## **Chapter 6: Tour of the Cell**

### 5. Which two domains consist of prokaryotic cells?

Organisms of the domains Bacteria and Archaea consist of prokaryotic cells. Protists, fungi, animals, and plants all consist of eukaryotic cells.

6. Describe the major difference in the location of DNA between prokaryotic and eukaryotic cells.

In a eukaryote, most of the DNA is in the nucleus, which is enclosed in a double membrane. In a prokaryote, DNA is concentrated in the nucleoid, which is not enclosed in a membrane.

## 7. Label each of these features of a prokaryotic cell.

The cell wall is a rigid structure outside the plasma membrane made of cellulose, other polysaccharides, and protein that maintains the cell's shape and protects the cell from mechanical damage. The plasma membrane is a membrane enclosing the cytoplasm that functions as a selective barrier, allowing passage of enough oxygen, nutrients, and wastes to service the entire cell. Bacterial chromosomes within the nucleoid carry the genetic information. The nucleoid is the region (not enclosed by a membrane) where the cell's DNA is located. The cytoplasm is the interior of the cell, consisting of a semifluid, gelatinous substance called cytosol, in which subcellular components are suspended. The flagella serve as the locomotion organelles of some bacteria.

#### 8. Why are cells so small?

As a cell decreases in size, its volume grows proportionally greater than its surface area. Thus, a smaller object has a larger surface area to volume ratio. The need for a surface area sufficiently large to accommodate the volume helps explain the microscopic size of most cells. A sufficiently high ratio of surface area to volume is especially important in cells that exchange a lot of material with their surroundings.

9. Describe in what way many neurons and intestinal cells have increased their surface area.

Nerve cells have narrow, elongated shapes. Intestinal cells may have many long, thin projections from their surface called *microvilli*, which increase surface area without an appreciable increase in volume.

10. Label the nuclear envelope, nuclear pores, and pore complex of the eukaryotic cell. 🖋

The double-membraned nuclear envelope encloses the nucleus, separating its contents from the cytoplasm, and is perforated by tiny pore structures. At the lip of each pore, the inner and outer membranes of the nuclear envelope are continuous. The pore complex, an intricate protein structure, lines each pore and plays an important role in the cell by regulating the entry and exit of proteins and RNAs, as well as large complexes of macromolecules.

#### 11. Describe the nuclear envelope.

The nuclear envelope separates the nucleus from the cytoplasm. It has two layers connected by the nuclear lamina, a netlike array of protein filaments.

## 12. What are the nuclear lamina and the nuclear matrix?

The nuclear lamina is a netlike array of protein filaments that maintains the shape of the nucleus by mechanically supporting the nuclear envelope. There is much evidence for a nuclear matrix, a framework of protein fibers extending throughout the nuclear interior. These may help organize the genetic material so it functions efficiently.

13. Chromosomes, consisting of chromatin, are found within the nucleus.

The components of chromatin are protein, DNA and RNA. The thin chromatin fibers condense to become distinct chromosomes by coiling enough to be distinguishable as separate structures, when the cell prepares to divide.

#### 14. When are the nucleoli visible?

Nucleoli are visible when stained. Ribosomal RNA (rRNA) is assembled here from instructions in the DNA.

#### 15. What is the function of ribosomes?

Ribosomes are the cellular components that carry out protein synthesis. Their two components, protein and RNA, are arranged as a large subunit atop a small subunit.

#### 16. Compare the two types of ribosomes.

Type of Ribosome	Where found	Protein product made
Free ribosomes	suspended in cytosol	proteins functioning within cytosol
Bound ribosomes	attached to outside of ER or nuclear envelope	proteins destined for insertion into membranes, packaging, or export

#### 17. List all the structures of the endomembrane system.

The endomembrane system includes the nuclear envelope, the endoplasmic reticulum, the Golgi apparatus, lysosomes, various kinds of vesicles and vacuoles, and the plasma membrane.

#### 18. Label the lumen, transport vesicles, and smooth and rough ER.

The lumen is the cisternal space of the ER, which is continuous with the space between the two membranes of the nuclear membrane, as the ER membrane is continuous within the nuclear envelope. Transport vesicles are in transit from one part of the cell to another. The surface of rough ER is studded with ribosomes, while smooth ER is not.

## 19. Describe three major functions of the smooth ER.

The smooth ER functions in diverse metabolic processes, which vary with cell type. These processes include synthesis of lipids, metabolism of carbohydrates, detoxification of drugs and poisons, and storage of calcium ions.

20. Why does alcohol abuse increase tolerance to other drugs, such as barbiturates?

Alcohol and many other drugs induce the proliferation of smooth ER and its associated detoxification enzymes, thus increasing the rate of detoxification.

