CELLS: A RADICAL IDEA

DYNAMIC DEVELOPMENTS AND FASCINATING FACTS IN BIOLOGY

Cells may have first evolved from simple chemical structures known as *liposomes* or *micelles*. Micelles are formed when fatty substances such as phospholipids are added to water, allowing a fatty soap bubble to form a thin membrane that has the ability to envelope and accommodate chemical compounds such as DNA. These "proto-cells" can replicate and begin other chemical processes that help them maintain their fragile membranes.

—Model of self-replicating cell capable of self-maintenance, by Naoaki Ono and Takashi Ikegami, —http://arxiv.org/PS_cache/adap-org/pdf/9905/9905002v2.pdf

When a cell becomes damaged or undergoes some type of infection, it will self destruct —commit suicide—by a process called *apoptosis*. Apoptosis (also called programmed cell death, or PCD) works to ensure proper development and to keep the body's natural process of mitosis in check. It is such a precise process that it is as intrinsic as is mitosis. A cell's inability to undergo apoptosis can result in the development of cancer.

—http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/A/Apoptosis.html

Researchers at the Craig Venter Institute, have synthesized the first self-replicating artificial cell. The cell was not made "from scratch," but was derived from the genome of a simple bacterium, *Mycoplasma mycoides*. Nucleotides were added until an entire copy of the genome could produce daughter cells that self-replicated.

—http://www.popularmechanics.com/science/health/breakthroughs/synthetic-cell-breakthrough#ixzz1Ji43sE24

A cell has been genetically engineered to emit laser light. Expressing green fluorescent protein (GFP), the cell can amplify photons into pulses of laser light. A living laser is especially unusual, because typical bioluminescence employs a diffuse light mixture of many frequencies, while laser light is "coherent" light of a single frequency (also known as "monochromatic"). The spherical shape of the cell itself acts as a lens, refocusing the light and inducing emission of laser light.

—http://www.nature.com/nphoton/index.html

Cells have been revealed to communicate through the exchange of photons. Living cells in culture synchronize their internal chemical processes, even though they are mechanically, chemically, and electrically isolated from one another. Biologists have long known that photons play a central role in the biochemistry of many plant and bacterial cells. This is the basic theory behind photosynthesis, but photon exchange and stimulation is now understood to occur in animal cells as well. Optical or UV photons enter a cell and stimulate the creation of *excitons* (a species of electron) on certain long-chain molecules. The exciton travels along the molecule, influencing the way it reacts with molecules in other cells. This discovery generates more questions than answers. For example, how do cells discriminate between biophotons and background light? And what to make of other evidence that the photons can sometimes be coherent, as in a laser beam?

—http://www.photobiology.com/photobiology99/contrib/applegate/index.htm

CELLS: A RADICAL IDEA

INTRODUCTION

Educated people of the early 1800's had the belief that some invisible force was responsible for life in all its growing and changing forms. In 1839, Schleiden and Schwann presented the idea that ***cells*** were the creative force responsible for living organisms. Even though it was a radical change from the beliefs of the time, their ideas were accepted almost without question. The logic and proofs presented made perfect sense. Many puzzling questions were now answered.

The ***Cell Law*** states:

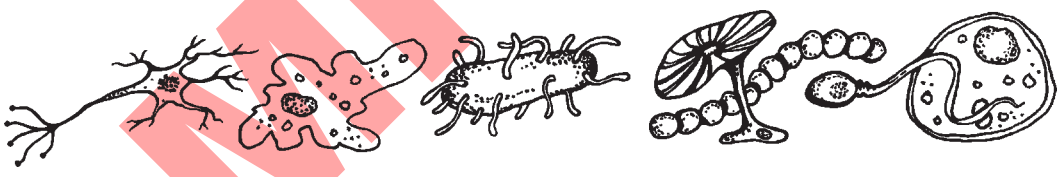
1. all of life consists of cells,
2. all cells come from previous cells, and
3. all life processes derive from cellular activities.

The implications of this principle are profound. It means that:

1. all life forms are related to each other at the cellular level,
2. all functions of organisms (including humans) are based on individual cell activities, and
3. all cellular activities are based on chemical processes.

Yet, in spite of what it implied, scientists and laymen were in agreement about cells. How different was the reception of Schlieden and Schwann when compared to other pioneers in biology, like Gregor Mendel in genetics research, and Charles Darwin in concepts of evolution.

