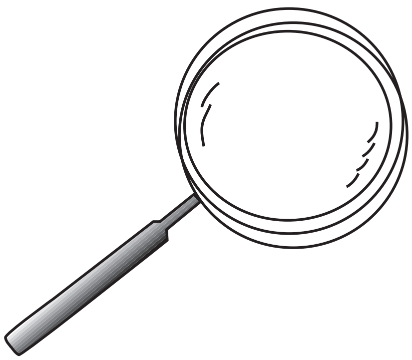
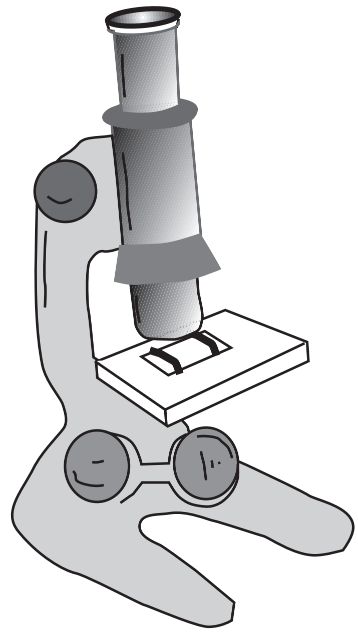
Appendix: Lesson 8

Cell Worksheet:
The Basic Unit of All Living Things is the Cell

Cells are so tiny that we cannot see them without help. Humans can see things as small as 0.001 meter across, but most cells are only about 0.00001 meter across! When the magnifying glass and microscope were invented, scientists suddenly had a whole new world to explore.





Using one of the instruments pictured, take a sample of each thing listed in the boxes, look at it, and draw what you see.

PHOTOGRAPH

HAIR

DUST

FEATHER

NEWSPAPER

What does a microscope do to help you study tiny things?

Appendix: Lesson 8

Embryology Terminology

Name ____

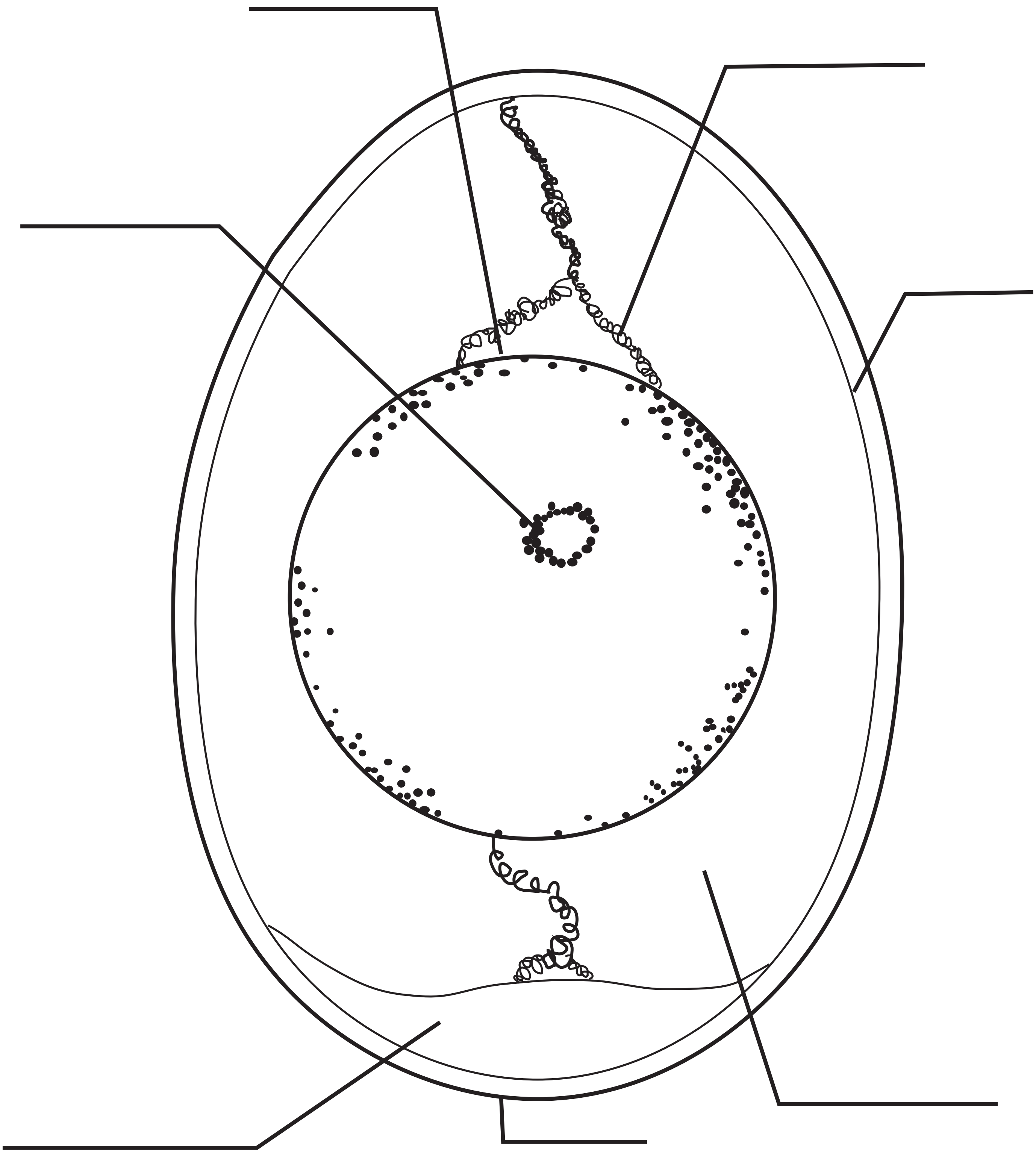
Match the terms to the definition by writing the correct letter in each eggshell.

