LAB EXERCISE 4

Cell Anatomy

The cell is often considered the basic unit of living organisms. Actually, cells are only one of several *levels of organization* in the human organism:

ATOMS

MOLECULES

ORGANELLES

CELLS

TISSUES

ORGANS

ORGAN SYSTEMS

ORGANISM

Thus cells are parts of larger units (tissues and organs) and are composed of smaller units (organelles).

For now, we will concentrate on the structure and function of the cell and its organelles. We will study some of the other levels of organization in later units.

BEFORE YOU BEGIN

- ❑ Read the appropriate chapter in your textbook.
- ❑ Set your learning goals. When you finish this exercise, you should be able to:
  - ❑ place the cell and its organelles within the scheme of organizational levels
  - ❑ identify the major organelles on a model, chart, specimen, or micrograph
  - ❑ describe primary function(s) of typical organelles
  - ❑ discuss the anatomical relationship among various cell parts
- ❑ Prepare your materials:
  - ❑ cell model or chart
  - ❑ compound light microscope
  - ❑ clean slides
  - ❑ coverslips
  - ❑ paper wipes
  - ❑ methylene blue stain
  - ❑ colored pencils or pens
  - ❑ prepared slides (instructor's option)
- ❑ Read the directions and safety tips for this exercise *carefully* before starting any procedure.

A. PARTS OF THE CELL

Cells are microscopic units composed of a bubble of fatty material filled with a water-based mixture of molecules and tiny particles. Parts of the cell are called **organelles** (meaning *small organs*). Begin your study of the cell by examining a *generalized* cell, such as that in the coloring exercise in Figure 4-1. A generalized cell is one with many cell features that are not all found in a single natural cell. Locate each of the listed organelles on a generalized cell model or chart.

❑ 1 The outer boundary of the cell is the **plasma membrane.** It is composed of a double layer (or *bilayer*) of **phospholipid** molecules imbedded with other molecules. Each phospholipid molecule has a polar, hydrophilic ("water loving") *head* made up of phosphate and glycerol; and a nonpolar, hydrophobic ("water fearing") *tail* made up of two fatty acid chains. Imbedded in the membrane are **integral proteins,** which may have additional protein molecules called **peripheral proteins** attached to them on one side of the membrane or the other. Figure 4-2 shows some of the types of molecules often associated with the plasma membrane. The plasma membrane has many functions, most involving transport and communication between the inside and outside of the cell.

HINT

Each membranous organelle described in the following is made of a lipid membrane similar to the cell membrane. Because they are so thin, cell membranes may seem invisible when observed with a light microscope.

❑ 2 The double-walled **nucleus** is a large bubble containing the cell's genetic code. The code is in the form of **deoxyribonucleic acid (DNA)** strands called **chromatin.** Portions of chromatin accept stains readily, giving the nucleus a very dark appearance.

❑ 3 A **nucleolus** (literally, *tiny nucleus*) is a small area within the nucleus for the synthesis of ribosomal **ribonucleic acid (RNA).** There may be more than one nucleolus (plural *nucleoli*) in a nucleus.

❑ 4 The **endoplasmic reticulum (ER)** is a network of membranous tubes and canals winding through the interior of the cell. A *rough ER* is speckled with tiny granules (ribosomes); a *smooth ER* is not. The ER transports proteins synthesized by ribosomes and other molecules synthesized within its membrane. The ER also manufactures molecules that make up cellular membranes.

❑ 5 The material within the plasma membrane is the **cytoplasm** (literally, *cell stuff*) and includes both the organelles and the liquid, or **cytosol,** surrounding the organelles.

❑ 6 **Ribosomes** are tiny bodies that serve as a site for protein synthesis. Some ribosomes are found on the outer surface of the ER, and some are found scattered elsewhere within the cell.

❑ 7 The **Golgi apparatus,** or *Golgi body*, appears as a stack of flattened sacs. The apparatus receives material from the ER, processes it, then packages it in tiny *vesicles* (bubbles) for possible export from the cell.

