Lab 4 - Cells to Organisms

(June 2014)

Section 1- Molecules Essential to Cells

[2] Welcome to Lab 4. This is Pat Farris speaking and today I'll be introducing you to the things that make you an organism. We'll start with the internal workings of cells and go through tissues, organs and organ systems. Let's get started.

[3] To begin, let's do a little review of the chemistry that will be essential to today's lab. Take a

[9] Take a moment and recall the structure of a phosopholid. Remember the long tail represented a long non-polar chain of CH_2 groups and the small circle at the other end represents the polar section of the molecule. In other words, the two ends of the molecule act differently in response to water. Copy this diagram and label the hydrophobic and hydrophilic sections on your drawing.

[10] If we were to put these phospholipids into water, they would arrange themselves with the least amount of drama. What I mean by that is that the hydrophobic parts would get as far from the water as they could, and the hydrophilic parts would get as close to the water as they could, as shown in your lab book. This results in an arrangement called a phospholipid bilayer, which as you could probably guess, means there are two layers in which all the molecules have their preferred arrangement regarding water. Label the hydrophobic and philic areas of the bilayer as shown here.

[11] Well that's a very pleasant arrangement, but all we have so far is a boundary between two water-based environments. What we really need is the outer layer of a cell, which will require oxygen, water and food molecules to get in and for waste molecules to get out. This is where the "mosaic" part of the model comes in.

[12] In art, a "mosaic" is made up of thousands of little pieces of different colors that, when viewed from a distance, become a complete picture. The cell does the same thing with different organic components. A cell membrane is a collection of millions of phospholipids which have other organic molecules incorporated into the bilayer to accomplish the bigger job of moving molecules in and out of the cell.

[13] These additional components are listed here and in your lab book. Record the various roles of these molecules in the table. I'm sure you've heard of cholesterol before, but you may not have realized it is an important part of cell membranes, sometimes making up 25% of the membrane.

[14] And here are those molecules in place in a complete Fluid Mosaic Model. Please go back

[17] Now remember the proteins we looked at in last week's lab - the enzymes? What better

[25] First up is the very important cell membrane. Remember that every cell has one. I think you can remember the function of a cell membrane from just a few minutes ago, but just to help you along - cell membranes are the boundary of cells, controlling the flow of molecules that move in and out.

[26] Another organelle that forms a boundary for some cells is the cell wall. It is NOT found in animal cells, so check off only the bacteria and plant columns in your lab book. A cell wall is a tough outer cell layer that supports the cell. This will be a very easy way to tell plant cells from animal cells, just in case we ever ask...

[27] The nucleus is next. Remember, we won't find a nucleus in prok

[34] Our march through the organelles continues with the vacuole - a large fluid-filled sack easily seen in plants. It can   be found in animal cells, but not commonly, so maybe

Section 5 - Animal Cells

[44] At the beginning of Section 5, you have a diagram of the typical cell organelles found in animal cells. Review the names and functions. They should all sound familiar, except the extra one shown inside the nucleus called the nucleolus. We will see these later in the semester, but for now, just remember that you may see extra bodies within the nucleus of some cells, but they aren't separate organelles.

[45] Next you will look at a living animal cell - one out of your own mouth. These cells occur in layers to protect your mouth against all the wear and tear that happens when you eat, so you always have a few extra cells that we can examine.

[46] This photograph shows how to get your sample of cells. Follow the directions carefully in Section 5 and I bet you'll be able to see some bacterial cells as well. It all depends on how long it's been since you've brushed your teeth... Continue when you have finished your drawing and measurement of the cheek cells.

[47] Did you remember to label the parts of the cell and to convert your measurement to micrometers? Great! The cells lining your mouth are called epithelial cells, and specifically a type called squamous epithelium. "Squamous" means "flat". You will be observing a different type of epithelium later in the lab.

Section 6 - Plant Cells

[48] Now we can compare your animal cell to some plant cells. We'll be looking at the cells of an aquatic plant called .