Air Cell	**A.**	The white of an egg. This watery substance supplies the growing embryo with food and water.
Albumen	**B.**	The hard protective outer covering of an egg. This has tiny pores in it to allow the passage of air and moisture in and out of the egg.
Chalazae	**C.**	The "white spot" on the yolk where the embryo develops.
Shell	**D.**	The two twisted cords at each end of the yolk. These keep the yolk from moving about and sticking to the shell.
Yolk	**E.**	The yellow of the egg. This is the primary food source for the growing embryo.
Shell Membrane	**F.**	The pocket of air at the large end of the egg.
Germ Spot	**G.**	The two thin layers inside the egg-shell. Usually when the egg is cracked, this will stick to the shell.

Appendix: Lesson 8

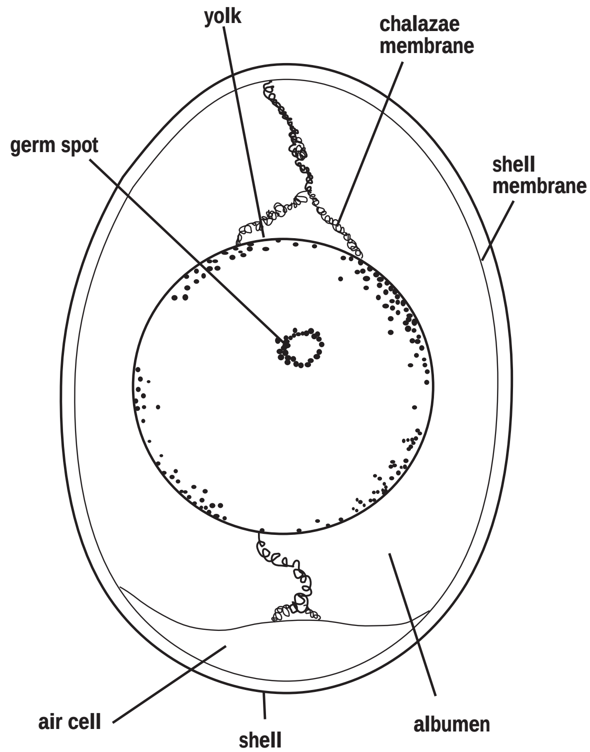
Egg Worksheet: The Parts of an Egg

Name ____



Appendix: Lesson 8

Egg Worksheets Answers



F	**Air Cell**	**A.** The white of an egg. This watery substance supplies the growing embryo with food and water.
A	**Albumen**	**B.** The hard protective outer covering of an egg. This has tiny pores in it to allow the passage of air and moisture in and out of the egg.
D	**Chalazae**	**C.** The "white spot" on the yolk where the embryo develops.
B	**Shell**	**D.** The two twisted cords at each end of the yolk. These keep the yolk from moving about and sticking to the shell.
E	**Yolk**	**E.** The yellow of the egg. This is the primary food source for the growing embryo.
G	**Shell Membrane**	**F.** The pocket of air at the large end of the egg.
C	**Germ Spot**	**G.** The two thin layers inside the eggshell. Usually when the egg is cracked, this will stick to the shell.

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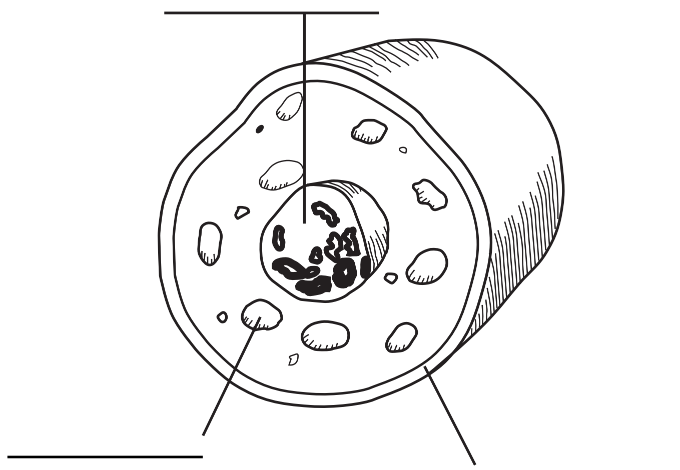
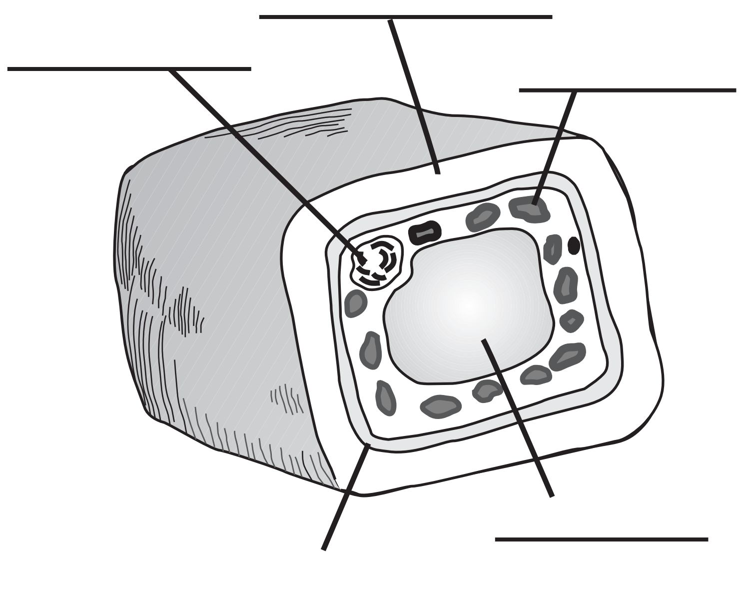
Cell Parts

Label the cell parts.

