SUPPLEMENTAL ACTIVITIES

CHAPTER 1

Most of the recommended activities for this chapter are printed in the student booklet. If you have microscopes available and want to try viewing cork cells, that is fairly easily done. Just make sure to slice your cork in a thin wedge shape. Look for cells way out on the edge where it gets extremely thin. However, you'll find that cork cells are pretty boring and the students won't be that impressed by what they see. The cork cells are dead and look very empty.

1) SUPPLEMENTAL VIDEO

Here is a nice supplemental video (7 minutes long) about Leeuwenhoek that you might want to consider using. It's not listed in the student text simply because, at exactly 2 minutes and 3 seconds into it, they show a classical painting that has a female figure with one breast partially showing. Depending on your audience, this may or may not be a problem. For a high school audience, it shouldn't be a big deal. It's just a classical painting you'd see in a European art gallery. For an elementary audience, you could just put your hand over the lens at 2:02 and take it off at 2:05. Otherwise, it's a great video. Don't hesitate to use it if you are looking for more resources on Leeuwenhoek.

http://www.youtube.com/watch?v=_D5Gu_9hEus

2) INTERACTIVE COMPUTER ACTIVITY: HOW BIG IS A CELL?

This interactive activity lets students zoom in and out on a series of microscopic things, starting with a coffee bean and a grain of rice and ending with a carbon atom. Cells and cell parts are shown along they way, along with bacteria and viruses.

http://learn.genetics.utah.edu/content/begin/cells/scale/

CHAPTER 2

1) DEMONSTRATION: A FLUID MOSAIC MODEL

This activity helps students to understand the fluid nature of the membrane. We mentioned in the text that the phospholipid molecules can move around, sort of like ping pong balls floating in a bathtub. This demonstration is a fun way to help them understand this concept.

You will need:

- a large, shallow metal or plastic tray of some kind (a 9x13 cake pan would be adequate)
- a pitcher of water
- a bag of "miniature" marshmallows (these will represent the heads of the phospholipid molecules)
- Chunks of apple that are slightly larger than the mini-marshmallows (You could also use chunks of Styrofoam® or anything else that is waterproof and will float.) Cut some of the chunks into thick discs you can use to represent lipid rafts. Cut some oddly shaped chunks that you can use to represent proteins.
- a few toothpicks

What to tell the students:

This will be a demonstration to show what it means when scientists say that a phospholipid membrane is a "fluid mosaic." The word "mosaic" means a pattern made from small pieces. "Fluid" means "flowing." In this demonstration, we will pretend we are looking down on the outer membrane of a cell. We will only be able to see the heads of the phospholipid molecules. The marshmallows will represent these phospholipid heads. We will see how lipid rafts and membrane-bound proteins can move around in and among the phospholipids.

What to do:

Pour at least an inch of water into the tray. Dump in marshmallows until they cover most of the surface of the water. Add your representations of lipid rafts and membrane-bound proteins. You might want to use a few toothpicks to create proteins that are sticking up above the surface. Fill in any remaining gaps with marshmallows.

Allow the students to gently push the rafts and the proteins around. (You could even provide very small chunks of "protein" that they could set on top of the lipid rafts.) Notice how the marshmallows won't allow an empty patch of water. They immediately fill any gaps you try to create. The surface of the water remains covered at all times even though the positions of the rafts and proteins are constantly changing.

Extra tips:

You might want to put a bath towel under your pan to absorb any slop-over accidents. You might also want to have some paper towels on hand.

2) DEMONSTRATION: SIMULATE THE MERGING OF MEMBRANES

This demonstration may seem almost too obvious and too simple. Because of its simplicity, we hesitated to use this demonstration with our middle school students (ages 12-14), but found that they had great enthusiasm for it and thoroughly enjoyed it.

We tried both plastic and paper plates. On our Styrofoam plates, the oil droplets tended to move to the sides. Oil is a non-polar substance and will move toward other non-polar substances, like plastic or Styrofoam, and away from polar substances, like water. (This would be an optional side discussion if you are looking for ways to emphasize chemistry.) If the paper plates are coated with wax (another non-polar substance) you may see the same thing happening. However, this problem is not a major one and if disposable plates are the obvious choice for your situation, go ahead and use them.

These instructions are for a single experiment using one plate. If you have more than two or three students, use multiple plates.