This week you will look at cells and discover some of their general features.



ACTIVITIES

ACTIVITY #1

"HOW TO MAKE A WET MOUNT SLIDE"

In order to observe cells, you will have to become good at the technique of making a slide. This requires patience and careful handling of equipment. Take your time.

Whenever you make a slide of something during this semester, you should use the wet mount method. It is the very best way to get a clear view of the object, and it prevents the specimen from drying out.

STEP 1 You will need a microscope slide and a coverslip.

STEP 2 Put a *drop* of water on the slide.

STEP 3 Put the object into the drop of water. The object must be *very* thin. You will see the importance of this when you make a wet mount of onion cells.

STEP 4 Place the coverslip over the object by first placing one edge down, and then slowly lowering the other side so that you don't trap air bubbles. Air bubbles will look like discarded tires, and are actually quite interesting in appearance, but they will interfere with your view of the object you really want to see.

SIDE VIEW OF SLIDE

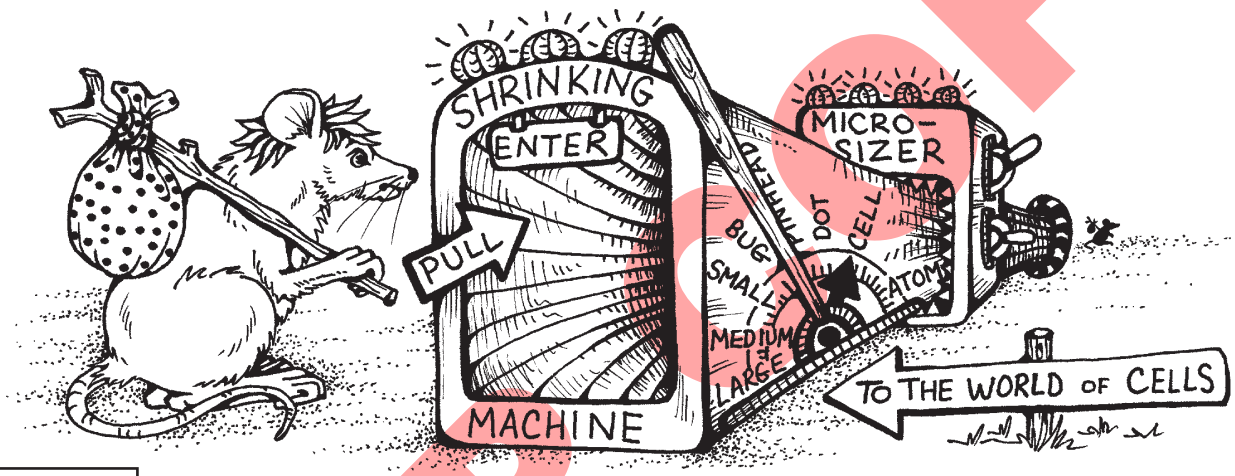
ACTIVITY #2

"HUMAN CHEEK CELLS"

There are two types of cells: *prokaryotic* and *eukaryotic*. All of the cells you look at in the lab today are of the type called ***eukaryotic*** (true nucleus). The eukaryotic type of cell is the basic component of all multi-celled life forms. Some eukaryotic cells, such as the *Paramecium*, are single-celled organisms.

However, the largest number of single-celled organisms are the bacteria and their relatives, and they are of another cell type called ***prokaryotic*** (before nucleus). You will have the opportunity to investigate them later in the semester.

Now you will begin your journey into the world of cells by looking at *human cheek cells.*



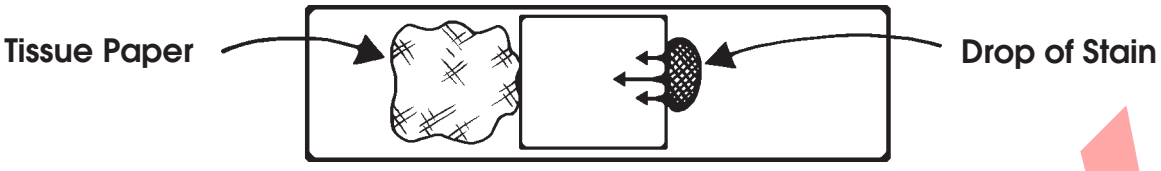
GO GET

1. A compound microscope.
2. A microscope slide and coverslip.
3. A toothpick.
4. Methylene Blue stain

NOW

1. Put a small drop of water on the microscope slide.
2. *Gently* scrape the inside of your cheek with the blunt end of the toothpick. You will have collected hundreds of eukaryotic cells on the toothpick.
3. Pay attention to exactly where you put the cells on the slide. They are hard to find. *Throw away the toothpick into the special waste container or disinfectant solution.*
4. Cover the drop with a coverslip.
5. Look at the cells under high power with your compound microscope. ***Remember:*** They will be very hard to see.

