

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

- 1) Robert Hooke coined the term *cell* when studying thin slices of cork. These _____ were the first cells observed because _____. 1) _____
- A) "little rooms"; they were 100 nm in diameter, much larger than most plant cells
 - B) dead animal cells; they were immobile and did not need to be fixed before viewing
 - C) dead plant cells; the thick cells walls did not require high resolution or magnification to view
 - D) compartments; they were actually the result of multiple cells that had merged and died to form large compartments that were easy to view
 - E) immune cells; they produce antibodies that embed in the cell membrane to make it visible
- 2) The Latin phrase *omnis cellula e cellula* refers to a cellular principle. Which of the following statements is the best interpretation of this phrase? 2) _____
- A) Cells generally are found in clusters.
 - B) All cells arise only from preexisting cells.
 - C) Tissues are composed of similar cells.
 - D) The cell is the basic unit of structure.
 - E) Organs are composed of tissues and cells.
- 3) _____ improved the original light microscope in the late 1600s, allowing the visualization of _____. 3) _____
- A) Antonie van Leeuwenhoek; sperm cells, bacteria, algae, and other protists
 - B) Theodor Schwann; the internal structures of cells, such as ribosomes, nuclei, and golgi bodies
 - C) Robert Brown; cell structures using fluorescent antibodies
 - D) Rudolf Virchow; collagen and muscle cells
 - E) Robert Hooke; bacteria and viruses
- 4) Which organelle stores most of the DNA in plant and animal cells? 4) _____
- A) lysosome
 - B) mitochondrion
 - C) Golgi complex
 - D) chloroplast
 - E) nucleus
- 5) Which of the following statements is *false*? 5) _____
- A) All cells have a membrane-bound nucleus.
 - B) Cells come in a wide variety of sizes and shapes.
 - C) The cell is the basic unit of structure for all organisms.
 - D) All organisms consist of one or more cells.
 - E) All cells arise from preexisting cells.
- 6) Which of the following is *true* of a nanometer? 6) _____
- A) A nanometer is one millionth of a meter.
 - B) The nanometer is the most common measurement used in measuring whole cells.
 - C) A nanometer is equivalent to 10 Angstroms (Å).
 - D) A nanometer is about the size of a common bacterial cell.
 - E) None of the above.

- 7) Which of the following is closest to a micrometer in size? 7) _____
- A) the width of a strand of DNA
 - B) the length of a chicken egg
 - C) the size of a ribosome
 - D) the length of a plant cell
 - E) a typical prokaryotic cell
- 8) Cell biology emerged from which of the following fields of biology? 8) _____
- A) cytology and biochemistry
 - B) genetics
 - C) biochemistry
 - D) biochemistry, cytology, and genetics
 - E) cytology
- 9) Which of the following is smallest? 9) _____
- A) prokaryote
 - B) mitochondrion
 - C) virus
 - D) protein
 - E) ribosome
- 10) Early microscopes did not allow clear visualization of cells because they were limited by 10) _____
- A) refraction.
 - B) resolution.
 - C) number of kernels.
 - D) magnification.
 - E) both magnification and resolution.
- 11) You are working on a project that involves the direct observation of DNA molecules. The microscope that would give you the best information at this time would be the 11) _____
- A) transmission electron microscope.
 - B) light microscope.
 - C) phase-contrast microscope.
 - D) fluorescent microscope.
 - E) digital video microscope.
- 12) The limit of resolution can best be defined as 12) _____
- A) the magnification power of a microscope.
 - B) the inverse of the wavelength of light; it is greatest for black light.
 - C) the solvent that must be available to remix a solution.
 - D) the distance that an object must be moved to be distinguished from its background.
 - E) the distance that two objects must be apart to be distinguished as separate objects.
- 13) How does brightfield microscopy allow images to be visualized? 13) _____
- A) Specimens are illuminated with white light.
 - B) Electrons strike the specimen being examined.
 - C) Specimens are illuminated with blue light to visualize internal features of cells smaller than 100 nm.
 - D) Specimens are fixed and have bright fluorescent molecules attached to them.
 - E) Specimens are viewed under phased light to improve magnification.