You will need:

- a plate (paper, plastic, or ceramic, but white or very light-colored)
- some cooking oil
- a pitcher of water
- optional: toothpicks or spoons to push oil droplets around (if you want to avoid oily fingers)
- paper towels
- optional: large containers to dispose of the used oil/water mix (if you are in a classroom)

What to tell the students:

In this demonstration, we will simulate the way membranes can merge together simply by coming into contact with each other. In future chapters, we will see how important this merging of membranes is to a cell. We will be using oil to represent a phospholipid sphere. Your job to observe the behavior of oil droplets as they come into contact with each other. The behavior of the oil droplets is similar to the behavior of phospholipid membranes.

What to do:

Pour some water into the plate until the bottom is covered. Then add some small circles of oil at various places on the plate. Tell the students to push the droplets around (either with fingers or the utensils-- as you choose) and observe what happens when they touch. The students will observe that when two droplets touch, they instantaneously merge and become one larger droplet. Encourage the students to experiment. Is it possible to make an oil patch that looks like the letter O? How hard is it to split a large droplet into two or more smaller droplets? If left undisturbed, do the droplets initiate any movement toward each other? How close can two droplets be before they merge?

Additional experiment: What happens when you add a drop or two of food coloring to the water?

3) GROUP ACTIVITY: A "HUMAN MEMBRANE"

This activity can only be done with a fairly large group of students. You might be able to do it with a dozen students, but more is better. This activity is ideal for kinetic learners and social learners, but it's fun for everyone, too.

You will need:

- a fairly large space (but an average-sized classroom will do, if you move the tables and chairs)
- a few small balls (ping pong or tennis balls) and one large ball (basketball size or larger)
- a long stick to be a "flag" (cell identification marker) You might even want to tape a piece of paper to the end, that says something like, "I belong" or "I am part of the body" or even the name of one of the students.
- a camera to record this unusual event!

What to tell the students:

In this activity, each of you will represent a phospholipid molecule. You will need to line up in pairs, just like real phospholipid molecules do. You can pretend that your head is the water-loving head of the phospholipid and you can stretch our your arms to be the water-hating tails. Just like in a real membrane, your water-hating tails will face each other and your water-loving heads will be on the outside. After you have lined up and created your membrane, we will do some demonstrations that show how the membrane works.

What to do:

Line up the students in two rows, facing each other, but not too close. Tell them that their heads will represent phosphate heads. Then have them put their arms out straight in front of them to represent the two lipid tails. Their hands should come close but not touch. (If you have enough students, try to form a circular membrane, as this is what phospholipids would do. One group of students would form an inner ring with their hands pointing out, and the others would form an outer ring with their hands pointing in.)

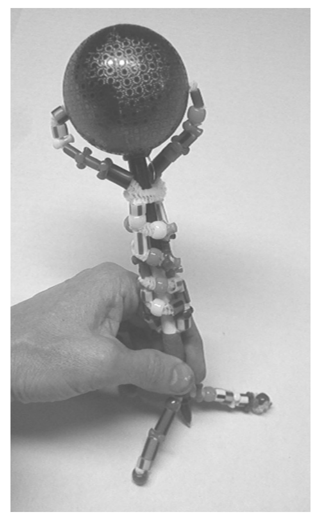
With the students lined up and modeling a piece of membrane, show the students a few small balls and tell them the balls represent very small molecules such as water or oxygen or carbon dioxide. Then gently toss or roll the balls between the students, in the spaces between legs and feet. Emphasize that this is to show that small molecules can pass right through the membrane. Then show them the large ball. Say that this represents a very large molecule, such as a food molecule or a piece of protein. Demonstrate that the molecule will not be able to slip through. (The students should be standing close enough together that the large ball can't get through the space between their legs or bodies. Then ask if anyone remembers how cells regulate the entry and exit of large molecules. Yes-- portal proteins. Volunteer one pair of students in the middle to be a portal protein. Have them turn to

On the left, one student is playing the role of a portal protein. The ball is a molecule. On the right, the student with the flag is playing the role of an ID protein, letting all other cells know that it is part of the body and not an invader.

the side and put their arms out to their sides. Designate one side to be "outside" the cell and give the ball to the portal protein who is on that side. Have the outer protein pass the ball to the inner protein. The inner protein can then just let go of the ball or give it a gentle toss into the "inside of the cell."
Volunteer a student on the outer side of the membrane to pull their hands in and pretend to be a protein instead of a phospholipid. Then give him/her a long stick to hold up. This will represent an identifying "flag" that will tell all other cells that come into contact with it that it's part of the body and not a foreign invader. These tags are especially important to the cells of the immune system (white blood cells) as they go about on their search and destroy missions, looking for cells that don't belong to the body. White cells know not to attack any cell that is displaying this identifying flag.

Extra tip: Don't forget to take some pictures!