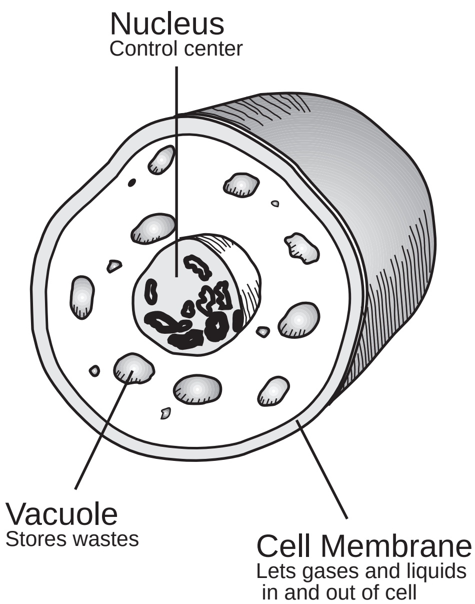


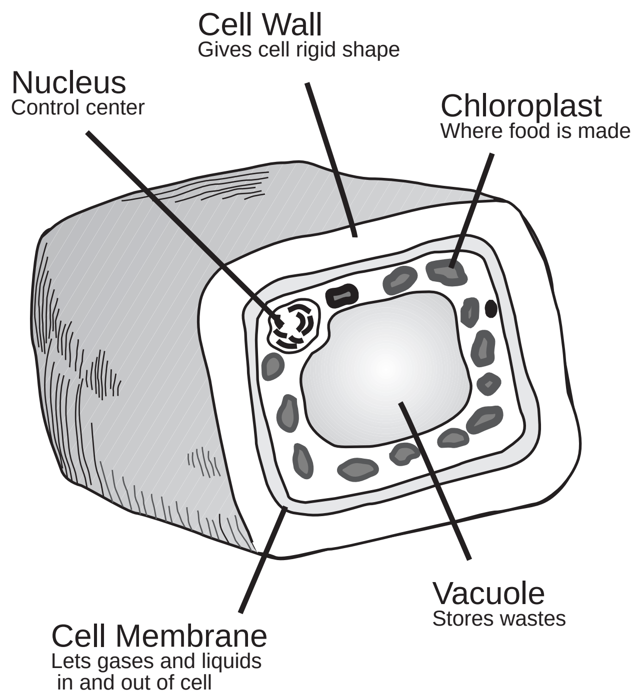


Appendix: Lesson 8

Cell Parts Answers

All cells have some things in common. However, animal cells are very different from plant cells. It can take millions of cells to make a living thing. The diagrams below show just two kinds of plant and animal cells—there are many differently-shaped animal cells in your body!





Write down your observations about how these cells are alike and different:
Why do we find chloroplasts in plant cells and not in animal cells?

Appendix: Lesson 8

Normal/Abnormal Cells: Teacher References

Blending inheritance in humans is seen in the genetic defect known as sickle-cell anemia, which is particularly prevalent in eastern Africa, southern Turkey, southern Saudi Arabia, Sicily, Cyprus, and Greece and is common among Americans whose ancestors came from those regions.

Color the heading Sickle-Cell Anemia and titles and structures A and B.

Sickle-cell anemia is caused by a gene that produces an abnormal hemoglobin, called hemoglobin S, that coalesces to form long tubules whenever the oxygen concentration gets low, grossly distorting the victim's red blood cells and frequently causing them to break open. The name comes from the irregular, often sicklelike shapes of the victim's red blood cells. These sickled cells clog the tiny blood vessels called capillaries, preventing the tissues from obtaining enough oxygen. They are often recognized as abnormal by white blood cells and devoured.

Persons homozygous for this condition are in great difficulty because they have too few red blood cells, a large number of which are sickled all the time. They are in almost constant pain from tissue damage due to the inadequate oxygen supply. Persons heterozygous for this gene may never know they have it but only notice that they have less stamina in physical tasks than other people. This is because the lowering of the oxygen flow to their muscles. Strenuous exercise, as in military basic training, or exposure to the thin air of high altitude may throw such people into a "sickle-cell crisis" in which large number of cells sickle, sometimes resulting in death.

Color the heading P_1 Genotypes and P_1 Gametes and titles and structures C through E in the associated illustration.

Here is a cross between two individuals who are heterozygous for sickle-cell anemia. Each has one gene for normal hemoglobin, known as hemoglobin A, and one gene for hemoglobin S. To emphasize there is no dominance in sickle-cell anemia, the genes are symbolized by an H for hemoglobin and a subscript A or S. Neither gene dominates the other, so heterozygotes produce both kinds of hemoglobin (about 45 percent hemoglobin S and 55 percent hemoglobin A). Since both parents in this case are heterozygous, each produces two kinds of gametes, one carrying the gene for hemoglobin A, the other the gene for hemoglobin S.

Color the heading Punnett Square and F_1 Genotypes and the gene symbols comprising the genotypes in the boxes.

As the Punnett square shows, the probabilities among the F_1 offspring are 1 in 4 for homozygous normal (H_AH_A), 1 in 2 for heterozygous, since there are two ways to get one gene of each kind, and 1 in 4 for homozygous recessive (H_SH_S). Thus two parents who may have no symptoms could carry the defect in recessive form and have a probability of 1 in 4 that any given child will be severely afflicted with sickle-cell anemia.