- 14) Which of the following is an application of immunofluorescence microscopy? 14) _____
- A) Identifying which organelle or cellular compartment contains a particular protein.
 - B) Visualization of the natural fluorescence of a specimen under UV light.
 - C) Identification of specific components of the immune system.
 - D) Visualization of the surface structures of a specimen.
 - E) Construction of three-dimensional images of structures smaller than 10 nm.
- 15) Which type of microscopy enhances and amplifies slight changes in the phase of transmitted light? 15) _____
- A) phase-contrast microscopy
 - B) differential interference contrast microscopy
 - C) both differential interference contrast microscopy and phase-contrast microscopy
 - D) digital video microscopy
 - E) fluorescence microscopy
- 16) Which type of microscopy has the greatest resolving power? 16) _____
- A) fluorescence microscopy
 - B) confocal scanning microscopy
 - C) phase-contrast microscopy
 - D) digital video microscopy
 - E) electron microscopy
- 17) Which of the following can *only* be viewed by electron microscopy? 17) _____
- A) nuclei
 - B) prokaryotes
 - C) DNA
 - D) mitochondria
 - E) frog eggs
- 18) Which of the following types of light microscopy improves the resolution of thick specimens by illuminating one plane of the specimen at a time? 18) _____
- A) confocal microscopy
 - B) brightfield microscopy
 - C) phase-contrast microscopy
 - D) fluorescence microscopy
 - E) differential interference contrast microscopy
- 19) A scientist is examining motile protist. He wishes to determine their direction of movement. Which of the following microscopic techniques is *least* likely to be used to view these cells? 19) _____
- A) differential interference contrast microscopy
 - B) phase-contrast microscopy
 - C) fluorescence microscopy
 - D) light microscopy
 - E) electron microscopy
- 20) Scanning electron microscopy (SEM) is especially suited to 20) _____
- A) creating a sense of depth.
 - B) simultaneously observing living specimens, examining internal cellular structure, and creating a sense of depth.
 - C) both observing living specimens and creating a sense of depth.
 - D) examining internal cellular structure.
 - E) observing living specimens.

- 21) Melvin Calvin and his colleagues used which of the following to deduce the steps in the Calvin cycle? 21) _____
- A) ultracentrifugation
 - B) radioisotopes
 - C) *Drosophila melanogaster*
 - D) negative staining
 - E) electron microscopy
- 22) A microtome is used to 22) _____
- A) slice thin sections of specimens.
 - B) dissect cellular organelles.
 - C) view microscopic organisms.
 - D) focus short wavelengths of light.
 - E) manipulate tiny objects.
- 23) The classic work of Friedrich Wöhler (1828) that united the fields of biology and chemistry was based on the 23) _____
- A) identification of nucleotide bases.
 - B) discovery of ATP.
 - C) discovery of yeast ferments.
 - D) production of urea in the laboratory.
 - E) analysis of gene segregation.
- 24) You wish to obtain a purified sample of mitochondria from lysed cells. The best way to obtain this sample would be 24) _____
- A) both centrifugation and polyacrylamide gel electrophoresis.
 - B) centrifugation.
 - C) chromatography.
 - D) polyacrylamide gel electrophoresis.
 - E) agarose gel electrophoresis.
- 25) 1 mm = _____ nm 25) _____
- A) 10
 - B) 1,000,000
 - C) 1/1000
 - D) 1/1,000,000
 - E) 1000
- 26) The outcome of the joining of cytology and biochemistry yielded a better understanding of the cell by 26) _____
- A) creating bioinformatics.
 - B) identification of cellular structures.
 - C) identification of biochemical pathways and creating bioinformatics.
 - D) identification of cellular structures and biochemical pathways.
 - E) identification of cellular biochemical pathways.

- 27) Wöhler revolutionized biology through his demonstration that biological molecules are governed by the ordinary laws of physics and chemistry. He demonstrated this principle by _____
- A) defining the laws of heredity.
 - B) synthesizing urea in the laboratory from ammonium cyanate.
 - C) inventing mass spectrometry which is commonly used to determine the size and composition of individual proteins.
 - D) developing techniques for isolating, purifying, and analyzing subcomponents of cells.
 - E) discovering active agents in cell extracts that were specific biological catalysts that have since come to be called enzymes.
- 28) Gregor Mendel was most influential in which field of biology? _____
- A) prokaryotic transformation
 - B) chromatography
 - C) cytology
 - D) genetics
 - E) biochemistry
- 29) The scientific work that established DNA, rather than protein, as the molecule of heredity was performed prior to _____
- A) the formation of the chromosome theory of heredity.
 - B) Antonie van Leeuwenhoek's observation of internal cell structures.
 - C) the description of the enzymatic steps of glycolysis.
 - D) Mendel's work on heredity.
 - E) the elucidation of the double helix structure of DNA.
- 30) Jacques Monod and François Jacob deduced the mechanism responsible for the regulation of prokaryotic gene expression. They are, therefore, responsible for launching the era of _____
- A) biochemistry.
 - B) the scientific method.
 - C) molecular genetics.
 - D) light microscopy.
 - E) radioisotopes.
- 31) Which of the following biochemical techniques uses an electrical field to separate macromolecules based on their mobility through a semisolid gel? _____
- A) ultracentrifugation.
 - B) mass spectrometry.
 - C) light microscopy.
 - D) electrophoresis.
 - E) chromatography.
- 32) To which of the following do Mendel's observations relate? _____
- A) heredity
 - B) diffusion
 - C) gravity
 - D) ideal gas laws
 - E) thermodynamics