❑ 8 **Mitochondria** (singular *mitochondrion*) are tiny bodies similar to bacteria that serve as sites for adenosine triphosphate (ATP) synthesis (energy conversion). Mitochondria have an outer membrane, forming a round or oblong capsule, and a folded inner membrane. The folds of the inner membrane are called **cristae.**

❑ 9 **Lysosomes** are vesicles containing digestive enzymes that digest foreign particles and worn cell parts.

❑ 10 **Microtubules** are very tiny, hollow beams that form part of the supporting cell skeleton, or *cytoskeleton*. They also form parts of other cell organelles (e.g., *flagella, cilia, centrioles,* and *spindle fibers*). Other components of the cytoskeleton include **microfilaments** and **intermediate filaments.**

❑ 11 The **centrosome,** or *microtubule organizing center,* is a dense area of cell fluid near the nucleus. The centrosome contains a pair of **centrioles,** cylinders formed by parallel microtubules. A network of microtubules called *spindle fibers* extends from the centrosome during cell division. Spindle fibers distribute DNA equally to the resulting daughter cells.

❑ 12 The cell may have any number of other assorted organelles. **Microvilli** are tiny, fingerlike projections of the cell that increase the membrane's surface area for more efficient absorption. **Cilia** are numerous short, hairlike organelles that propel material along a cell's surface. **Flagella** are single long, hairlike organelles found in sperm cells to propel them through the female reproductive tract toward the egg. **Vesicles** are membranous bubbles that may be formed by the Golgi apparatus, or by the pinching inward of the cell membrane to engulf external substances.

B. MICROSCOPIC CELL SPECIMEN

Prepare a stained wet-mount specimen of human cheek cells (see Lab Exercise 3 for instructions) or obtain another specimen provided by the instructor; try to identify as many cell parts as possible. Use high-power magnification (after first finding the specimen with low-power magnification). Sketch and label your observations in the Lab Report.

HINT

Many organelles are very small and can only be seen when properly prepared and examined with a more powerful microscope.

C. INTERPRETING MICROGRAPHS

An **electron microscope** is an instrument that uses a beam of electrons, rather than a beam of light, to form the image of a tiny specimen. *Transmission* electron microscopes send an electron beam through the specimen, similar to the manner in which a light microscope sends a light beam through a specimen. However, the magnifying power and resolution are much greater in the electron microscope. **Resolution** is the ability to distinguish detail. *Scanning* electron microscopes, on the other hand, reflect an electron beam off the specimen. The shadows produced by a scanning electron beam lend a three-dimensional effect.

A **TEM** is a transmission electron micrograph (photograph taken with a transmission electron microscope). Figure 4-3 shows TEM representations of major cell parts. Use them to help you identify all of the cell parts in the labeling exercises in Figure 4-4, which shows artists' renderings of TEM images; and in Figure 4-5, which shows actual TEMs of human cells. This will be a worthwhile challenge to illustrate the difficulty of studying cell structure.

