TEACHER'S NOTES LESSON 21

Present these key points and questions to the students during the *Activities* section of Lesson 21, as your lecture/discussion. Make sure that as you are speaking, students are taking notes.

Cell division is divided into two parts: division of the **nucleus** and division of the **cytoplasm**. There are two types of nuclear division: **mitosis** and **meiosis**. In mitosis the number of chromosomes stays the same, while the number is cut in half during meiosis. The function of mitosis is to grow, replace dead or worn-out cells, or repair tissues by mitosis in somatic cells. These cells are the cells that make up our bodies. If one of your skin cells dies, then another one divides to replace it. If you cut yourself, cells near the cut divide and replace the cells that were destroyed during the injury. In some species such as protistans, fungi, plants and some animals they reproduce asexually, which is essentially mitotic division.

Meiosis occurs only in germ cells, such as gametes like sperm and eggs. This is necessary to cut the chromosome number in half before the sex cells join during fertilization. You don't want cells that have twice the number of chromosomes.

What is a **chromosome**? It is a long thin strand of DNA and its associated proteins called histones. The DNA is wound around the histones. The chromosome must be duplicated before division occurs. After duplication each strand is called a sister chromatid and they are connected at the centromere. There are disk-shaped structures at the surface of the centromere called kinetochores. The microtubules attach to the kinetochores during division.

Each species has a different number of chromosomes. In humans, the number is 46. Actually, all our cells except sperm and eggs have two copies of each chromosome, which indicates that the chromosome number is diploid or 2n. This is true for all the chromosomes except the X and Y chromosomes that determine our sex. If you are female you get two copies of the X, but if you are a male you get one X and one Y. Sperm and eggs are haploid, n, which means they only have one copy of each chromosome.

The Cell Cycle
The cell cycle is the duplication and division that occurs in a cell and is the essential mechanism by which all living organisms reproduce. There are two phases, **interphase** and **mitosis** that are made up of many stages. Interphase is usually the longest phase. It is when the cell actually does its "work" in an organism. It is made up of 3 parts: G1, S and G2. G1, also called "Gap1," is when a cell grows and then does its function or job in a cell. For example, if it is a liver cell, it does its work as a liver cell during interphase (such as carbohydrate, fat and protein metabolism). Just after division, a cell is very small and doesn't have much energy left. Therefore, in interphase it grows and replaces the energy it used to divide. Then it goes to work doing whatever it is required to do in a cell.

S is called "synthesis." During this phase the DNA in the cell is replicated in preparation for division. G2 is called "Gap2" and occurs after S. The cell used lots of energy to duplicate its DNA so it must replenish its stores before it divides. Tomorrow we will discuss what happens during mitosis.

Mitosis
Mitosis is the actual division of a cell. Mitosis is made up of the following stages: prophase, metaphase, anaphase and telophase. What happens in each stage? The DNA that has been replicated starts to condense and form visible chromosomes. The cytoskeleton (microfilaments and microtubules), which gives a cell its shape, starts to break apart. You can't move your chromosomes around if you have a stiff scaffold holding everything in place. The centrioles that started duplicating themselves during interphase now start to move to opposite sides of the cell. A spindle apparatus starts forming and the microtubules attach to the sister chromatids. This apparatus is used later to move the chromosomes from the center to the edges. The nuclear envelope that normally surrounds the chromosomes starts to break up as well.

Why do you think the cells needs to do all these things? Well, if you have your DNA trapped in the nucleus it is very hard to move it to opposite sides of the cell. If your DNA is still in long thin strands it is very difficult to separate. Can you imagine trying to separate a pile of threads that are tangled up? Well, that is what would happen to your chromosomes if you didn't condense them into nice compact thick packets. In addition, if you have a cell that is not circular, but one that has many extensions it is difficult to evenly divide all the cytoplasm. Therefore, it is better to

get rid of the current cytoskeleton so your cell takes on the shape of a circle. It's much easier to divide and separate all your organelles this way. Draw an image of a fibroblast or cell with filapodia as an example. Point out how difficult it is to evenly divide the cytoplasm in this cell.

Metaphase occurs after prophase. The nuclear envelope completely breaks up now. This membrane is stored as flat little vesicles to be recollected later to form the new nuclear envelope. The chromosomes attach to the spindle apparatus, which is made of microtubules. They line up at the equator of the cell, thus, meta (middle) phase.

Anaphase follows metaphase. In this stage the attachments between the two sister chromosomes separate. Now each chromatid moves to the opposite pole. This movement occurs in two stages, anaphase A and anaphase B. In anaphase A, the microtubules attached to the chromosome shorten and in this manner pull it toward the pole. In anaphase B, the spindle elongates as the overlapping microtubules slide apart. This adds distance between the two poles, which in the end helps ensure that separation will occur. When the chromosomes reach the pole anaphase is over.

Telophase is the last stage. The chromosomes are released from the microtubules and start to decondense forming long thin filaments again. The nuclear envelope starts forming as the vesicles that contain the plasma membrane gather and fuse. This continues until a complete membrane is formed.

Cytokinesis or cytoplasmic division
After nuclear division you need to divide the cytoplasm. This occurs in different ways in plants and animals. In animals the cells divide by strangulation or by the cells pinching themselves into two parts. A cleave furrow forms that is made of microfilaments and myosin. These elements slide past each other like a purse string that closes the top of a bag. The more they move, the smaller the center gets until the two daughter cells are divided into two cells. In plant cells, the process is different because of the cell wall. They can't divide by strangulation. They use another process in which they form a plate in the center of the cell and it grows outward until it reaches the cell edge. Cell wall material accumulates at this plate. This is called cell plate formation. Now you have two cells.