6. Now, put a drop of *methylene blue* stain at the edge of the coverslip. Use a small piece of tissue paper at the other edge of the coverslip to absorb the excess fluid and pull the stain across the slide. This method allows you to apply a stain without removing the coverslip.



Applying stain to the object will darken some cell structures, allowing you to see them better. Experiment with the iris diaphragm, light intensity, and condenser (if your microscope has one) to get more contrast and clarity.

7. Look at the cells again under high power. You should be able to see the ***nucleus*** and the ***cell membrane***. The nucleus controls the cell functions, and the cell membrane controls what molecules go into and out of the cell.

8. The advantage of stains is that we can see structures better. The disadvantage is that stains kill the cells. *Never use a stain if you want to see living cells!*

9. Draw a simple sketch of your cheek cells. Label the cell membrane and the nucleus.

Human Cheek Cells

? QUESTION

1. How do you know that your cheek cells are *eukaryotic* cells?

2. You may be asked on a Lab Test to make a wet mount of cheek cells, and find them under the microscope. Can you do it?

3. Point out the cell membrane and cell nucleus to your lab partner. Be able to do the same for your instructor on a test.

FINALLY

Use alcohol or disinfectant solution to clean your slide before reuse in the next Activity. Follow the directions from your instructor.

ACTIVITY #3

"ONION CELLS"

In this Activity, you will be examining a plant cell. As you work through the steps, notice a difference between plant and animal cells (human cheek cells).

GO GET

1. Cutting board and knife.
2. Cut an onion into "onion rings."

NOW

1. The cut onion will come apart into $\frac{1}{8}$"-thick rings. Make your peel from the inside (not the outside) of one of the onion rings. You should be able to peel off a one-cell-thick layer of tissue. It will look like a piece of plastic wrap. You can use a razor blade or forceps to start the peel. But don't slice off a piece; that will be many cell layers thick. You need a one-cell layer.
2. Place the onion peel into a drop of water on the slide, trying not to fold it over on itself.
3. Finish the wet mount, and look at the cells under the compound microscope (low power first, then high power).
4. Now, put a drop of *iodine* stain at the edge of the coverslip. Use the tissue paper to draw the stain across.
5. Look at the cells again. You should be able to see the ***nucleus*** and the ***cell wall***. The nucleus controls cell functions, and the cell wall is a little box made of cellulose (wood) produced by the cell for support. *Draw a simple sketch of the onion cells at high power. Label the cell wall and the nucleus.*

Onion Cells

? QUESTION

What differences and similarities did you observe between the onion (plant) cells and the cheek (animal) cells?

FINALLY

Wash off the slide and coverslip so that you can use them for the next Activity. Don't throw them away. They can be used over and over again.

ACTIVITY #4

"PARAMECIUM"

A ***Paramecium*** is a one-celled organism. Because it must do everything in its life as only one cell, it is far more complex than any single human cell.

GO GET

A drop of water from the bottom of the *Paramecium* culture (these organisms usually settle near the bottom), and put the drop on your slide.

NOW

1. Make a wet mount, and find the *Paramecium* under the 10x objective lens (that will be 100x magnification).

Paramecium

2. Your job is to train your hands to be able to follow this organism under the microscope. ***Hint:*** Don't think! Let your hands work by themselves.
3. Practice your quick-vision skills by making a simple sketch of the *Paramecium*. Label the nucleus and the cell membrane.
4. ***Optional:*** We have a product called Protoslo® that can be added to the water drop sample. It will dramatically slow the movements of the *Paramecium* because it thickens the water. However, Protoslo® will also push the one-celled organisms to the outside perimeter of the water drop. You have to first mix the Protoslo® with the drop of sample.

? QUESTION

1. What obvious differences did you observe in the one-celled organism as compared to one cell of a multi-celled organism (cheek or onion cells)?
2. If you were asked on a test to find a *Paramecium* in "pond water," could you do it?
   Remember: Pond water will contain many different organisms.
3. How do you think a *Paramecium* eats? (Refer to your textbook for the answer.)