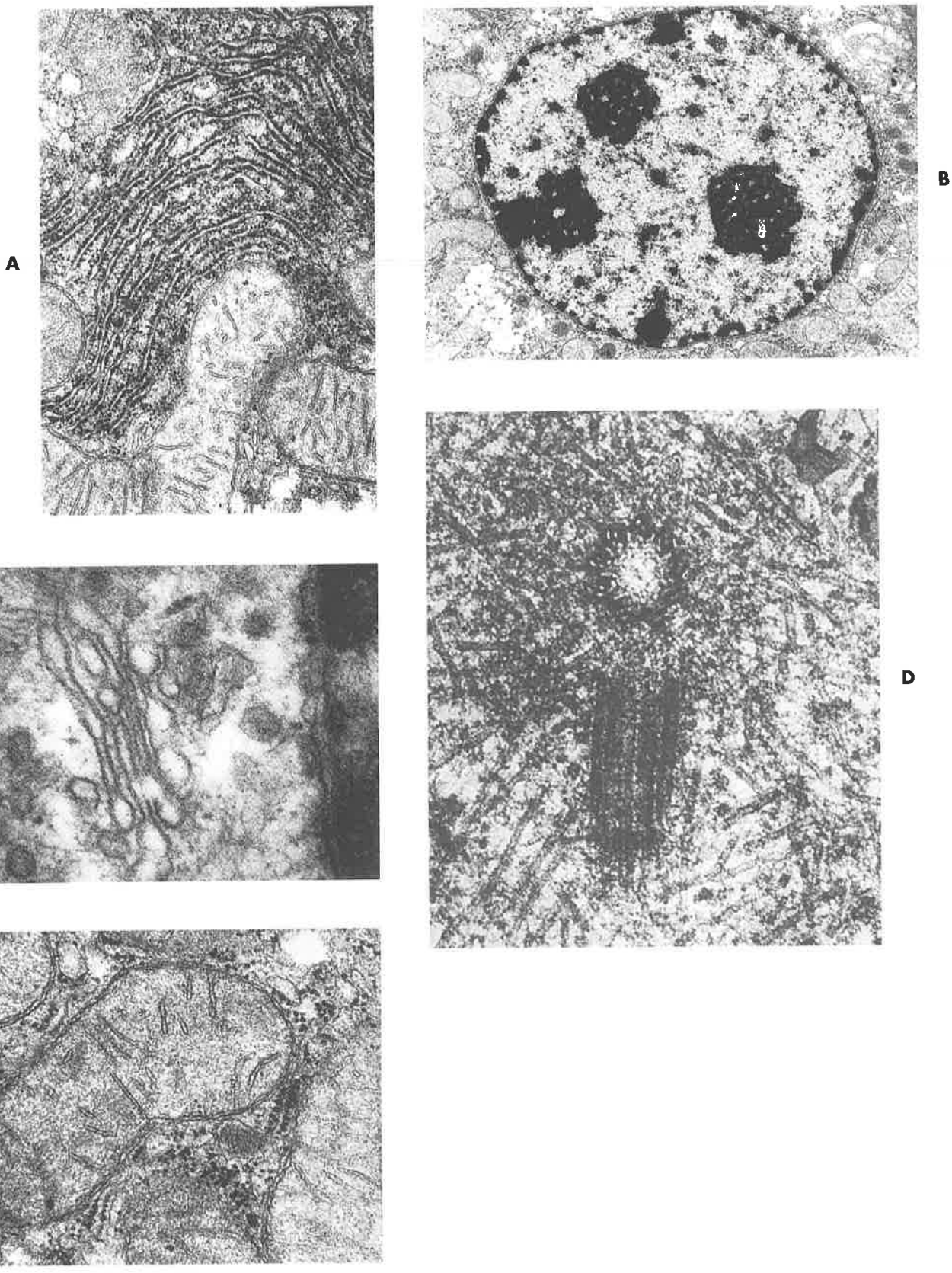


Figure 4-3 Transmission electron micrographs (TEMs) of major organelles. **A,** Rough and smooth endoplasmic reticulum (portions of several mitochondria are also visible). **B,** Nucleus with several nucleoli. **C,** Golgi apparatus. **D,** Centrosome with both centrioles visible. **E,** Mitochondrion with cristae visible.