Other kinds of abnormal hemoglobins are also known, and they follow the same hereditary pattern. Interestingly, these abnormal hemoglobins are common only in parts of the world where malaria is prevalent; there, 20 to 50 percent of the population may carry such a gene as a result of natural selection.

Color the heading Natural Selection and the remainder of the illustration. (To save space, the genes have been symbolized simply by A and S, rather than by H with a subscript letter). Use red for F, pink for G, and pale pink or white for H.

In the malaria-free environment, people homozygous for hemoglobin S generally die early in life, often before reproducing. Occasionally, a sickling crisis prematurely takes the life of a heterozygote as well. In such an environment, these genes are a significant disadvantage.

In a malaria-infested environment, however, people homozygous for the normal hemoglobin A frequently die from malaria, while those heterozygous for hemoglobin S find that they have a high resistance to malaria. The sporozoan parasite that causes malaria is simply not able to attack their red blood cells as effectively, so they become the predominant genotype in their population. Where both parents are heterozygous, some of their children are homozygous for sickle-cell anemia and die young from that, and some of their children are homozygous normal and die from malaria. But approximately half of their children are heterozygous and usually survive both problems. Over many generations, people heterozygous for abnormal hemoglobin come to make up a larger and larger percentage of the population because malaria kills off so many people with normal hemoglobin.

Normal/Abnormal Cells: Teacher References

Sickle-Cell Anemia $_*$ Hemoglobin S Gene $_D$

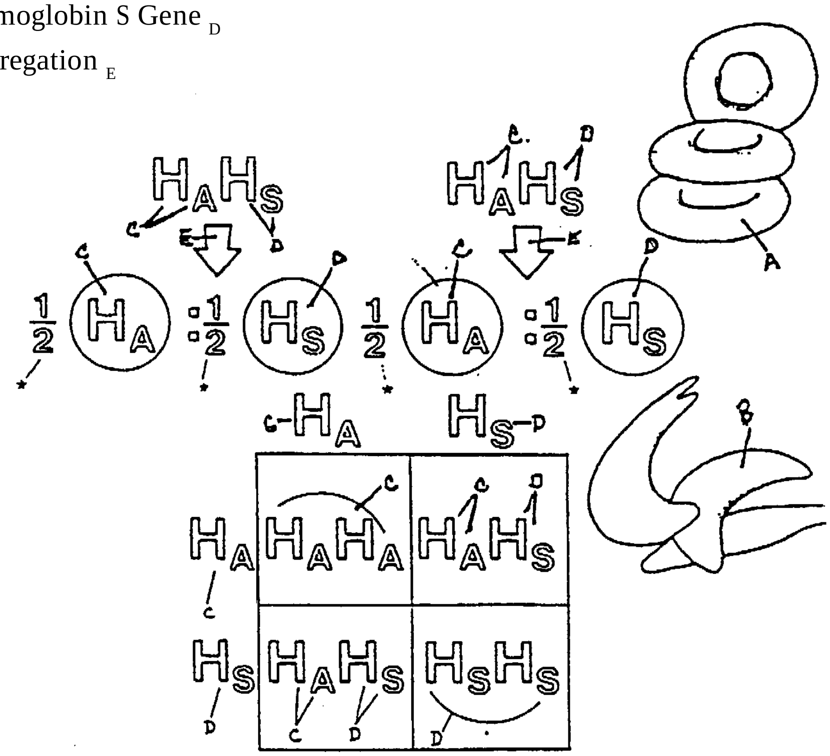
Normal Red Blood Cell $_A$ Segregation $_E$

Sickled Red Blood Cell $_B$

Hemoglobin A Gene $_C$

P1 Genotypes *

P1 Gametes *



Punnett Square $_*$

F1 Genotypes $_*$

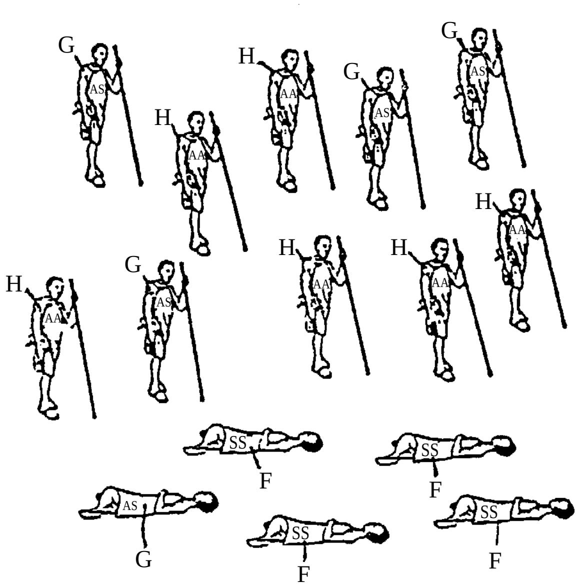
Natural Selection $_*$

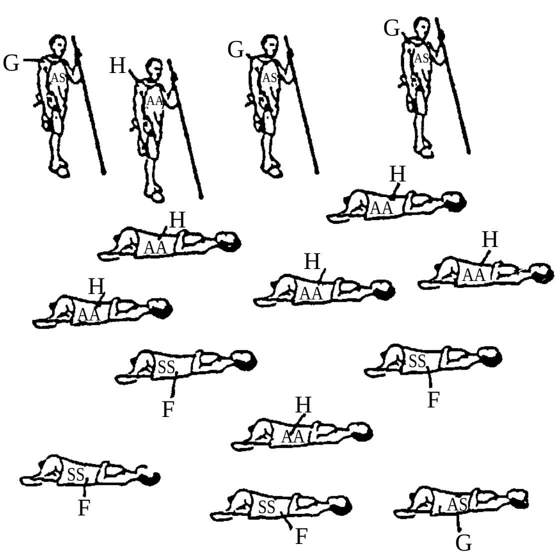
Homozygous for S $_F$

Heterozygous $_G$

Homozygous for A $_H$

Malaria-free area $_*$ Malaria-infested area $_*$





Appendix: Lesson 8

Plant Cell: Teacher References

In a typical plant cell, we see virtually all of the structures found in animal cells except for centrioles and certain protrusions used for locomotion or absorption. On the other hand, plant cells contain certain structures not found in animal cells at all.

