***World of the Cell***

**A Preview of the Cell**

Multiple-Choice Questions

1) Which scientist is credited with coining the term *cell* from the Latin *cellulae*?

A) Robert Brown

B) Antonie van Leeuwenhoek

C) Theodor Schwann

D) Matthias Schleiden

E) Robert Hooke

Answer: E

2) The Latin phrase *omnis cellula e cellula* refers to a cellular principle. Which of the following statements is the best translation of this phrase?

A) Tissues are composed of similar cells.

B) Cells generally are found in clusters.

C) All cells arise only from preexisting cells.

D) Organs are composed of tissues and cells.

E) The cell is the basic unit of structure.

Answer: C

3) In 1665, \_\_\_\_\_\_\_\_ used a microscope that he had built to examine thin slices of \_\_\_\_\_\_\_\_. While examining this material, he observed tiny compartments that he called *cellulae.*

A) Theodor Schwann; animal tissue

B) Robert Hooke; cork

C) Antonie van Leeuwenhoek; sperm cells

D) Robert Brown; plant material

E) Rudolf Virchow; collagen

Answer: B

4) Which organelle is round and derives its name from the Latin word for "kernel"?

A) Golgi complex

B) mitochondrion

C) chloroplast

D) nucleus

E) lysosome

Answer: D

5) Which of the following is *not* a tenet of the cell theory?

A) All organisms consist of one or more cells.

B) All cells arise from preexisting cells.

C) The cell is the basic unit of structure for all organisms.

D) All cells have a membrane-bound nucleus.

E) none of the above

Answer: D

6) Which of the following is *true* of a nanometer?

A) A nanometer is about the size of a common bacterial cell.

B) A nanometer is one millionth of a meter.

C) A nanometer is equivalent to 10 Angstroms (Å).

D) The nanometer is the most common measurement used in measuring whole cells.

E) none of the above

Answer: C

7) Which of the following is closest to a micrometer in size?

A) the width of a strand of DNA

B) the length of a plant cell

C) the length of a chicken egg

D) a typical bacterial cell

E) the size of a ribosome

Answer: D

8) Cell biology emerged from which of the following fields of biology?

A) biochemistry

B) cytology

C) genetics

D) all of the above

E) none of the above

Answer: D

9) Which of the following is smallest?

A) ribosome

B) virus

C) protein

D) mitochondrion

E) bacterium

Answer: C

10) Early microscopes did not allow clear visualization of cells because they were limited by

A) magnification.

B) number of kernels.

C) resolution.

D) refraction.

E) both choices A and C

Answer: C

11) You are working on a project that involves the direct three-dimensional observation of DNA molecules. The microscope that would give you the best information at this time would be the

A) light microscope.

B) transmission electron microscope.

C) scanning tunneling microscope.

D) phase-contrast microscope.

E) none of the above

Answer: C

12) The limit of resolution can best be defined as

A) the distance that an object must be moved to be distinguished from its background.

B) the inverse of the wavelength of light; it is greatest for black light.

C) the distance that two objects must be apart to be distinguished as separate objects.

D) the solvent that must be available to remix a solution.

E) the magnification power of a microscope.

Answer: C

13) Which of the following is *false* of brightfield microscopy?

A) White light is utilized.

B) Light passes through the object being examined.

C) Phase-contrast microscopy is a variant of brightfield microscopy.

D) Specimens are always viewed without being stained.

E) Specimens usually must be fixed.

Answer: D

14) Which of the following is *true* of fluorescence microscopy?

A) Fluorescent light is emitted throughout the specimen being viewed.

B) Fluorescence microscopy is best at viewing rounded, thicker specimens.

C) Fluorescence microscopy is used to view dead specimens only.

D) Fluorescence microscopy is able to overcome problems encountered with using confocal scanning microscopy.

E) Fluorescence microscopy presents images in three dimensions.