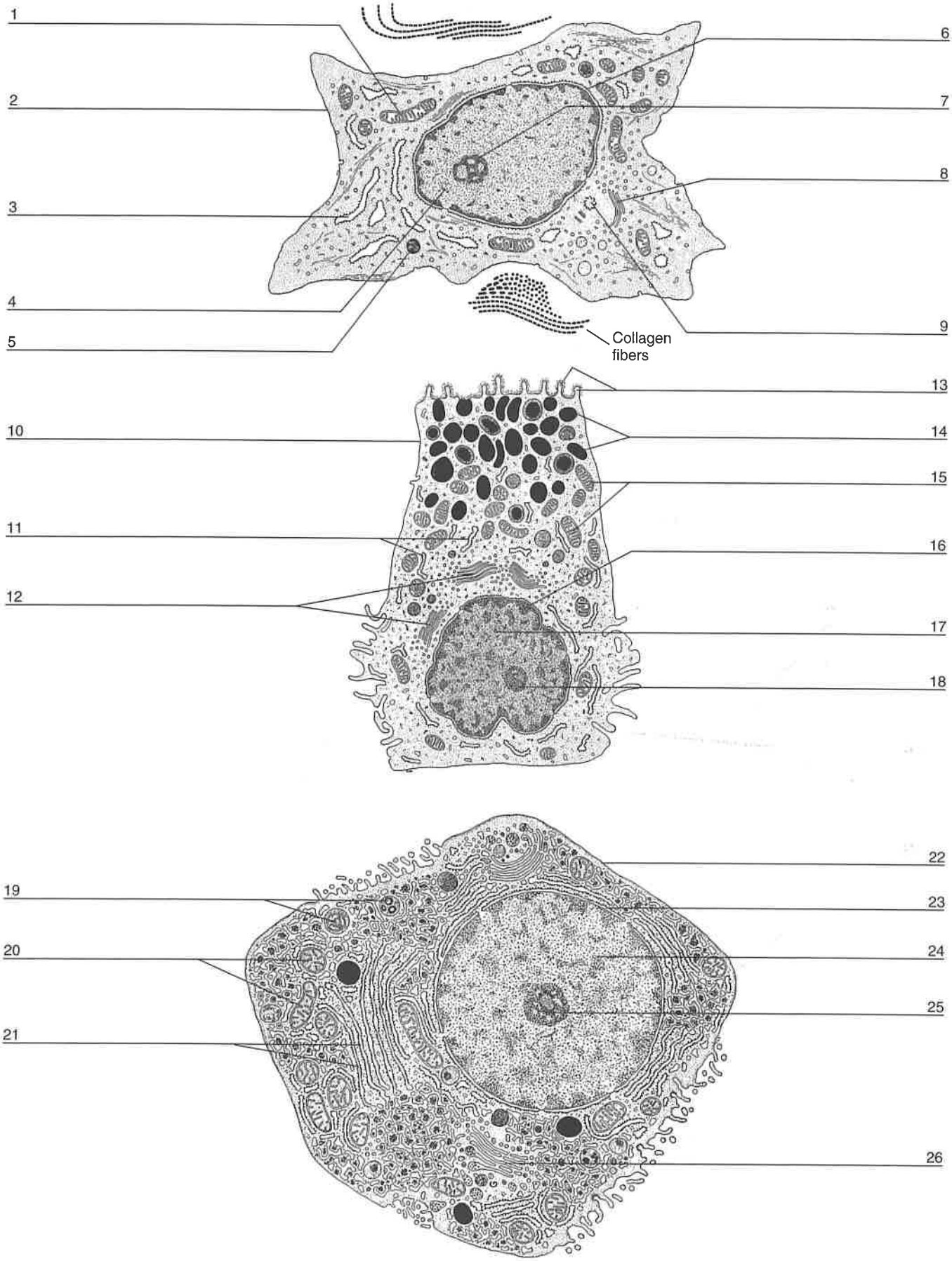


Figure 4-4 Try to identify the cell organelles labeled in these artist's renderings of TEMs; list them on the lines provided and also on the blanks in the Lab Report at the end of this exercise.

