has been supported by many observations and experiments, and enables scientists to understand the history and nature of life. A theory can sometimes be considered a law or principle if it has been overwhelmingly accepted by the scientific community.

An Example of a Controlled Study

Controlled laboratory studies involve two groups of subjects, a control group not given the test medication or treatment and a test group given the medication or treatment. It is important to reduce the number of possible differences between the two groups.

Experimental Design

Independent test groups are randomly assigned to be recipients of the variable being tested. The larger the sample size, the greater the chance of reducing the influence of external variables. The data from this group are compared to those from a control group. An example would be the control group receiving the placebo and the test groups receiving the drug.

The Results and Conclusion

A double-blind study is when the examiner is not aware of which group the subject is in, which prevents subjective influences.

1.4 Science and the Challenges Facing Society

Science is a systematic way of acquiring knowledge about the natural world. It can examine only those things that can be observed objectively, not supernatural or religious beliefs. Science differs from technology. Technology is the application of scientific knowledge to the interests of humans. Science and technology are not risk-free.

Climate Change

Climate change is primarily due to an imbalance in the chemical cycling of the element carbon. Due to human activities, more carbon dioxide is being released into the atmosphere than is being removed. These greenhouse gases are causing a rise in temperature called global warming. This is causing significant changes to Earth's ecosystems.

Biodiversity and Habitat Loss

Biodiversity is the total number and relative abundance of species, the variability of their genes, and the different ecosystems in which they live. Due to human activities, biodiversity is threatened with hundreds of species becoming extinct each year. Extinctions are accelerated by habitat loss and climate change. The current rate of extinction may rival those of the previous five mass extinctions.

Emerging and Reemerging Diseases

New diseases have generated a lot of publicity. These emerging diseases may result from human behavior, the use of technology, globalization, and vector mutations that allow infection of new hosts. Reemerging diseases are known to cause disease but generally have not been considered a

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health risk due to the low level of incidence in human populations. Even so, reemerging diseases can cause problems when they cause an outbreak and spread.

STUDENT ACTIVITIES

Is It Alive?

1. Bring to class a collection of living things and inanimate objects. Plastic models of living organisms are particularly useful. Have students gather around the specimens and identify the features that distinguish the living specimens from the inanimate ones. List the distinguishing features on the board or overhead as students suggest them.

Humans Are Related to Other Animals

2. Give students a list of organisms that includes members of the four kingdoms within Eukarya (animals, plants, fungi, and protists). Ask them to divide the organisms into the various groups based on what they already know about these organisms. Then ask them to describe the common characteristics of each group.

Exploring the Scientific Method

3. Propose a simple hypothetical experiment in class, such as how salt affects the hatching of brine shrimp. Suggest the use of water, weak salt solution, and strong salt solution as the three "habitats." Have students formulate a hypothesis and discuss the steps needed to carry out their plan. Have some brine shrimp or photographs of brine shrimp available for observation.

Animals in the Lab

4. Arrange to take your students to a laboratory on campus or a nearby research facility to tour the animal housing facilities. Have the laboratory technician in charge of the lab explain what methods are used to ensure the animals receive good care and adequate housing. Explain the nature of the research involving animals in the research lab. Allow time for the students to ask questions.

One Application of the Scientific Method

5. Invite a fellow faculty member engaged in research on your campus to tell the class how they use the scientific method to address a specific question. Ask them to include a description of the control group(s) used in their research.

CLASSROOM DISCUSSION TOPICS

1. Viruses are not considered to be living organisms. Have students determine which of the characteristics of life viruses do not possess. Why would another parasitic organism, such as a disease-causing bacterium, be considered a living organism?
2. How does evolution explain both the unity and the diversity of life? Have students discuss what living things have in common and why these commonalities suggest a common ancestor. Have students discuss how living things are diverse and how this came about.
3. If humans are members of the biosphere, what gives them the right to modify and/or destroy the habitats of other organisms? Are humans "above" other organisms? Are they in some way "special" or "different"? What responsibilities do humans have to take care of the other organisms of the biosphere?
4. Read BIOLOGY TODAY-Science "Adapting to Life at High Elevations" in the text. Have students answer the following questions: What is the function of hemoglobin? How is the hemoglobin of people who live at high elevations different from that of people who live at low elevations? How is the gene *EPSA1* and the transcription factor it encodes involved with hemoglobin production? Define the term *adaptation* using the example of Tibetans who reside at high altitudes.
5. Read BIOLOGY TODAY-Science "Discovering the Cause of Ulcers" in the text. Have students explain how Marshall's approach was similar to and different from the scientific method.

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