- 33) The steps of the scientific method, in the correct order, are 33) _____
- A) collect data, interpret results, test the hypothesis, make observations, and design experiments.
 - B) make observations, formulate the hypothesis, design experiments, collect data, interpret results, and draw conclusions.
 - C) design experiments, draw conclusions, collect data, interpret results, make observations, and test the hypothesis.
 - D) collect data, interpret results, test the hypothesis, design experiments, make observations, and draw conclusions.
 - E) none of the above.
- 34) Scientists use various terms to describe conclusions reached through the scientific method. Which of the following terms conveys the least degree of certainty? 34) _____
- A) law
 - B) hypothesis
 - C) theory
 - D) both hypothesis and theory
 - E) both theory and law
- 35) Once a scientific theory becomes a law, it 35) _____
- A) becomes static.
 - B) cannot be challenged.
 - C) is irrefutable.
 - D) is subject to modification.
 - E) cannot be changed.
- 36) You are studying the response of macrophages infected with the intracellular bacterium *Brucella*, specifically by examining which gene products are being expressed. You would be studying the macrophage _____ to obtain this information. 36) _____
- A) transcriptome
 - B) proteome
 - C) genome
 - D) amplicon
 - E) metabolome
- 37) Which of the following is an important characteristic for a model organism? 37) _____
- A) widely studied
 - B) prone to random changes that alter primary characteristics
 - C) difficult to manipulate in the laboratory
 - D) marginally characterized
 - E) all of the above
- 38) All of the following are model organisms, *except* 38) _____
- A) *Homo sapiens*.
 - B) *Saccharomyces cerevisiae*.
 - C) *Caenorhabditis elegans*.
 - D) *Arabidopsis thaliana*.
 - E) *Drosophila melanogaster*.

39) In studying osteoporosis in humans, you wish to test a newly designed treatment for efficacy. Your best choice for a model organism would be 39) _____

- A) *Escherichia coli*.
- B) *Pisum sativum*.
- C) *Caenorhabditis elegans*.
- D) *Arabidopsis thaliana*.
- E) *Mus musculus*.

40) Which of the following is mismatched? 40) _____

- A) *Caenorhabditis elegans* – photosynthesis
- B) *Escherichia coli* – genetics
- C) *Drosophila melanogaster* – embryogenesis
- D) *Mus musculus* – immunology
- E) *Arabidopsis thaliana* – plant gene function

MATCHING. Choose the item in column 2 that best matches each item in column 1.

Match each scientist or group of scientists on the left with the appropriate phrase to the right.

41) Gregor Mendel	A) dog saliva	41) _____
42) Walter Sutton	B) cell theory	42) _____
43) Matthias Schleiden	C) translation	43) _____
44) Oswald Avery, Colin MacLeod, and Maclyn McCarty	D) hereditary factors	44) _____
45) George Beadle and Edward Tatum	E) embryonic bacteria	45) _____
46) James Watson and Francis Crick	F) chromosome theory of heredity	46) _____
	G) transcription	
	H) pollen grain	
	I) DNA double helix	
	J) "one gene—one enzyme"	
	K) transfer RNA	
	L) transformation	

- | | | |
|------------------------|------------------------|-----------|
| 47) Thomas Hunt Morgan | A) Calvin cycle | 47) _____ |
| 48) Friedrich Wöhler | B) fruit fly | 48) _____ |
| 49) Louis Pasteur | C) urea | 49) _____ |
| | D) "ferments" of yeast | |
| | E) oral prokaryotes | |

Match the type of microscopy with the appropriate characteristic.