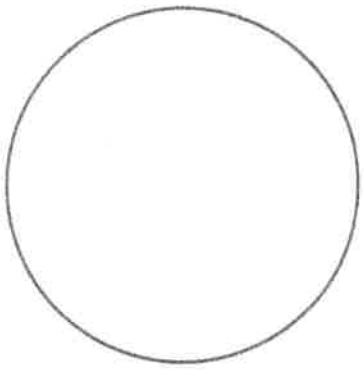
Name: _____ **Date:** _____ **Section:** _____

Lab Report 4

Cell Anatomy

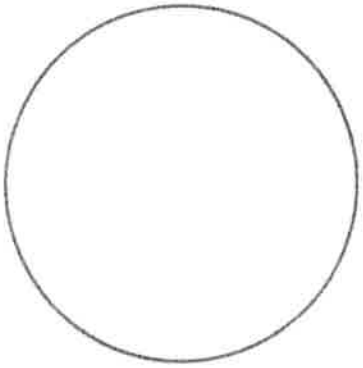
Procedure:

1. Put a drop of methylene blue on a slide. Caution: methylene blue will stain clothes and skin.
2. Gently scrape the inside of your cheek with the flat side of a toothpick. Scrape lightly.
3. Stir the end of the toothpick into the stain and throw the toothpick away.
4. To place a cover slip, touch one edge of a coverslip on the slide next to the specimen, then let it drop slowly on the specimen. This method prevents forming air bubbles.
5. Absorb any excess fluid around the edges of the coverslip with the edge of a paper towel.
6. Use the low-power objective to locate some cells.
7. Switch to medium power. Cells should be visible, but they will be small and look like nearly clear yellowish-brown blobs. If you are looking at something dark blue, it is probably not a cell.
8. Once you think you have located a cell, switch to high-power and refocus to see more detail. (Remember, use the fine adjustment knob at this point!)
9. Sketch your observations, without enlarging too much, precisely color your drawings, and label the **nucleus, nuclear envelope, plasma membrane,** and **cytoplasm.**



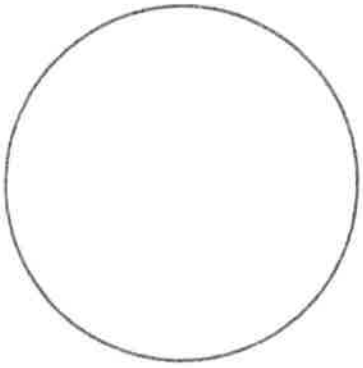
Specimen: _____

Total Magnification: ____



Specimen: _____

Total Magnification: ____



Specimen: _____

Total Magnification: ____

Figure 4-4

1. _____
2. _____
3. _____
4. _____
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24. _____
25. _____
26. _____

Matching

1. _____ 6. _____
2. _____ 7. _____
3. _____ 8. _____
4. _____ 9. _____
5. _____ 10. _____

Matching (may be used more than once or not at all)

a. plasma membrane
b. centriole
c. endoplasmic reticulum
d. Golgi apparatus
e. lysosome
f. mitochondrion
g. nucleolus
h. nucleus
i. ribosome

1. A double-walled structure containing the cell's genetic code
2. A network of membranous tubes and canals that transports proteins
3. A stack of flattened sacs that process and package proteins
4. Site of manufacture of ribosomal RNA
5. A cylinder formed by parallel microtubules
6. An organelle that serves as the site of protein synthesis
7. A bubble containing digestive enzymes
8. May be *rough* (with ribosomes) or *smooth* (ribosome-free)
9. Allows communication between the internal and external cell environment
10. Forms secretory vesicles

Fill-in Table (write out the names of the organelles listed, *a* to *i*, in the section above in the appropriate column of the table)

Membranous	Nonmembranous

Compare and Contrast (describe similarities and differences)

Describe the similarities (at least 2) between all the three specimen observed today. Then, describe some differences (at least 2) among the specimen.

COLORING EXERCISE

Use colored pens or pencils to shade in both the figure and the labels. Each red numeral in the figure corresponds to a blue numeral following the appropriate label.

