

ESSENTIAL CELL BIOLOGY, 5th EDITION CHAPTER 1: CELLS: THE FUNDAMENTAL UNITS OF LIFE

Unity and Diversity of Cells

1-1 Living systems are incredibly diverse in size, shape, environment, and behavior. It is estimated that there are between 10 million and 100 million different species. Despite this wide variety of organisms, it remains difficult to define what it means to say something is alive. Which of the following can be described as the smallest living unit?

- (a) DNA
- (b) cell
- (c) organelle
- (d) protein

1-2 Indicate whether the following statements are *true* or *false*. If the statement is false, explain why it is false.

- A. The *Paramecium* is a multicellular microorganism covered with hairlike cilia.
- B. Cells of different types can have different chemical requirements.
- C. The branchlike extensions that sprout from a single nerve cell in a mammalian brain can extend over several hundred micrometers.

1-3 For each of the following sentences, fill in the blanks with the best word or phrase selected from the list below. Not all words or phrases will be used; each word or phrase should be used only once.

Cells can be very diverse: superficially, they come in various sizes, ranging from bacterial cells such as *Lactobacillus*, which is a few _____ in length, to larger cells such as a frog's egg, which has a diameter of about one _____. Despite the diversity, cells resemble each other to an astonishing degree in their chemistry. For example, the same 20 _____ are used to make proteins. Similarly, the genetic information of all cells is stored in their _____. Although _____ contain the same types of molecules as cells, their inability to reproduce themselves by their own efforts means that they are not considered living matter.

amino acids micrometer(s) viruses
DNA millimeter(s) yeast
fatty acids plants
meter plasma membranes

1-4 How does cellular specialization serve multicellular organisms and how might a high degree of specialization be detrimental?

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1-5 The flow of genetic information is controlled by a series of biochemical reactions that result in the production of proteins, each with its own specific order of amino acids. Choose the correct series of biochemical reactions from the options presented here.

- (a) replication, transcription, translation
- (b) replication, translation, transcription
- (c) translation, transcription, replication
- (d) translation, replication, transcription

1-6 Proteins are important architectural and catalytic components within the cell, helping to determine its chemistry, its shape, and its ability to respond to changes in the environment. Remarkably, all of the different proteins in a cell are made from the same 20 _____. By linking them in different sequences, the cell can make protein molecules with different conformations and surface chemistries, and therefore different functions.

- (a) nucleotides.
- (b) sugars.
- (c) amino acids.
- (d) fatty acids.

1-7 Which statement is NOT true about mutations?

- (a) A mutation is a change in the DNA that can generate offspring less fit for survival than their parents.
- (b) A mutation can be a result of imperfect DNA duplication.
- (c) A mutation is a result of sexual reproduction.
- (d) A mutation is a change in the DNA that can generate offspring that are as fit for survival as their parents are.

1-8 Changes in DNA sequence from one generation to the next may result in offspring that are altered in fitness compared with their parents. The process of change and selection over the course of many generations is the basis of _____.

- (a) mutation.
- (b) evolution.
- (c) heredity.
- (d) reproduction.

1-9 Select the option that *best* finishes the following statement: “Evolution is a process _____.”

- (a) that can be understood based on the principles of mutation and selection.
- (b) that results from repeated cycles of adaptation over billions of years.
- (c) by which all present-day cells arose from 4–5 different ancestral cells.
- (d) that requires hundreds of thousands of years.

1-10 Select the option that correctly finishes the following statement: “A cell’s genome _____.”

(a) is defined as all the genes being used to make protein.

(b) contains all of a cell’s DNA.

- (c) constantly changes, depending upon the cell's environment.
- (d) is altered during embryonic development.

Cells Under the Microscope

1-11 Which statement is NOT true about the events/conclusions from studies during the mid-1800s surrounding the discovery of cells?

- (a) Cells came to be known as the smallest universal building block of living organisms.
- (b) Scientists came to the conclusion that new cells can form spontaneously from the remnants of ruptured cells.
- (c) Light microscopy was essential in demonstrating the commonalities between plant and animal tissues.
- (d) New cells arise from the growth and division of previously existing cells.

1-12 What unit of length would you generally use to measure atypical plant or animal cell?

- (a) centimeters
- (b) nanometers
- (c) millimeters
- (d) micrometers

1-13 Match the type of microscopy on the left with the corresponding description provided below. There is one best match for each.

- A. confocal
- B. transmission electron
- C. fluorescence
- D. phase-contrast
- E. scanning electron
- F. bright-field

_____ uses a light microscope with an optical component to take advantage of the different refractive indices of light passing through different regions of the cell.