[49] When we looked at the thin epithelial cells of your mouth, we had to use a stain called methylene blue, but we don't need any stain to look at plant cells – they're filled with bright green chloroplasts that are very easy to see. But because we aren't using a stain, we won't be able to see the nucleus of these particular cells.

[50] Return to the program when you have completed Section 6. Keep your slide handy if you are going directly on to Section 7 - we can use the same leaf slide for our next exercise for diffusion and osmosis.

[51] Let's try a couple of questions before we go on. (Difference between animal and plant cells)

[52] You may want to review your lab a bit before you try this question. (outer layer of bacteria, plant and animal cell called)

Section 7 - Diffusion and Osmosis

[53] Now that we've examined the two major cell types, prokaryotic and eukaryotic, and seen some typical plant and animal cells, it's time to address how these cells function. All cells need to balance their intake of molecules, and of particular interest to us is water. Even an aquatic plant like Elodea needs to control water levels inside the cell. You'll need your Elodea slide from the previous exercise in just a minute, so keep it handy.

[54] But first, let's go over a few definitions before we discuss the process of water movement.

[61] Now we have what we need for osmosis - a difference in solute concentration AND water on both sides. Here's what the water will do - more of it will end up on the concentrated side, in other words, the sugar side of the membrane inside the bag. Why? Because water is obeying the same diffusion principle as the perfume - it's moving to the area of its lower concentration.

[62] It's sort of like offering food at a party. If the food platters are in the kitchen, they stay in the kitchen, like the solute will stay in the bag. Every person at the party is free to move through the rooms of the house, like water molecules can move through the membrane. However, once people have found the food in the kitchen, they tend to stay there because they don't want to leave the food. Think of people as the water molecules and the food platters as the solute that can't leave the membrane.

[63] Keep this movement of water molecules in mind and complete the drawing of what happens to the bag after osmosis before beginning the experiment.

[64] Now you will see how a living cell reacts to a hypertonic environment. When you have

[71] Next we'll examine how these various tissues are arranged within an organ. We're going to look at the small intestine of a frog because it is very similar to what you'd find in a human, but their little intestines fit nicely onto a microscope slide.

[72] Follow the directions in your lab book for observing the frog intestine slide on scanning. Find the structures shown here and complete the labels in your lab book. Note the projections called villi. A single projection is called a villus. Their function is to increase the surface area of the intestine, because the main function of the intestine is to absorb nutrients. The more surface area inside the lumen, the faster the food is absorbed.

[73] But where do the food molecules go? Although you can't see them in your frog slide, each villus has tiny blood vessels called capillaries, and they eventually deliver the nutrient-rich blood into your bloodstream. The central tube in the villus is called a lacteal and is part of your lymphatic system. The lacteal absorbs fats, so you can see each little villus is quite complicated. You can summarize the function of the capillaries and the lacteal by saying they both absorb nutrients.

[74] Now look at your slide on low power and look closely at the tall cells that line each villus. There is a darkly stained nucleus at the base of each of these cells. These tall cells are called "columnar epithelium" and are strikingly different in shape from the squamous epithelium we looked at when we observed your cheek cells. These tall, columnar cells have a much different function than your cheek cells, because it is the job of these cells to absorb food molecules as they pass by. Measure the thickness of this columnar epithelial layer before you continue.

[75] Now go to high power to examine the columnar epithelium layer in detail. You may notice the other type of cell in between the columnar cells and these are called goblet cells. Goblet cells act as tiny glands that secrete mucus, a slippery substance that keeps everything moving. I bet you didn't know a frog could be this complicated! Complete the cell labels in your lab book shown here before you continue.

[76] Now's a good time for a question.

[77] Finish up Section 8 and make sure you've finished labeling all the diagrams and answered the last couple of questions. Continue the program when you are ready to begin Section 9.

Section 9 - Organs of the Digestive System

[78] Now that we've looked at organelles, cells and tissues within just the small intestine, it's time to examine some other organs and how they work together. Please record the definitions for organs and organ systems before we go on. An organ is a group of tissues that accomplish a common function and an organ system is a collection of organs working together to perform a major body function.