Color titles and structures A through H, including the heading Plastids. Use green for F and a light color for D and D[1]. In nature, G is white. Color H with any bright color you wish (If this were a ripening tomato, H would be red).

The plant cell membrane is essentially the same as an animal cell membrane. Immediately outside the plant cell membrane, however, is a cell wall consisting mostly of fibers of cellulose, although other kinds of molecules also become incorporated into it. When a cell is first formed by division of its parent cell, the cell is relatively elastic and is called a primary cell wall. As the cell grows, the wall is made thicker and more rigid and becomes known as a secondary cell wall. The cell wall is perforated by numerous small pores called plasmodesmata (singular, plamodesma), which appear to allow a direct bridge of cytoplasm from one cell to the next.

Although animal cells often contain some small vacuoles, plant cells usually contain one or a few very large ones. As plant cells mature, the vacuoles tend to get larger and usually fuse to form a single very large vacuole that may comprise up to 90 percent of the cell's volume. These large vacuoles are sometimes called "water vacuoles" because they contain large quantities of water. However, they also contain a wide variety of dissolved substances, including nutrients stored for later use, and toxic substances, which may be broken down into harmless subunits in the vacuole. It is because of the dissolved substances that water flows into the vacuole and creates osmotic pressure, which is responsible for the rigidity of plants. When water is in short supply, the vacuoles lose their osmotic pressure, and the plant wilts. Sometimes substances are stored in vacuoles as solid crystals, and many flowers receive their coloring from the pigments dissolved or crystallized in their vacuoles. The membrane of the vacuole is often called the tonoplast.

Plants are also colored by their plastids, but chloroplasts, which are green, have a much more important function than merely making plants green. They trap light energy and convert it to chemical energy for the manufacture of food in the process called photosynthesis. Leucoplasts are whitish in color and serve to store starch, lipid, or protein. Chromoplasts are plastids that produce and store other pigments that impart color to particular parts of a plant, as when fruit ripens or leaves turn color in the fall. They are formed by modification of chloroplasts or leucoplasts.

Color all the remaining titles and structures in the illustration, including the heading Nucleus. Use a dark color for J, light colors for K and R, and a very light color for Q.

Golgi complexes in plant cells are usually called dictysomes. They are very much like the Golgi complexes in animal cells except that they are usually smaller and more numerous. In addition to synthesizing various complex molecules needed within the cell, they appear to be responsible for manufacturing the components of the cell wall, which animal cells never have. All the remaining structures are virtually identical to those found in animal cells: ribosomes synthesize proteins and are found attached to the endoplasmic reticulum and free in the cytoplasm; mitochondria provide energy by oxidizing the carbohydrate made in the chloroplasts; microtubules and microfilaments seem to provide support and produce movement; lysosomes and microbodies contain enzymes; and the apparently structureless fluid making up the rest of the cytoplasm is called the hyaloplasm. The nucleus, too, is virtually the same; for that reason, this illustration shows only the exterior of the nuclear envelope with its numerous pores.

