1. Consider some questions about cell structure or function that you would be interested in answering. Would the data required to answer the question be easier to collect by working on an entire plant or animal or on a population of cultured cells? What might be the advantages and disadvantages of working on a whole organism versus a cell culture?

Ans: The specific answer would depend on the question asked. Advantages of working with a cell culture include the ability to study a single cell type, ease of obtaining large numbers of cells, ability to minimize number of unknown variables by using carefully controlled in vitro conditions. The advantage of using a whole organism is that information obtained is more meaningful in understanding the role of the process in the overall activity of the organism. For example, one might want to study glucose transport across the plasma membrane of cultured liver cells in response to insulin, but the results would not tell you much about the role of this process in maintaining proper blood glucose levels.

Difficulty: Difficult
Section Reference:
1.2

2. Figure 1.3 shows an intestinal epithelial cell with large numbers of microvilli. What is the advantage to the organism of having these microvilli? What do you expect would happen to an individual that lacked such microvilli as the result of an inherited mutation?

Ans: They greatly increase the surface area/volume ratio of the cell, allowing much greater exchange between the cell and the lumen of the intestine. Would be unable to absorb sufficient nutrients from the lumen to survive.

Difficulty: Medium
Section Reference:
1.2

3. The first human cells to be successfully cultured were derived from a malignant tumor. Do you think this simply reflects the availability of cancer cells, or might such cells be better subjects for cell culture? Why?

Ans: Cancer cells grow in a much less controlled manner than normal cells, which is why they continue to proliferate in the body. Cancer cells tend to have fewer requirements for growth and are therefore more readily cultured in diverse media than normal cells. Culturing such cells was a logical first step in the development of culture conditions.

Difficulty: Difficult
Section Reference:
1.2

4. The drawings of plant and animal cells in Figure 1.8*b,c* include certain structures that are present in plant cells but absent in animal cells. How do you think each of these structures affects the life of the plant?

Ans: A major difference between plant and animal cells is the presence of chloroplasts and their associated light harvesting molecules which allow plants to convert light energy to ATP. Plant cells also typically have large vacuoles that consist of fused membrane bound organelles. In plants, vacuoles are often filled with water and help maintain hydrostatic pressure or turgor.

Difficulty: Difficult
Section Reference:
1.3

5. It was noted that cells possess receptors on their surface that allow them to respond to specific stimuli. Many cells in the human body possess receptors that allow them to bind specific hormones that circulate in the blood. Why do you think these hormone receptors are important? What would be the effect on the physiological activities of the body if cells lacked these receptors, or if all cells had the same receptors?

Ans: These receptors mark specific cells as targets for particular hormones. Without such receptors, cells would not be able to bind a specific hormone and thus would not be able to respond to it. If all cells had the same receptors, hormones would not be able to selectively activate specific target cells. All cells would become potential targets.

Difficulty: Easy
Section Reference:
1.2

6. If you were to argue that viruses are living organisms, what features of viral structure and function might you use in your argument?

Ans: That viruses contain genetic material; that they are capable of producing more of themselves, albeit only inside a host cell; that they contain complex biological macromolecules; that they evolve. These are all important criteria of living organisms.

Difficulty: Difficult
Section Reference:
1.8

7. If we presume that activities within cells do occur in a manner analogous to that shown in the Rube Goldberg cartoon of Figure 1.7, how would this differ from a human activity, such as building a car on an assembly line or shooting a free throw in a basketball game?

Ans: Activities in cells are not directed by agents with a conscious, purposeful goal. Activities that occur in a cell must be directed and regulated by mechanisms operating within the system.

Difficulty: Difficult
Section Reference:
1.2

8. Unlike bacterial cells, the nucleus of a eukaryotic cell is bounded by a double-layered membrane studded by complex pores. How do you think this might affect traffic between the DNA and cytoplasm of a eukaryotic cell compared to that of a prokaryotic cell?

Ans: The nuclear envelope that separates the nucleus and cytoplasm in a eukaryotic cell provides the basis for regulating the movement of substances between the two compartments. The DNA of a bacterial cell is presumably much more accessible to cytoplasmic substances than that of a eukaryotic cell.

Difficulty: Easy
Section Reference:
1.3

9. Examine the photograph of the ciliated protist in Figure 1.16 and consider some of the activities in which this cell engages that a muscle or nerve cell in your body does not.

Ans: Such as, the capture and uptake of other organisms, the sensing of conditions in the external environment and making the appropriate responses, the ability for locomotion. Most activities of this cell are shared by a muscle or nerve cell.

Difficulty: Difficult
Section Reference:
1.5

10. Which type of cell would you expect to achieve the largest volume: a highly flattened cell or a spherical cell? Why?

Ans: A highly flattened cell because it will have a much greater surface area/volume ratio.

Difficulty: Medium
Section Reference:
1.3

11. Suppose you were a scientist living in the 1890s and were studying a disease of tobacco crops that stunted the growth of the plants and mottled their leaves. You find that the sap from a diseased plant, when added to a healthy plant, is capable of transmitting the disease, to that plant.You examine the sap in the best light microscopes of the period and see no evidence of bacteria. You force the sap through filters whose pores are so small that they retard the passage of the smallest known bacteria, yet the fluid that passes through the filters is still able to transmit the disease. Like Dimitri Ivanovsky, who conducted these experiments more than a hundred years ago, you would probably conclude that the infectious agent was an unknown type of unusually small bacterium.What kinds of experiments might you perform today to test this hypothesis?

Ans: You could examine the filtrate under the electron microscope and determine whether the infectious agent was cellular, i.e., bacterial, or noncellular, i.e., viral. You could try to culture the infective agent. If it was a bacterium, you should be able to culture the agent in the absence of host cells, but not so if it were a virus. You could determine the size of the genome (i.e., the RNA or DNA that constituted its genetic material). If it was cellular, it would be expected to have a much larger genome than if it was viral.

Difficulty: Difficult
Section Reference:
1.8

12. Most evolutionary biologists believe that all mitochondria have evolved from a single ancestral mitochondrion and all chloroplasts have evolved from a single ancestral chloroplast.
In other words, the symbiotic event that gave rise to each of these organelles occurred only once. If this is the case, where on the phylogenetic tree of Figure 3, page 27, would you place the acquisition of each of these organelles?

Ans: Mitochondria would have been acquired somewhere along the line connecting the branch to Archaea and the line leading to the diplomonads. Chloroplasts would have been acquired along the short line leading to plants (which in this tree also includes green algae).

Difficulty: Difficult
Section Reference:
1.9

13. Publication of the complete sequence of the 1918 flu virus and reconstitution of active viral particles was met with great controversy. Those who favored publication of the work argued that this type of information can help to better understand the virulence of influenza viruses and help develop better therapeutics against them. Those opposed to its publication argued that the virus could be reconstituted by bioterrorists or that another pandemic could be created by the accidental release of the virus by a careless investigator. What is your opinion on the merits of conducting this type of work?

Ans: Answers will vary.

Difficulty: Medium
Section Reference:
1.8