[79] In the frog intestine slide that you examined a moment ago, you saw how four tissue types accomplished the common function of nutrient absorption. The intestine is just one component

of the entire digestive system, and now we will look at the other digestive organs and how they work together.

[80] Before we start, go to the demo table and examine our human model. Let's see how much you know about your body and see if you can identify the parts before I give you the answers. Fill in your guesses in your lab book. Good thing you're using pencil...

[81] We'll begin by filling in the table in your book. The first food processing that you do is obviously in the mouth. In addition to chewing, you're incorporating your first digestive enzyme from your salivary glands. The enzyme is called amylase and it starts the breakdown of starch. Record this first step in the category for "salivary glands and mouth".

[82] When you swallow, food enters the esophagus, a smooth muscular tube that connects the throat to the stomach. Other than the chewing and enzyme treatment you gave the food in the mouth, not too much has happened yet, the esophagus simply transfers the food to the stomach.

[83] In the stomach though, is where the magic begins. The food is dropped off into a pool of powerful acids and an enzyme called pepsin, which will break the food up into smaller chemical pieces that the rest of your digestive enzymes can work on. The stomach is also quite muscular, and will act to mix up the food, acids and enzymes until it is in a liquid state. Please record the processing accomplished by the stomach in your lab book before we go on.

[84] After the stomach has worked on your meal for about 3 hours, a small valve at the base of the stomach will open, allowing the food slowly into the small intestine. At this point the food is a sloshy liquid and several more digestive chemicals are added by the pancreas and gall bladder. The actual time it takes to get all the way through the small intestine varies a great deal depending on what kind of food was eaten - ranging from 15 minutes to 5 hours. Most of the time though, the food will move through the small intestine in less than 2 hours. Record the processing done by the small intestine before we go on.

[85] A normal human small intestine is about an inch in diameter and 23 feet long. That's right, 23 feet. Now you already know from looking at a frog's small intestine that an intestine is not just a big open tube. The lumen has villi to increase the internal surface area.

[86] Now put these two facts together, huge numbers of villi and 23 feet of intestine that contain them, and you can see how much surface area is contained in this organ. Some people with too much time on their hands have calculated that the human intestine has the about the same surface

[88] In addition to the large intestine absorbing the extra water, it acts as a comfy home for 100's of kinds of bacteria that live in your colon. Don't panic about these bacteria - they are definitely the friendly kind because they are actually performing a service for you that you can't do on your own. They're making Vitamin K that you absorb directly into your bloodstream. So finish our digestive journey by recording the role of the large intestine in your lab book.

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Section 11 - Organisms

[98] To finish the lab today, we'll look at an entire organism, in this case an aquatic one - the common goldfish. Probably everyone has had a pet goldfish at some point, so you already know they can survive many years with just a few basics - clean water and some food. Let's think about this organism in terms of its structures and adaptations.

[99] I think you already know that fish take in oxygen through their gills, not lungs like we do. Gills are bright red because they are filled with blood vessels to pick up the oxygen from the water and deliver it directly into the fish's bloodstream. This organ has a very large surface area to gather this oxygen, as you can see from this photo of a tuna gill.

[100] One source of oxygen in the water is the air. Oxygen diffuses into a body of water from the surface of the water, so the greater the surface area, the more oxygen and the better for your fish. If you kept your little friend in a fish bowl, you probably noticed him or her coming to the surface to "gulp" air. This is a sign of low oxygen levels and your fish would really like a bigger tank or a little air bubbler to increase the oxygen supply, thank you very much.

[101] Take a moment to observe our little goldfish on the demo table if available. Notice the bright red gills and the fish's breathing behavior. When they open their mouth, they are simply moving water over the gills - they are not actually swallowing the water. Answer the questions about humans and goldfish in your lab book before we continue.

[102] And of course, it's time for a couple of questions before you go.

[103] And can you name another organ that had a large surface area?

[104] Well, that was probably more about goldfish than you needed to know, but I hope you saw the relevance of all the topics in today's lab. We looked at the interactions of molecules, membranes, organelles, tissues, organs and organ systems. I hope you liked learning about all these biological connections. That's it for this week - now go think about a bigger tank for your friend... See you next week.