Answer: A

15) Which type of microscopy enhances and amplifies slight changes in the phase of transmitted light?

A) differential interference contrast microscopy

B) digital video microscopy

C) fluorescence microscopy

D) phase-contrast microscopy

E) both choices A and D

Answer: E

16) Which type of microscopy has the greatest resolving power?

A) electron

B) phase-contrast

C) fluorescence

D) digital video

E) confocal scanning

Answer: A

17) Which of the following can *only* be viewed by electron microscopy?

A) frog eggs

B) viruses

C) nuclei

D) mitochondria

E) bacteria

Answer: B

18) Of the following specialized procedures, which may be used with the electron microscope?

A) shadowing with gold

B) negative staining

C) scanning electron microscopy

D) freeze fracturing

E) all of the above

Answer: E

19) A scientist is examining motile protozoa. He wishes to determine their direction of movement. Which of the following microscopic techniques is *least* likely to be used to view these cells?

A) light microscopy

B) electron microscopy

C) differential interference contrast microscopy

D) fluorescence microscopy

E) phase-contrast microscopy

Answer: B

20) Scanning electron microscopy (SEM) is especially suited to

A) observe living specimens.

B) examine internal cellular structure.

C) create a sense of depth.

D) both choices A and C

E) choices A, B, and C

Answer: C

21) Melvin Calvin and his colleagues used which of the following to deduce the steps in the Calvin-Benson cycle?

A) negative staining

B) *Drosophila melanogaster*

C) electron microscopy

D) ultracentrifugation

E) radioisotopes

Answer: E

22) A microtome is used to

A) view microscopic organisms.

B) slice thin sections of specimens.

C) focus short wavelengths of light.

D) manipulate tiny objects.

E) dissect cellular organelles.

Answer: B

23) The classic work of Friedrich Wöhler (1828) that united the fields of biology and chemistry was based on the

A) discovery of yeast ferments.

B) production of urea in the laboratory.

C) discovery of ATP.

D) identification of nucleotide bases.

E) analysis of gene segregation.

Answer: B

24) You wish to obtain a pure mitochondria sample from lysed cells. The best way to obtain this sample would be

A) centrifugation.

B) chromatography.

C) polyacrylamide gel electrophoresis.

D) agarose gel electrophoresis.

E) both choices A and C

Answer: A

25) 1 mm = \_\_\_\_\_\_\_\_ nm

A) 1,000,000

B) 1000

C) 10

D) 1/1000

E) 1/1,000,000

Answer: A

26) The outcome of the joining of cytology and biochemistry yielded a better understanding of the cell by

A) identification of cellular structures.

B) identification of cellular biochemical pathways.

C) demonstration of bioinformatics.

D) both choices A and B

E) both choices B and C

Answer: D

27) Which of the following scientists revolutionized biology by demonstrating that living organisms were also governed by the laws of physics and chemistry by synthesizing urea in the laboratory from ammonium cyanate?

A) Wöhler

B) van Leeuwenhook

C) Mendel

D) Schwann

E) Rohrer

Answer: A

28) Gregor Mendel was most influential in which field of biology?

A) genetics

B) chromatography

C) biochemistry

D) bacterial transformation

E) cytology

Answer: A

29) The scientific work that established DNA, rather than protein, as the molecule of heredity is credited to

A) Monod and Jacob.

B) Watson and Crick.

C) Avery, MacLeod, and McCarty.

D) Beadle and Tatum.

E) Correns, von Tschermak, and de Vries.

Answer: C

30) Jacques Monod and François Jacob deduced the mechanism responsible for the regulation of bacterial gene expression. They are, therefore, responsible for launching the era of

A) the scientific method.

B) molecular genetics.

C) biochemistry.

D) light microscopy.

E) radioisotopes.

Answer: B

31) All of the following biochemical techniques have allowed us to understand cell structure and function *except*

A) light microscopy.

B) ultracentrifugation.

C) chromatography.