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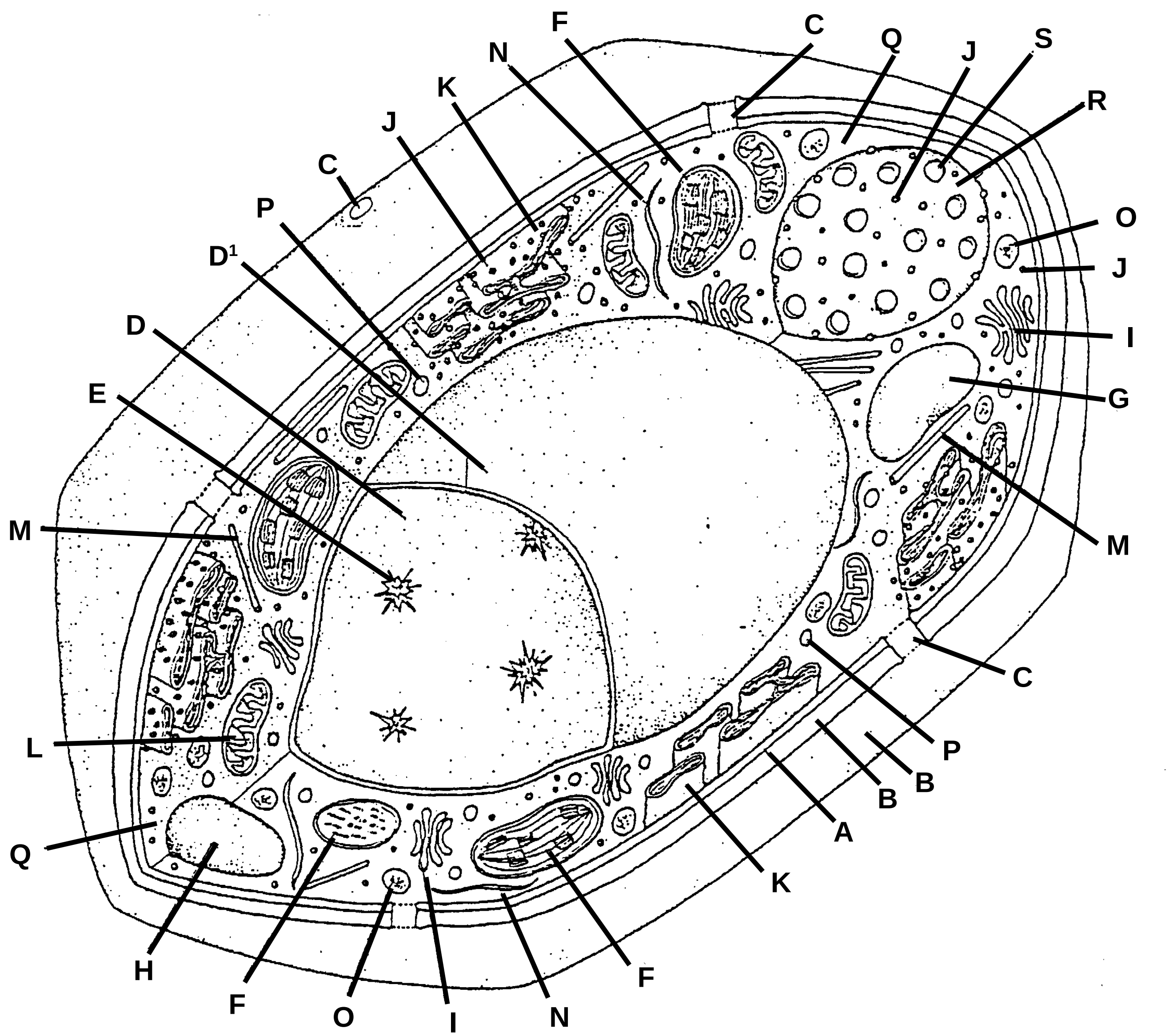
Plant Cell

Cell Membrane $_A$
Cell Wall $_B$
Plasmodesma $_C$
Vacuole $_D$
- Tonoplast $_{D}^{1}$
- Crystal $_E$

Plastids $_*$
- Chloroplast $_F$
- Leucoplast $_G$
- Chromoplast $_H$

Golgi Complex $_I$
Ribosome $_J$
Endoplasmic Reticulum $_K$
Mitochondrion $_L$
Microtubule $_M$
Microfilament $_N$
Lysosome $_O$

Microbody $_P$
Hyaloplasm $_Q$
Nucleus $_*$
- Nuclear Envelope $_R$
- Nuclear Pore $_S$



Appendix: Lesson 8

Animal Cell: Teacher References

Although the earliest light microscopes show the cell as hardly more than a mass of amorphous fluid enclosed within a membrane, modern research has shown that the cell is not only the structural unit of living organisms but also the functional unit. Each cell carries out all the physical and chemical reactions we associate with life. This illustration is an artist's reconstruction of a typical animal cell as it might look with its upper half cut away. We see that the cell is organized into many distinct structures. These are called organelles, and each is specialized for a particular function. This illustration gives you an overview of these organelles; the following illustrations will cover the details of structure and function.

Color title A and the cell membrane with a pale color.

The cell membrane (sometimes called the plasma membrane or plasmalemma) completely covers the entire cell and serves to hold it together. It also actively regulates what enters and leaves the cell. It is only about 10 nanometers thick, so its thickness has to be greatly exaggerated in the drawing to give you something thick enough to color. This is also true of the membranes within the cell. Everything else is drawn to scale.

Color titles and structures B through F. Color the pores (C) with a darker color. Color D and E in rather dark colors, and leave F uncolored (all the remaining space within the nucleus).

In animal cells (as well as in plant, protist, and fungus cells), the nucleus is separated from the rest of the cell by the nuclear envelope. Such cells are called eukaryotic to distinguish them from prokaryotic cells, which lack a true membrane-enclosed nucleus and are more primitively organized. (Prokaryotic cells are found only among the bacteria and their close relatives.) The nuclear envelope is made of two layers of membrane. These are very similar to the cell membrane but have numerous pores. Within the nucleus is a prominent structure called the nucleolus—sometimes there are two or more nucleoli—and a network of thin threads called chromatin. The chromatin contains the hereditary material of the cell. The fluid that fills the rest of the space in the nucleus is called the nuclear sap.

Color the heading Cytoplasm and titles and structures G through N. Color over the lines that represent microfilaments.

The term "cytoplasm" is still used to designate all of the cell contents outside the nucleus but inside the cell membrane, although we realize that cytoplasm is not the homogeneous substance it was once thought to be. One of the prominent organelles in the cytoplasm is the mitochondrion, often called the "powerhouse of the cell" because about 90 percent of the energy that eukaryotic cells get from oxidizing food molecules is developed there. The Golgi complex is a stack of membrane sacs in which various molecules are manufactured and packaged for "export" from the cell. Centrioles are cylindrical bundles of microtubules that seem to give rise to the longer spindle microtubules that separate the two duplicate sets of chromatin at the time of cell division. Most animal cells have a pair of centrioles lined up 90 degrees to each other. Additional microtubules are found singly or in groups elsewhere in the cytoplasm. They appear to provide structural support to the cell and may be involved in movement. Vacuoles are fluid-filled sacs of membrane that may contain anything from food being digested to oil droplets. Lysosomes look like small vacuoles but contain digestive enzymes. Microbodies look like small vacuoles as well, but contain various enzymes not involved in digestion. Microfilaments are found in various places around the cytoplasm and are involved in movement and attachment to other cells.