4) CRAFT: MOTOR PROTEIN PENS



Even "craft-shy" students will probably like this craft because it is so bizarre. The students will be making a model of a motor protein that is also a functional pen they can write with.

NOTE: There are full-color pictures of this craft at the back of this booklet.

You will need the following for each student:

- a ballpoint pen (the kind with the cap that comes off, not the clickable kind)
- a handful of assorted colored beads for each student (miscellaneous sizes, shapes and colors)
- chenille stems (3 per student)
- floral tape (the green tape florists use--it doesn't feel very sticky) One roll will be enough for up to 20 students.
- some kind of ball (You will have to determine what kind of ball will work best for your situation. We found very inexpensive hollow plastic Christmas tree balls that worked very nicely. You could also use a Styrofoam™ ball, or any lightweight plastic ball. If you can't find any suitable balls, just improvise. You could use heavy card stock paper to make a cube or a dodecahedron. (If you need a pattern, you can use the dodecahedron at this address: ellenjmchenry.com/id108.html Just click on the blue line where it says "download patterns and instructions." One of those pages has a printable pattern.) Just make sure the ball is not too heavy. A heavy ball will make writing with the pen difficult.

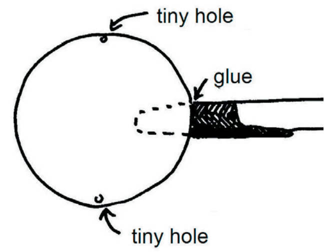
What to tell the students:

You will be making a model of a motor protein. The ball on the top will represent a protein that is being carried. At the bottom of the motor protein will be two things that look like legs. In fact, they are very much like legs. They walk along a microtubule as you would walk on a sidewalk. The model will contain many plastic beads that will represent the structural proteins from which the motor protein is made. The nice thing about this model is that it is also useful. It will also be a pen you can write with. You can have a lot of fun making people guess what it is, then explaining about motor proteins.

How to assemble the pen:

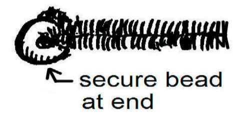
1) Take the cap off the pen and put it on the other end, as if you were going to write with the pen. Press it on as firmly as you can.

2) Drill or punch a hole in the ball. The hole must be just the right size so tat it fits onto the cap at the halfway point. (see drawing at right) Adhere the ball to the pen with appropriate glue. (Recommendation: "Quick Grip" or a similar all-purpose hobby glue that is clear, has a thick texture, and dries quickly. This type of glue is often a bit smelly, but not dangerously so.)

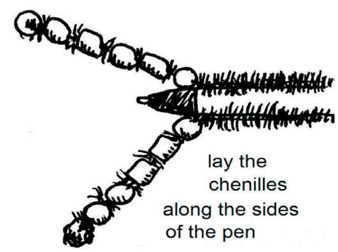


3) Drill or punch two more holes in the ball. These should be very small holes--just large enough to accommodate the end of a chenille stem.

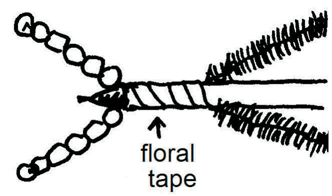
4) Take two of the chenille stems and secure a bead to one end of each stem. Just loop the chenille stem around, give it a twist and tuck the end back into the bead. Make sure there isn't a sharp metal end sticking out. Then thread some beads onto them until you've covered about 5 cm (2 inches) of the chenille stem. The measurement does not have to be exact.



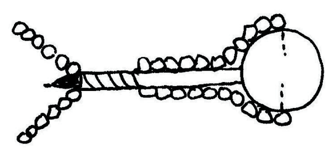
5) Lay the chenille stems alongside the pen so that the yet-to-beaded part is flush with the pen tip. (see drawing for clarification) Wrap some floral tape around at the tip, to secure them, then wind the tape up the pen about 4 cm (1.5 inches). The measurement does not have to be exact. Tear off the tape and continue wrapping until the end of the tape is sealed on. Press firmly. Floral tape won't seem very sticky so you may think it won't hold, but surprisingly, it will adhere very well and will stay in place even while the pen is being used to write with. The floral tape won't stick to fingers, just to itself. (For further clarification, look at the color pictures in the appendix.)



6) Thread some more beads along those two chenille stems until you reach about 2 cm (3/4 inch) from the end. Those two ends will fit into the small holes you drilled or punched in the ball. (Look at color picture in appendix.) You may want to glue the ends of the stems into these holes. (Ours stayed secure even without glue.)



7) You may need to make adjustments for your particular situation, depending on what you are using as a ball and how large your beads are. Use the color pictures in the appendix as guides for the general concept, then make necessary adjustments according to the materials you are working with.