FINALLY

Wash off the slide and coverslip in preparation for the next Activity.

ACTIVITY #5

"*ELODEA* LEAF"

Elodea is found in freshwater ponds, and is commercially grown and sold as an aquarium plant. Pay attention to the differences between the *Elodea* cells and the onion cells that you observed in Activity #3.

GO GET

An *Elodea* leaf from near the tip of a healthy plant. Use forceps to pluck the leaf. Keep track of which side is the *upper* side of the leaf.

NOW

1. Make a wet mount with the upper side of the leaf facing up, and find the *Elodea* cells under the 10x objective. Look near the tip of the leaf. These are often very active cells. Then switch to high power magnification.

2. You will know that the cells are alive and active if you can see ***chloroplasts*** moving around the cell. It may take a few minutes of warming under the microscope light before the chloroplasts begin to move. Chloroplasts are the cell structures (organelles) that do *photosynthesis* (food production) in plants.

3. There is a large sac of fluid inside the *Elodea* cell called the ***central vacuole***. Imagine a swimming pool that has a huge clear sac of water floating in it. You can't actually see the sac of water, but the movements of everyone in the pool will be influenced as they bump into that large clear sac.

   Now watch the movement of chloroplasts. See if you can observe the indirect evidence that the central vacuole is in the cell and is influencing the movement of those chloroplasts.

   Draw a sketch of the *Elodea* leaf cell and label the central vacuole and the chloroplasts.

Elodea Cells

4. During the Microscope Lab you used the fine focus at high power to determine which color of thread was on top of the others.

   An *Elodea* leaf is two cells thick. You should be able to decide whether the top layer is made of bigger or smaller size cells than the bottom layer. Do this now.

? QUESTION

1. What color are the chloroplasts?

2. When you see the color of plants, what *structures* are you actually seeing?

3. What does the *movement* of the chloroplasts tell you about the cell?

4. If you can't actually see the central vacuole inside the *Elodea* cell, then how do you know that it is there?

5. *Elodea* leaves are two cells thick. One of the layers has thick cell walls. Those cells are in the . . . (circle your choice)

Top layer or Bottom layer

6. What is the most obvious difference you observed between the *Elodea* cell and the onion cell?

What does that observation tell you about the activity of food production in the onion cell?

Where is food produced in the onion plant?

FINALLY

Save this* Elodea *slide for the next Activity. You will look at the cells one more time.

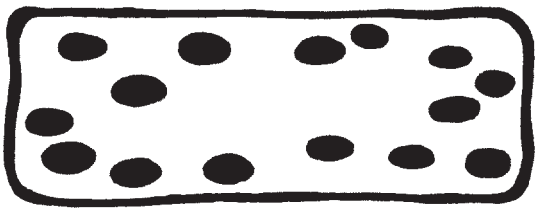
ACTIVITY #6

"COMPARISON OF COLOR IN FLOWER PETAL, RED-ONION SKIN, AND *ELODEA* LEAF"

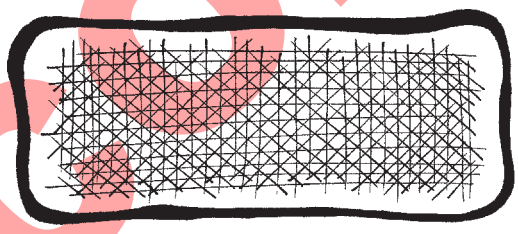
The color of plant parts is determined by various *pigments* inside the cells. In some cells the color is inside organelles called ***plastids***. Chloroplasts are one kind of plastid. There are other plastids that contain different colored pigments.

In other cells the pigment is distributed throughout the *water* of the central vacuole. Your task in this Activity, is to determine and compare where the color is located in an *Elodea* leaf, red-onion skin, and yellow flower petal.

In order to determine whether a pigment is in the central vacuole or inside the plastids, you must look at one cell layer, and note the distribution of the color within the individual cells.



A color distribution like this indicates that the pigment is inside the plastids.



A color distribution like this indicates that the pigment is in the water of the central vacuole.