21. As proteins are synthesized, they are threaded into the lumen of the rough ER. Some have carbohydrates attached to them in the ER to form glycoproteins. What does the ER do with these secretory proteins?

After secretory proteins are formed, the ER membrane keeps them separate from proteins that are produced by free ribosomes and will remain in the cytosol, instead transporting them out of the transitional ER wrapped in the membranes of vesicles.

- 22. Besides packaging secretory proteins into transport vesicles, what is another major function of the rough ER? Rough ER is also a membrane factory for the cell; it grows in place by adding membrane proteins and phospholipids to its own membrane.
- 23. The transport vesicles formed from the rough ER fuse with the Golgi apparatus. Label the cisterna of the Golgi apparatus, and its cis and trans faces.

Vesicles coalesce to form new *cis* Golgi cisternae (1-2). By cisternal maturation, Golgi cisternae move in a *cis* to *trans* direction. Products of the ER are usually modified during their transit from the *cis* region to the *trans* region of the Golgi apparatus. Then, vesicles form and leave Golgi (3), carrying specific products to other locations or to the plasma

membrane for secretion. Vesicles also transport some proteins backward to their site of function, such as less mature Golgi cisternae (4) or the ER (5).

#### 24. What is a lysosome?

Lysosomes contain hydrolytic (degradative) enzymes. They are highly acidic, so their pH is very low.

## 25. One function of lysosomes is intracellular digestion of particles engulfed by phagocytosis.

In phagocytosis, a food vacuole (formed when amoebas and many other protists engulf smaller organisms or food particles) fuses with a lysosome, whose enzymes digest the food. Digestion products, including simple sugars, amino acids, and other monomers, pass into the cytosol and become nutrients for the cell. Human cells such as macrophages, a type of white blood cell that helps defend the body by engulfing and destroying pathogens, also carry out phagocytosis.

## 26. A second function of lysosomes is to recycle cellular components in a process called autophagy.

During autophagy, a damaged organelle or small amount of cytosol becomes surrounded by a double membrane (of unknown origin), and a lysosome fuses with the outer membrane of this vesicle. The lysosomal enzymes dismantle the enclosed material, and the organic monomers are returned to the cytosol for reuse.

## 27. What happens in Tay-Sachs disease?

In Tay-Sachs disease, a lipid-digesting enzyme is missing or inactive, and the brain becomes impaired by an accumulation of lipids in the cells.

#### 28. Briefly describe the different types of vacuoles.

Food vacuoles, formed by phagocytosis, fuse with lysosomes, whose enzymes digest food. Contractile vacuoles pump excess water out of the cell, thereby maintaining a suitable concentration of ions and molecules inside the cell. Mature plant cells generally contain a large central vacuole, which develops by the coalescence of smaller vacuoles. The cell sap solution inside the central vacuole is the planet cell's main repository of inorganic ions, including potassium and chloride. The central vacuole plays a major role in the growth of plant cells.

# 29. Explain how the elements of the endomembrane system function together to secrete a protein and to digest a cellular component.

The nuclear envelope is connected to the rough ER, which is connected to the smooth ER. Proteins produced by the ER are brought to the Golgi apparatus in transport vesicles, where they become specialized vesicles, such as lysosomes, or vacuoles. Lysosomes are available for fusion with another vesicle in order to aid in cell digestion. Transport vesicles carry proteins to the plasma membrane for secretion. The plasma membrane expands by fusion of vesicles, allowing the proteins to be secreted from the cell.

## 32. What is the function of mitochondria?

Mitochondria (which are not considered part of the endomembrane system, although they are enclosed by membranes) are the sites of cellular respiration.

#### 33. What is the function of chloroplasts?

Chloroplasts (which are not considered part of the endomembrane system, although they are enclosed by membranes), found in plants and algae, are the sites of photosynthesis.

## 34. Recall the relationship of structure to function.

The many folds in the inner membrane of mitochondria and the many individual thylakoid membranes serve to increase the organelle's surface area without greatly increasing its volume. Chloroplasts and mitochondria, semiautonomous organelles that grow and reproduce within the cell, both have ribosomes and their own DNA.

## 35. Explain the important role of peroxisomes.

Peroxisomes are specialized metabolic compartments bound by a single membrane that contain enzymes which remove hydrogen atoms from various substrates and transfer them to oxygen, thus producing hydrogen peroxide as a by-product. Peroxisomes in the liver detoxify alcohol and other harmful compounds. The enzymes that produce hydrogen peroxide and those that dispose of this toxic compound are sequestered away from other cellular components that could be damaged.