_____ employs a light microscope and requires that samples be fixed and stained in order to reveal cellular details.

_____ requires the use of two sets of filters. The first filter narrows the wavelength range that reaches the specimen and the second blocks out all wavelengths that pass back up to the eyepiece except for those emitted by the dye in the sample.

_____ scans the specimen with a focused laser beam to obtain a series of two-dimensional optical sections, which can be used to reconstruct an image of the specimen in three dimensions. The laser excites a fluorescent dye molecule, and the emitted light from each illuminated point is captured through a pinhole and recorded by a detector.

_____ has the ability to resolve cellular components as small as 2 nm.

_____ requires coating the sample with a thin layer of a heavy metal to produce three-dimensional images of the surface of a sample.

1-14 Indicate whether the following statements are *true* or *false*. If the statement is false, explain why it is false.

- A. The nucleus of an animal cell is round, small, and difficult to distinguish using light microscopy.
- B. The presence of the plasma membrane can be inferred by the well-defined boundary of the cell.
- C. The cytosol is fairly empty, containing a limited number of organelles, which allows room for rapid movement via diffusion.

1-15 Cell biologists employ targeted fluorescent dyes or modified fluorescent proteins in both standard fluorescence microscopy and confocal microscopy to observe specific details in the cell. Even though fluorescence permits better visualization, the resolving power is essentially the same as that of a standard light microscope because the resolving power of a microscope is limited by the _____ of light.

- (a) absorption
- (b) intensity
- (c) filtering
- (d) wavelength

1-16 What is the smallest distance two points can be separated and still resolved using light microscopy?

- (a) 20 nm
- (b) 0.2 μm
- (c) 2 μm
- (d) 200 μm

The Prokaryotic Cell

1-17 By definition, prokaryotic cells do not possess _____.

- (a) a nucleus.
- (b) replication machinery.
- (c) ribosomes.
- (d) membrane bilayers.

1-18 Although there are many distinct prokaryotic species, most have a small range of shapes, sizes, and growth rates. Which of the following characteristics are *not* observed in prokaryotes?

- (a) a highly structured cytoplasm
- (b) endoplasmic reticulum
- (c) the ability to divide rapidly
- (d) a cell wall

1-19 Indicate whether the following statements are *true* or *false*. If the statement is false,

explain why it is false.

A. The terms “prokaryote” and “bacterium” are synonyms.

B. Prokaryotes can adopt several different basic shapes, including spherical, rod-shaped, and spiral.

C. Some prokaryotes have cell walls surrounding the plasma membrane.

- 1-20** Prokaryotic cells are able to evolve very fast, which helps them to rapidly adapt to new food sources and develop resistance to antibiotics. Which of the options below lists the three main characteristics that support the rapid evolution of prokaryotic populations?
- (a) microscopic, motile, anaerobic
 - (b) aerobic, motile, rapid growth
 - (c) no organelles, cell wall, can exchange DNA
 - (d) large population, rapid growth, can exchange DNA

1-21 Indicate whether the following statements are *true* or *false*. If the statement is false, explain why it is false.

A. Oxygen is toxic to certain prokaryotic organisms.

B. Mitochondria are thought to have evolved from anaerobic bacteria.

C.

Photosynthetic bacteria contain chloroplasts.

- 1-22** Some prokaryotes can live by utilizing entirely inorganic materials. Which of the following inorganic molecules would you predict to be the predominant building block for fats, sugars, and proteins?
- (a) O₂
 - (b) N₂
 - (c) CO₂
 - (d) H₂

The Eukaryotic Cell

- 1-23** Use the list of structures below to label the schematic drawing of an animal cell in Figure Q1-23.

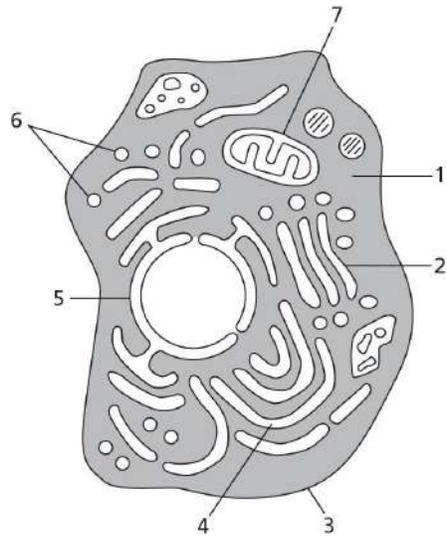


Figure Q1-23