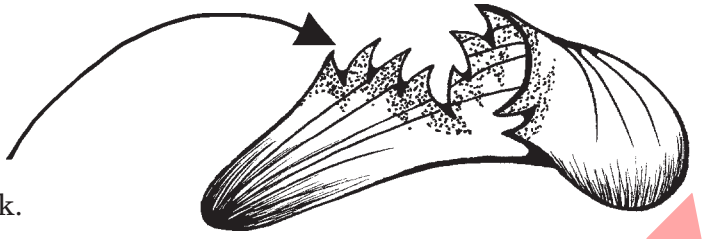
GO GET

1. A small piece of red onion.
2. A yellow flower petal. (Your lab may substitute red bell pepper.)
3. Your *Elodea* leaf slide from Activity #5.
4. Two more slides and coverslips.

NOW

1. Make a wet mount of a one-cell-thick layer of the red-onion skin. Peel a layer from the inside red part of the onion (not from the dry outside skin).
2. Determine whether the red color is inside the plastids or distributed throughout the water of the central vacuole.

THEN



1. Make a tearing peel of the yellow flower petal.

   The ragged edge will be one cell thick.

2. Make a wet mount of the yellow flower petal, and look at the *one-cell-thick* area on the ragged edge of the tearing peel.

3. Determine whether the yellow color is inside of the plastids, or distributed throughout the water of the central vacuole.

Note: If your lab is using red bell pepper, then cut a very small piece (without the skin) and crush it on your slide with a razor blade. Apply a drop of water and coverslip.

? QUESTION

1. Look again at your slide of the *Elodea* leaf. Where is the green color in *Elodea* cells?

2. Where is the red color in the red-onion skin cells?

3. Where is the yellow color in the yellow flower petal cells (or red bell pepper cells)?

4. If you were asked on a Lab Test to determine where the color is in red rose petal cells, or orange flower petals, could you do it and show your evidence (including your skill at making a *one-cell-thick* wet mount)?

FINALLY

Wash off your slides and coverslips. Save one for the next Activity.

ACTIVITY #7

"*ZEBRINA* LEAF EPIDERMIS WITH STOMATA"

Most animals have some method of breathing. Do plants have any such equivalent process?

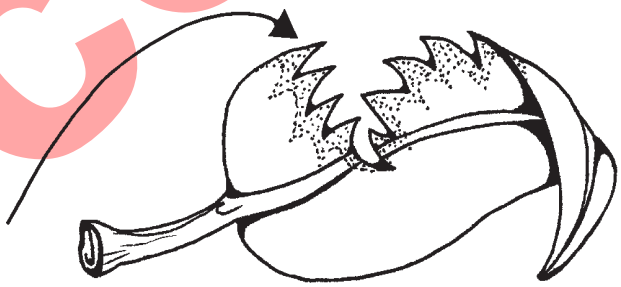
Scattered throughout the *underside* skin of the *Zebrina* leaf are small openings called ***stomata***. Stoma is the Greek word for "mouth." These openings look like green lips.

The stomata regulate the flow of air into and out of the leaf. Your job is to find these stomata.

GO GET

A *Zebrina* leaf.

NOW



1. Make a leaf peel with the leaf upside down so that you can get a one-cell-thick peel of the ***underside*** of the *Zebrina* leaf. (The top side of the leaf does not have stomata.) A thin layer will peel off the bottom of the leaf as you tear if you are doing the procedure correctly. Cut off the thin layer piece with a razor blade. Don't try to make a thin slice with your razor blade. You won't get a single-layer slide. Always use the tear/peel technique.

2. Make a wet mount and look for the stomata.

3. Look closely at the structure of the stomata. Notice whether you can identify the organelles inside of the two cells that make up the stomata. These two stomata cells are called *guard cells* because they "guard" the opening. (Your textbook discusses the details of the chemical processes by which the stomata are opened and closed.)

4. Look at the skin cells around the stomata. Notice what cell organelles they *don't* have.

5. Draw a simple sketch of the *Zebrina* leaf stomata and the surrounding cells.

Stomata

? QUESTION

1. *Zebrina* leaf stomata perform a specific function. What is it?

2. What organelles do the guard cells contain that are absent in the skin cells of the leaf?

3. Why would the guard cells have chloroplasts when the other skin cells of the leaf don't have chloroplasts?

4. If you were asked on a Lab Test to make a *one-cell-thick* wet mount of leaf stomata, could you do it?

FINALLY

Wash off your slide and coverslip, and return them to the supply table. Return your compound microscope to the cabinet.