8) Secure a third chenille stem to one of the side stems right at the top of the floral tape. Begin a pattern in which you alternate winding with threading a few beads on. Wind tightly. Once again, look at the color photo in the appendix to see how it will look. (Yours doesn't need to look exactly like this one.)

9) After you have wound to the top, right under the ball, secure the chenille stem to one of the beads (or the stems) right under the ball.

10) To use the pen, move the "legs" upward, out of the way of the paper. When not writing, move them back down so they look like legs again.

5) CRAFT: MAKE A SMALL PAPER MODEL OF A MEMBRANE

Cut and assemble a small, three-dimensional paper model of a piece of membrane. (It includes membrane-bound proteins and portal protein.) Finished dimensions: 8 cm (3 in.) wide, 18 cm (7.5 in.) long, and about 8 cm (3 in.) high. You will need paper copies of pattern pieces, scissors, clear tape or some glue sticks, and colored pencils if you want to color the model (it comes in black and white).

Go to: **http://learn.genetics.utah.edu,** click on "Teacher Resources and Lesson Plans" (top right corner), then click on "Print-and-Go Lesson Plan Index" (on right side), then scroll down and click on "Amazing Cells: Supplemental Materials" then scroll down and click on "Build-A-Membrane."

6) ACTIVE GAME: MOTOR PROTEIN RELAY RACE

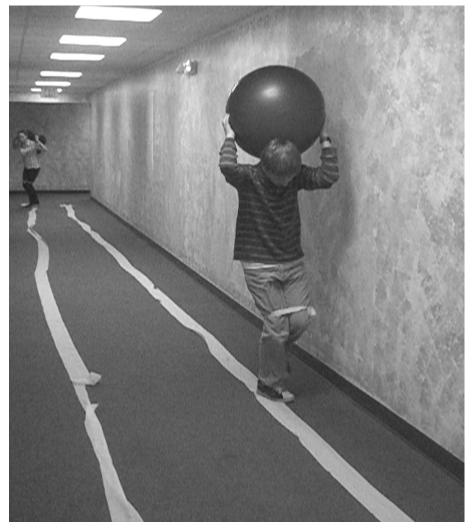
This activity is mainly about having fun pretending to be a motor protein.

You will need:

- a fairly large space (long and narrow is fine, like a hallway)
- two very large, but lightweight, objects such as beach balls (or other large inflatables) or the balance balls commonly used for exercise programs in gyms.
- a roll of toilet paper
- some duct tape or blue masking tape (painter's tape that isn't very sticky) to secure the toilet paper to the floor at each end and to make repairs to the paper if it tears. Clear tape or regular masking tape could also be used to make repairs. Just don't use anything on the floor that won't come off easily! (We've found that on carpeted floors, almost any tape comes off easily.)
- two pieces of wide elastic, tied at the ends to make loops that will fit tightly but comfortably around the knees

What to tell the students:

In this relay race, you will play the role of a motor protein carrying a large protein molecule while walking down a microtubule road. You will have to walk carefully so as not to tear the microtubule! If you tear it, someone on your team will have to come and repair it before you continue. Cells often have to repair parts of their cytoskeleton and they can do it very quickly and efficiently. They can effect a repair in a fraction of a second. Your repairs will take a bit longer than that! The goal of the race is to have every member of the team take a turn as the motor protein, traveling down the microtubule and back again.



How to set up for the race:

You will need to roll out two long pieces of toilet paper. Make them stretch almost the full length of your space, leaving just a bit of space at the beginning for the team members. Secure the ends with tape. Leave the roll of tape at the starting line so the team members can use it if they need to make repairs.

Have a loop of elastic for each team at the starting line. (Also, have the balls ready at the starting line.)

How to run the relay race:

Divide the group into two teams. (If you have an odd number of students, assign one student on the smaller team to go twice.)

The first runners stick their feet into an elastic loop and pull it up to just above their knees. They are only allowed to move the lower part of their legs, below the elastic. This will make them move more like a real motor protein. (Motor proteins don't have jointed legs with ankles, knees and hips!) It will also add a humorous "twist" to the relay race and make it more fun. Then the runners pick up a ball and hold it over their heads. Now they are ready to start down the microtubule road. They must walk along the toilet paper without tearing it. If it tears, one of the team members must take a piece of tape and go fix the tear. The mending job doesn't have to be great. The minimum is that the two ends of the paper must be touching. When the runners reach the end, they turn around and come back. Then they put down the ball and take the elastic off their legs, handing them to the next runner in the line.

The first team to get all their members down and back wins the race!