D) electrophoresis.

E) mass spectrometry.

Answer: A

32) Which laws were formulated by Mendel?

A) thermodynamics

B) gravity

C) ideal gas laws

D) heredity

E) diffusion

Answer: D

33) The steps of the scientific method, in the correct order, are:

A) design experiments, draw conclusions, collect data, interpret results, make observations, and test the hypothesis.

B) make observations, formulate the hypothesis, design experiments, collect data, interpret results, and draw conclusions.

C) collect data, interpret results, test the hypothesis, design experiments, make observations, and draw conclusions.

D) collect data, interpret results, test the hypothesis, make observations, and design experiments.

E) none of the above

Answer: B

34) When scientists use the scientific method, they use terms to indicate their degree of certainty. Which of the following terms conveys the least degree of certainty?

A) theory

B) hypothesis

C) law

D) both hypothesis and theory

E) both theory and law

Answer: B

35) Once a scientific theory becomes a law, it

A) cannot be changed.

B) cannot be challenged.

C) becomes static.

D) is subject to modification.

E) is irrefutable.

Answer: D

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.

A) proteome

B) genome

C) transciptome

D) amplicon

E) metabolome

Answer: C

37) Which of the following is an important characteristic for a model organism?

A) marginally characterized

B) difficult to manipulate in the laboratory

C) prone to random changes that alter primary characteristics

D) widely studied

E) all of the above

Answer: D

38) All of the following are model organisms, *except*

A) *Saccharomyces cerevisiae.*

B) *Drosophila melanogaster.*

C) *Caenorhabditis elegans.*

D) *Arabidopsis thialana.*

E) *Homo sapiens.*

Answer: E

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

A) *Escherichia coli.*

B) *Mus musculus.*

C) *Caenorhabditis elegans.*

D) *Arabidopsis thaliana.*

E) *Pisum sativum.*

Answer: B

40) Which of the following is mismatched?

A) *Escherichia coli* - genetics

B) *Drosophila* - embryogenesis

C) Mouse - immunology

D) *Chlamydomonas* - cell differentiation

E) *Arabidopsis* - plant gene function

Answer: D

Matching Questions

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

A) hereditary factors

B) pollen grain

C) chromosome theory of heredity

D) dog saliva

E) "ferments" of yeast

F) transformation

G) DNA double helix

H) embryonic plant

I) transfer RNA

J) embryonic bacteria

K) fruit fly

L) transcription

M) translation

N) Calvin-Benson cycle

O) "one gene—one enzyme"

P) oral bacteria

Q) urea

1) Gregor Mendel

2) Walter Sutton

3) Matthias Schleiden

4) Oswald Avery, Colin MacLeod, and Maclyn McCarty

5) George Beadle and Edward Tatum

6) James Watson and Francis Crick

7) Thomas Hunt Morgan

8) Friedrich Wöhler

9) Louis Pasteur

Answers: 1) A 2) C 3) H 4) F 5) O 6) G 7) K 8) Q 9) E

**Match the type of microscopy with the appropriate characteristic.**

A) uses a laser to view a single plane of a specimen

B) detects electrons passing through a specimen

C) light passes directly through specimen

D) detects electrons deflected from the surface of the specimen

E) shows specific molecules

F) amplifies variations in density

10) Brightfield

11) Fluorescence

12) Phase-contrast

13) Confocal

14) Transmission electron microscopy

15) Scanning electron microscopy

Answers: 10) C 11) E 12) F 13) A 14) B 15) D

Short Answer Questions

1) To be useful to scientists, a hypothesis must be \_\_\_\_\_\_\_\_; in other words, the hypothesis must be able to be confirmed or discredited.

Answer: testable

2) A scientific \_\_\_\_\_\_\_\_ must be so thoroughly confirmed that virtually no doubt remains about its accuracy.

Answer: law

3) Glycolysis is also called the \_\_\_\_\_\_\_\_ pathway after the scientists who did most of the work to define it.