Color titles and structures O and P. Be sure to use pale color for P to avoid obscuring the ribosomes (O). Do not color Q.

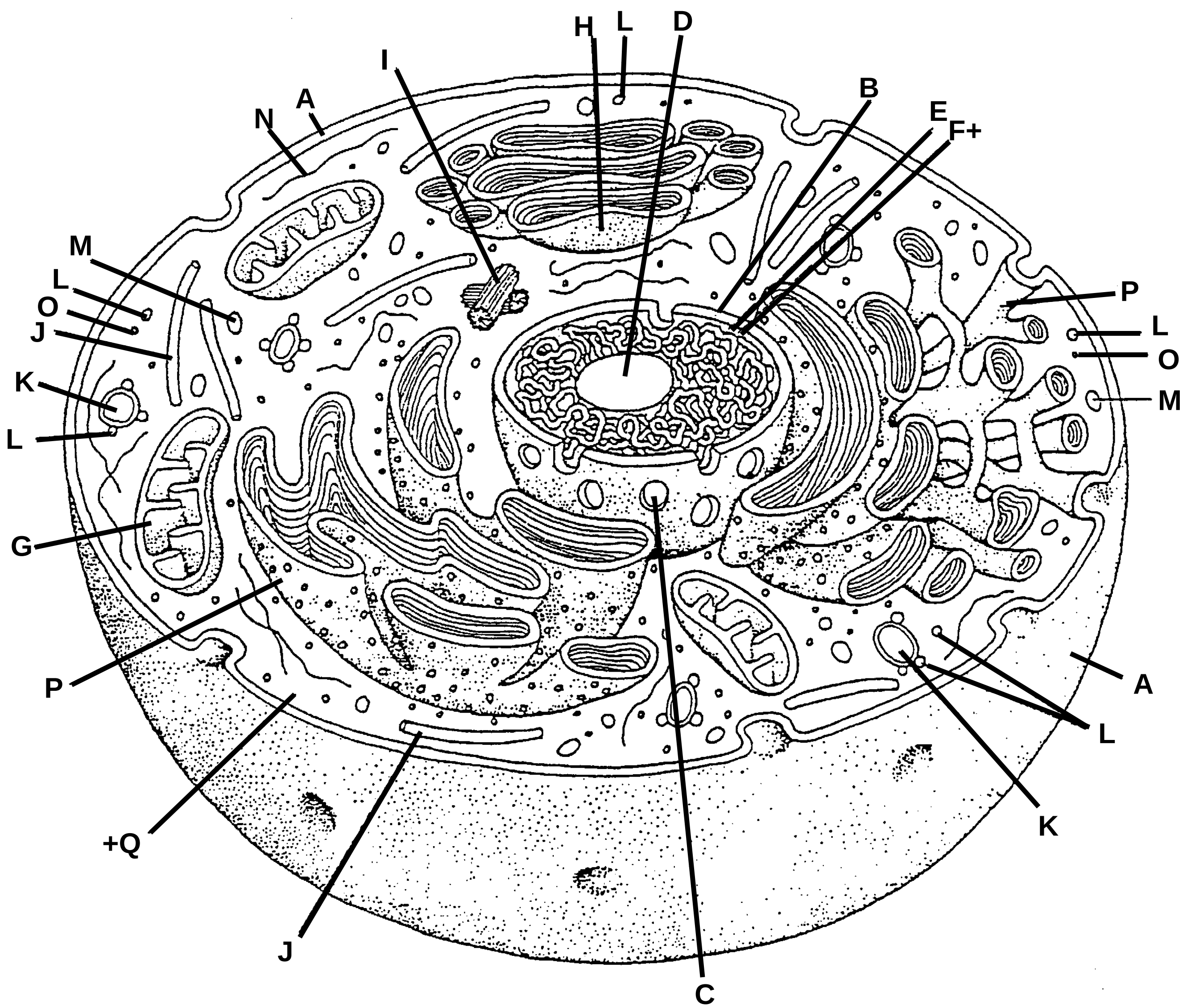
Throughout the cytoplasm are many tiny structures called ribosomes, which manufacture proteins. Some are free in the fluid portion of the cytoplasm, but many others are attached to the endoplasmic reticulum (ER), a system of membranes that extends throughout much of the cytoplasm. Some parts of the endoplasmic reticulum (known as the rough ER) have many ribosomes attached; other parts (known as the smooth ER) have none. The remaining portion of the cytoplasm, which seems to be a structureless fluid, is called the hyaloplasm. (Some biologists call it the cell sap or the cell matrix.)

Animal Cell

Cell Membrane A
Nucleus *
Nuclear Envelope B
Nuclear Pore C
Nucleolus D
Chromatin E

Nuclear Sap F
Cytoplasm *
Mitochondrion G
Golgi Complex H
Centriole I
Microtubule J

Vacuole K
Lysosome L
Microbody M
Microfilament N
Ribosome O
Endoplasmic Reticulum P
Hyaloplasm Q



Appendix: Lesson 8

The Microscope: Teacher Reference

Your microscope is expensive and fragile. It is important for you to use it correctly to avoid damaging it and to avoid breaking slides or destroying specimens. When you are using your microscope, it should rest securely on your table or bench, away from the edge. When you carry your microscope, always use two hands. Hold its base with one hand and its arms with your other hand.

Always use an appropriate light source. If your microscope has a lamp, plug it in and turn the lamp on. If your microscope has a mirror, adjust it to get a good amount of light through the eyepiece. CAUTION: Never use direct sunlight as your light source. Make sure the diaphragm is sufficiently open so enough light can get through. This will be especially important if you look through the eyepiece and see nothing.