The Cell

PLASMA MEMBRANE 1
CENTRIOLE 2
CENTROSOME 3
CHROMATIN 4
CYTOSOL 5
GOLGI APPARATUS 6
LYSOSOME 7
MICROVILLI 8
MITOCHONDRION 9
NUCLEAR MEMBRANE 10
NUCLEOLUS 11
NUCLEAR PORE 12
RIBOSOME 13
ROUGH ER 14
SMOOTH ER 15
VESICLE 16

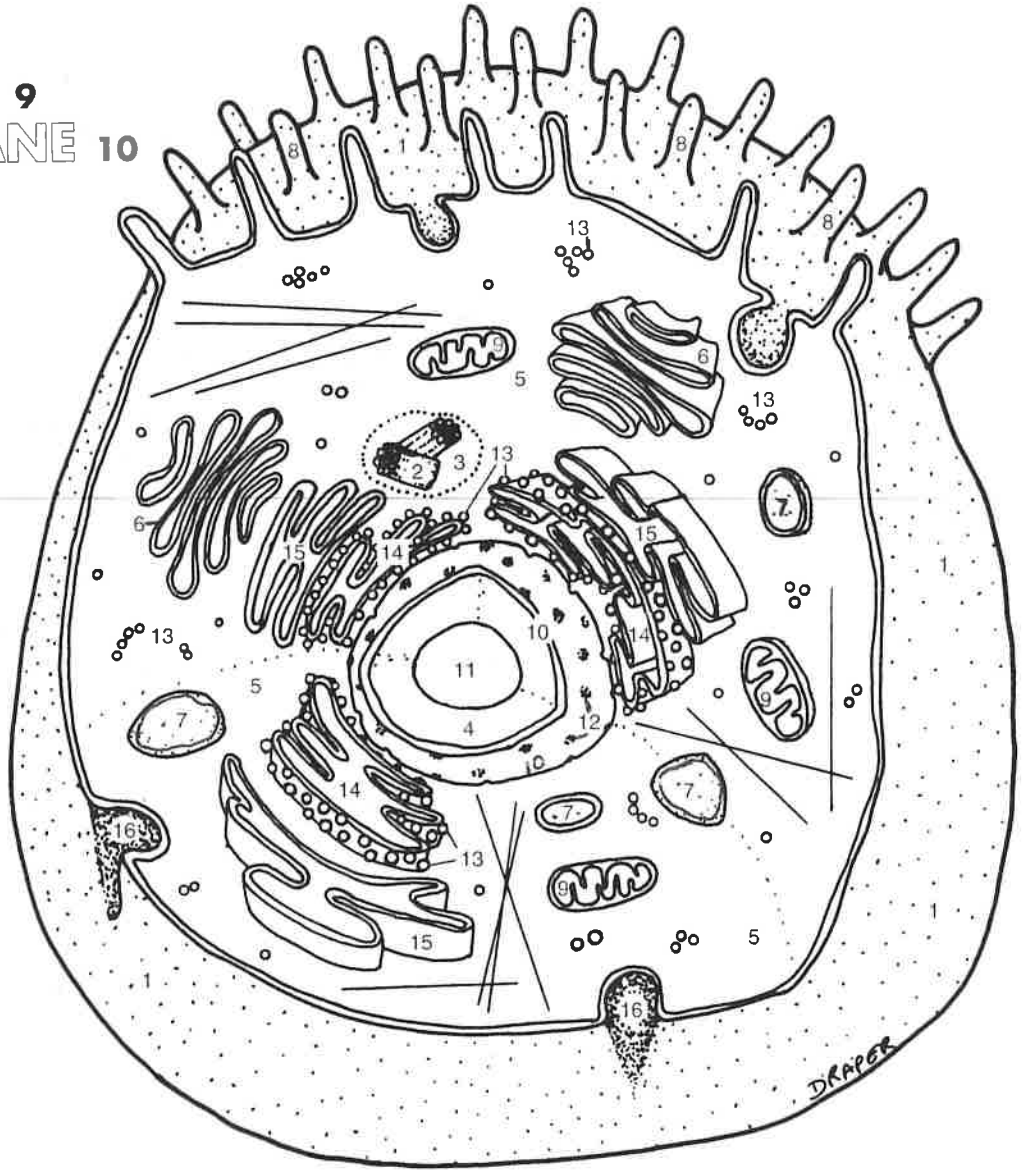

Figure 4-1

Figure 1

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____

Figure 1 - Animal Cell