- | | | |
|--------------------------------------|---|-----------|
| 50) brightfield | A) detects electrons deflected from the surface of the specimen | 50) _____ |
| 51) fluorescence | B) detects electrons passing through a specimen | 51) _____ |
| 52) phase-contrast | C) uses a laser to view a single plane of a specimen | 52) _____ |
| 53) confocal | D) light passes directly through specimen | 53) _____ |
| 54) transmission electron microscopy | E) shows specific molecules | 54) _____ |
| 55) scanning electron microscopy | F) amplifies variations in density | 55) _____ |

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

- 56) To be useful to scientists, a hypothesis must be _____; in other words, the hypothesis must be able to be confirmed or discredited. 56) _____
- 57) A scientific _____ must be so thoroughly confirmed that virtually no doubt remains about its accuracy. 57) _____
- 58) Glycolysis is also called the _____ pathway after the scientists who did most of the work to define it. 58) _____
- 59) _____ synthesized urea in the laboratory from inorganic starting materials. Much of what is now called _____ dates from this discovery. 59) _____
- 60) Melvin Calvin used _____, a specific _____, to deduce the Calvin cycle of photosynthesis. 60) _____
- 61) A(n) _____ is an instrument used to separate subcellular structures and macromolecules on the basis of size, shape, and density. _____ developed this instrument in Sweden during the period 1925–1930. 61) _____

- 62) Around 1914, _____ determined that DNA was an important component in _____ by using a staining technique that is still in use today. 62) _____
- 63) Because of the low penetration power of electrons, samples for transmission electron microscopy must be extremely thin. A(n) _____ is able to cut sections as thin as 20 nm. 63) _____
- 64) In 1880, Walther Flemming identified _____, threadlike bodies seen in dividing cells. 64) _____
- 65) The _____ was developed in the late 1920s by Theodore Svedberg. He originally used it to determine the sedimentation rate of proteins. 65) _____
- 66) _____ is a biochemical technique that allows one to separate biological molecules based on size, shape, and/or affinity for specific molecules or functional groups. 66) _____
- 67) The total protein content of the cell is called the _____. 67) _____
- 68) _____ is the ability to distinguish two objects that are close together as separate. In any microscope, this ability is determined by _____. 68) _____

MATCHING. Choose the item in column 2 that best matches each item in column 1.

Scientific discoveries have had great impact in human history. The people who make these discoveries and the circumstances that surround these discoveries are very important to our understanding of science. Can you identify the individuals as they might have described themselves?

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|---|--|-----------|
| 69) I am a seventeenth-century shopkeeper from Holland. My hobby involves hand-polishing glass to make lenses, some of which can magnify almost 300-fold. I was the first to observe living cells and am known as the "Father of Microbiology." | A) Alfred Hershey and Martha Chase
B) Robert Hooke
C) James Watson and Francis Crick
D) Friedrich Wöhler
E) Antonie van Leeuwenhoek
F) Melvin Calvin
G) Theodor Svedberg | 69) _____ |
| 70) I was the Curator of Instruments for the Royal Society of London in 1665. I developed a microscope that could magnify around 30-fold. I examined plant material and observed many small chambers that I called cells. | | 70) _____ |
| 71) At the University of California, Berkeley, I worked with radioisotopes. In the late 1940s and early 1950s, I used ^{14}C to identify the most common pathway for photosynthetic carbon metabolism. | | 71) _____ |
| 72) We worked out the double helix model of DNA structure in 1953. We later received the Nobel Prize for this work. | | 72) _____ |
| 73) I am a nineteenth-century German chemist. By synthesizing an organic molecule from inorganic components, I dispelled the idea that biological processes were exempt from the laws of chemistry. | | 73) _____ |
| 74) My colleague and I worked with bacterial viruses. We were able to demonstrate that DNA—not protein—was the genetic material of the cell. | | 74) _____ |
| 75) I am a Swedish scientist. I developed the ultracentrifuge to determine sedimentation rates of proteins. The ultracentrifuge was later used to isolate subcellular fractions. | | 75) _____ |

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

- 76) The following paragraph describes the activities of hypothetical scientists. After reading this paragraph, list the steps of the scientific method, and list the activities that correspond to the steps of the scientific method.

A rancher noticed that several grazing animals had become sick after grazing in a new area. The rancher asked a team of scientists to analyze this problem. They visited the area and found that the food available to the animals was similar to the food they had been eating. The water supply in the area was adequate but limited to a single spring. Some of the scientists felt that the water might be contaminated with a pathogen. Therefore, they collected water samples from the spring in the new area and compared them with water samples taken from previous grazing sites. The scientists noticed that water from the new area was cloudier than water obtained from other areas. Culturing this water revealed that a pathogenic strain of bacteria was present. This bacterial strain was found to be identical to a strain obtained from sick animals. This strain was not present in healthy animals. They concluded that a contaminated water supply in the new area was responsible for the problem and instructed the rancher to avoid the water supply. The disease was not found in the rancher's livestock again.