Always keep both eyes open as you look into the eyepiece. This is important because it reduces eyestrain. If you find this difficult, cover your other eye with your hand. This may feel awkward at first but it will become easier with practice.

Keep the lenses on your microscope clean. Never touch them with your fingers. If the eyepiece or objective lenses get dirty, clean them with a piece of lens paper moistened with alcohol (or xylene). Wipe the lens in a light circular motion and change the lens paper as it picks up the dirt. Make certain that you leave no streaks on the lens. NOTE: Cleaning the lens with anything other than lens paper, or wiping too hard will scratch the lens.

The purpose of the microscope is to magnify your specimen. Microscopes use two lenses—the eyepiece and an objective—to magnify the image. The magnification is the number of times the size of an object appears increased. If the magnification of an object is 10x, it will appear 10 times larger than it really is.

The magnification of your microscope is equal to the product of the separate magnifications of the eyepiece and the objective. (The magnification of each lens is written on the lens case.) If the eyepiece is 10x and the low power objective is 10x, then the magnification under low power is 100x. In equation form, this is written:

(eyepiece magnification) X (objective magnification) = total microscope magnification

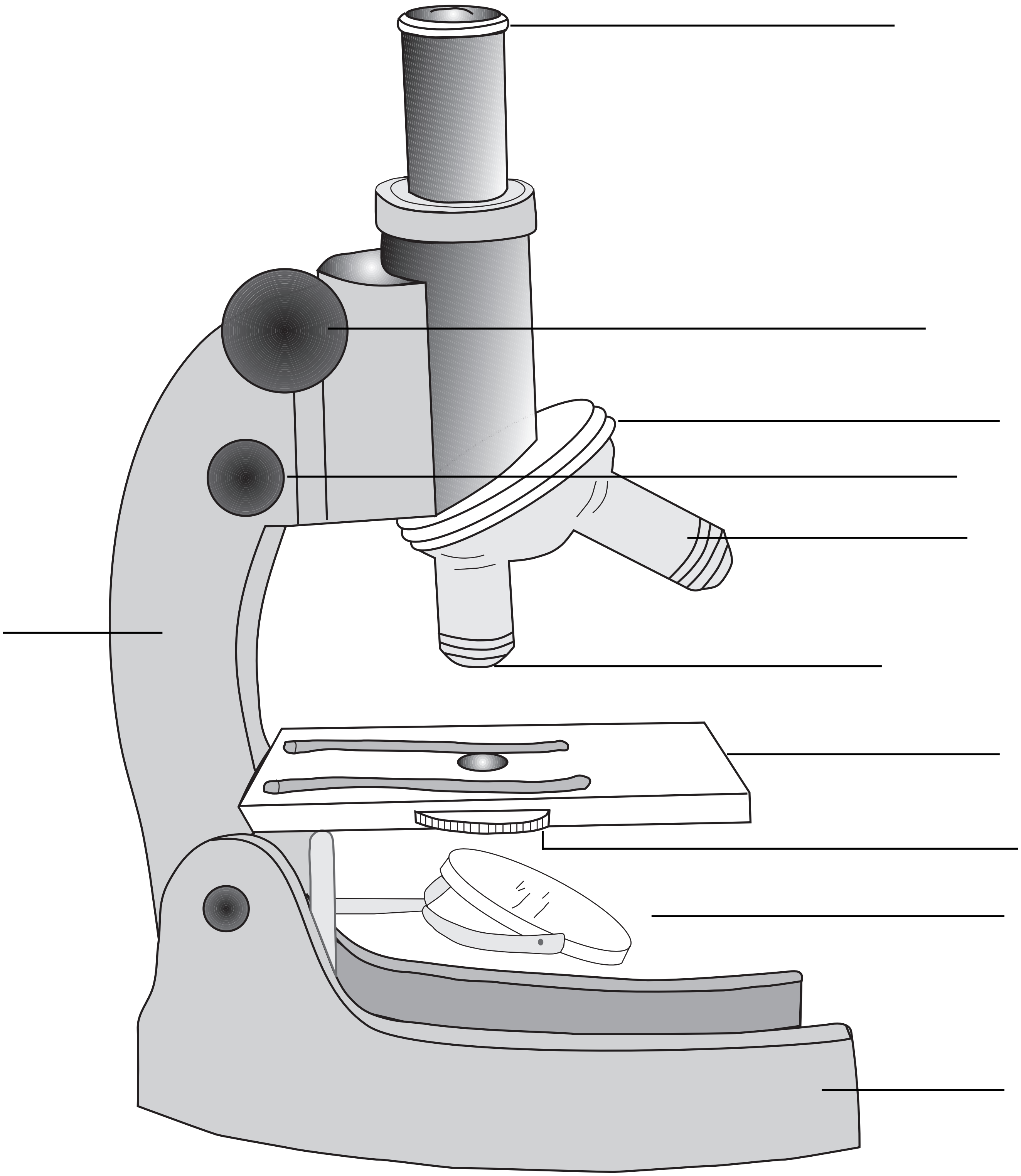
1. If the magnification of the eyepiece is 10x and the magnification of the high power objective is 40x, what is the total magnification under high power?
2. How many times larger than life will a specimen appear under this magnification?

If you have a scanning power (4x objective), note that it gives a very low magnification. This is useful for locating a specimen on the slide, but in many cases it is not appropriate for observation.

Appendix: Lesson 8

Microscope Worksheet

Your Name ______________________________



Appendix: Lesson 8

Microscope Answer Sheet