Answer: Embden-Meyerhof

4) \_\_\_\_\_\_\_\_ synthesized urea in the laboratory from inorganic starting materials. Much of what is now called \_\_\_\_\_\_\_\_ dates from this discovery.

Answer: Friedrich Wöhler; biochemistry

5) Melvin Calvin used \_\_\_\_\_\_\_\_, a specific \_\_\_\_\_\_\_\_, to deduce the Calvin-Benson cycle of photosynthesis.

Answer: 14C; radioisotope

6) 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.

Answer: ultracentrifuge; Theodor Svedberg

7) Around 1914, \_\_\_\_\_\_\_\_ determined that DNA was an important component in \_\_\_\_\_\_\_\_ by using a staining technique that is still in use today.

Answer: Robert Feulgen; chromosomes

8) 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.

Answer: ultramicrotome

9) In 1880, Walther Flemming identified \_\_\_\_\_\_\_\_, threadlike bodies seen in dividing cells.

Answer: chromosomes

10) The \_\_\_\_\_\_\_\_ was developed in the late 1920s by Theodore Svedberg. He originally used it to determine the sedimentation rate of proteins.

Answer: ultracentrifuge

11) \_\_\_\_\_\_\_\_ is a biochemical technique that allows one to separate biological molecules based on size, shape, and/or affinity for specific molecules or functional groups.

Answer: Chromatography

12) The total protein content of the cell is called the \_\_\_\_\_\_\_\_.

Answer: proteome

13) \_\_\_\_\_\_\_\_ is the ability to distinguish two objects that are close together as separate. When using a light microscope, this ability is determined by \_\_\_\_\_\_\_\_.

Answer: Resolution; lambda (λ, or wavelength)

Inquiry

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?

a. 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."

b. I was the Curator of Instruments for the Royal Society of London in 1665. I developed a crude microscope that could magnify around 30-fold. I examined plant material and observed many small chambers that I called *cellulae*.

c. At the University of California, Berkeley, I worked with radioisotopes. In the late 1940s and early 1950s, I used carbon-14 to identify the most common pathway for photosynthetic carbon metabolism.

d. We worked out the double helix model of DNA structure in 1953. We later received the Nobel Prize for this work.

e. 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.

f. My colleague and I worked with bacterial viruses. We were able to demonstrate that DNA–not protein–was the genetic material of the cell.

g. I am a Swedish scientist. I developed the ultracentrifuge to determine sedimentation rates of proteins. The ultracentrifuge was later used to isolate subcellular fractions.

Answer:

a. Antonie van Leeuwenhoek

b. Robert Hooke

c. Melvin Calvin

d. James Watson and Francis Crick

e. Friedrich Wöhler

f. Alfred Hershey and Martha Chase

g. Theodor Svedberg

2) 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.

Answer: (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

3) 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 situation below?

a. A cell biologist wishes to visualize the ribosomes of a cell.

b. A bacteriologist wishes to examine the motility of a bacterium.

c. An immunologist wishes to determine if a lymphocyte possesses a certain surface protein.

d. A virologist is trying to determine the three-dimensional shape of a virus.

e. A pathologist is trying to examine the cytoplasm of a cell for changes that result from viral infection.

Answer: (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.

4) You have identified a new cytokine associated with the immune system that drastically reduces cell division by lymphoma 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.

Answer: 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.

5) You have been a sample of *Mimivirus*, which has the largest capsid diameter of all currently known viruses (600 nm) and is hexagon shaped (icosahedral). Based on your knowledge of microscopes, what would you be able to see/determine about mimiviral structure using each of the following microscopes?

a. simple compound (light) microscope

b. fluorescent microscope using fluorescently labeled antibodies to a novel capsid protein

c. magnetic resonance force microscope

Answer:

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. Magnetic resonance microscope: would allow imaging of the various macromolecules of the nucleus and capsid