- 77) A number of different types of microscopy exist. Each type of microscopy has advantages and disadvantages. Can you identify the microscope that would be most advantageous for the situations below?
- A cell biologist wishes to visualize the ribosomes of a cell.
 - A microbiologist wishes to examine the motility of a bacterium.
 - An immunologist wishes to determine if a lymphocyte possesses a certain surface protein.
 - A virologist is trying to determine the three-dimensional shape of a virus.
 - A pathologist is trying to examine the cytoplasm of a cell for changes that result from viral infection.
- 78) You have identified a new molecule associated with the immune system that drastically reduces cell division by tumor cells *in vivo*. Develop a hypothesis and design an experiment to test your hypothesis using a model organism. Include an explanation as to why it is the best model for your experiment.
- 79) You have been given a sample of *Mimivirus*, which has the largest capsid diameter of all currently known viruses (600 nm) and has the form of a 20-sided polyhedron (an icosahedron). Based on your knowledge of microscopes, what would you be able to see/determine about mimiviral structure using each of the following microscopes?
- simple compound (light) microscope
 - fluorescent microscope using fluorescently labeled antibodies to a novel capsid protein
 - scanning electron microscope

Answer Key

Testname: UNTITLED1

- 1) C
- 2) B
- 3) A
- 4) E
- 5) A
- 6) C
- 7) E
- 8) D
- 9) D
- 10) E
- 11) A
- 12) E
- 13) A
- 14) A
- 15) C
- 16) E
- 17) C
- 18) A
- 19) E
- 20) A
- 21) B
- 22) A
- 23) D
- 24) B
- 25) B
- 26) D
- 27) B
- 28) D
- 29) E
- 30) C
- 31) D
- 32) A
- 33) B
- 34) B
- 35) D
- 36) A
- 37) A
- 38) A
- 39) E
- 40) A
- 41) D
- 42) F
- 43) B
- 44) L
- 45) J
- 46) I
- 47) B
- 48) C
- 49) D
- 50) D

Answer Key

Testname: UNTITLED1

- 51) E
- 52) F
- 53) C
- 54) B
- 55) A
- 56) testable
- 57) law
- 58) Embden-Meyerhof
- 59) Friedrich Wöhler; biochemistry
- 60) ^{14}C ; radioisotope
- 61) ultracentrifuge; Theodor Svedberg
- 62) Robert Feulgen; chromosomes
- 63) ultramicrotome
- 64) chromosomes
- 65) ultracentrifuge
- 66) Chromatography
- 67) proteome
- 68) Resolution; wavelength
- 69) E
- 70) B
- 71) F
- 72) C
- 73) D
- 74) A
- 75) G
- 76) (Answers may vary.)
 - Observation.* The rancher and the scientists made initial observations regarding the food and water that the livestock consumed.
 - Hypothesis.* The water supply was contaminated with a pathogen.
 - Experimentation.* Water was collected, examined, and cultured.
 - Collect data.* The turbidity of the water was examined. The cultures were positive for a pathogenic strain of bacterium.
 - Interpret results.* The data was compared to other water samples. The cultures were compared to those obtained from livestock.
 - Draw conclusion.* The water was contaminated and responsible for the outbreak.
- 77) (Answers may vary.)
 - a. Electron microscopy, preferably transmission electron microscopy, should be used.
 - b. Phase contrast or differential-interference-contrast would be most helpful.
 - c. Fluorescence microscopy is often used.
 - d. Scanning electron microscopy should be used.
 - e. Transmission electron microscopy will enable the pathologist to visualize the interior.
- 78) Answers will vary; however, the hypothesis would indicate the utility of the cytokine for lymphoma treatment. The obvious model organism would be the mouse model. It shares a great many similarities to humans at the cellular, anatomical, and physiological levels. It is well characterized, and the genome has been sequenced. Further, there is a mouse model of lymphoma currently available. Mice are easy to care for and require a relatively small amount of space to maintain.
- 79) a. Light microscope: will be able to see basic viral shape, especially if particles are stained
b. Fluorescent microscope: should illuminate the outside of the viral particles
c. Scanning electron microscope: would allow imaging of the surface structure of the virus