TEACHER'S GUIDE

SCIENCE KEY CONCEPTS SERIES: BIOLOGY

CELLS AND TISSUES

15 minutes, Video

Distributed by **BENCHMARK MEDIA**

FOR USE IN: General Science, Biology

LEVEL: Grades 7-12

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EDUCATIONAL OBJECTIVES:

To help the student understand these key concepts about cells and tissues:

- ⇒ how the different functions of cells and tissues, explain their different structures;
- ⇒ the differences and similarities between plant and animal cells;
- ⇒ the differences in cell division between mitosis and meiosis, and why.

BACKGROUND INFORMATION:

Among the myriad evolutionary pathways that have led to the rich biodiversity of life, it is very remarkable that certain key cellular characteristics fully separate all plants from animals. These include the presence of a cellulose wall surrounding plant cells and the presence of photosynthetic plastids that are never found in true animal cells. Some of the common characteristics of plant and animal cells are presented here and the differentiating features clearly exhibited. It is important to keep in perspective that the capacity to form tissues requires cellular adhesion into multicellular masses and regulation of genetic expression, such that out of all the myriad possibilities in the genetic code, only those pertinent to the tissue are expressed at any point in time. These two essential aspects of tissue organization and control should be kept in mind as the video is discussed with students.

Adhesion of cells into a coherent cell mass, forming a tissue, requires recognition and specific binding to one another. Modern cell biological research has clarified how surface molecules on cell membranes permit cells of the same tissue type to recognize one another and cohere. Some simple but elegant experiments illustrate this. When a living sponge is disrupted into individual cells by passing it through a mesh, cells of a particular type re-aggregate through specific cell-cell recognition to form a complete intact animal.

Similarly, modern molecular genetics helps to explain how certain genes are activated in a tissue, thus ensuring its specialized function and giving it a particular role in an organism. Timing of activities in tissues is partially determined by hormones that signal when specific activities will be expressed, or not. Some of these hormones signal the cells to become active by binding on the outer membrane of the cell initiating intracellular signals to activate the cell (protein hormones are characteristic of this class). Other hormones are lipid (fat) soluble and penetrate across the outer membrane of the cell, entering the nucleus and activating genes (steroid hormones are included here). Tissue organization, combined with hormonal and nervous system signaling, account for much of the remarkable elegance of coordinated activity in multicellular organisms including humans.

BEFORE SHOWING THE VIDEO:

Many students study single-celled organisms including protozoa before considering metazoans. Protozoa, therefore, provide a good starting point to introduce this video on cells and tissues. Display a diagram of a ciliate such as Paramecium. Elicit from the students some of the functions of life exhibited by the single-celled organism, including feeding by sweeping food particles into the gullet, digestion by enclosing the food into digestive vacuoles, defecation by expelling waste from the anal pore, asexual reproduction by mitosis and sexual reproduction by meiosis and union of two cells, sensitivity to the environment including swimming toward food and avoiding noxious stimuli, and motility by ciliary beating. Discuss this remarkable combination of activities within a single cell. Note, however, that with all of this happening inside a single cell there is less capacity to respond to the environment in the complex ways that can be achieved if there is more than one cell. When an organism has more than one cell, there can be specialization, each group of cells dedicated to a particular function.

The potential for this specialization, however, is shown by all of the many activities that take place in the single-celled protozoa. If all of these potential functions were not included in the cellular genetic code, there could be no specialized role for groups of cells. In multicellular organisms, these processes are delegated to certain groups of cells, so the work is more efficient and is controlled more effectively.

To provide a perspective on the levels of organization in living things, make a chart on the board listing the following categories: 1. molecular, 2. cellular, 3. tissue and 4. organ, leaving space after each one for descriptions to be added by the students. Ask the students to give examples of each level based on their prior

knowledge of living things. Help the students understand that each of the levels builds into the other. We need molecules to make up the structure of cells, such as the molecules found in membranes, enzymes, DNA, etc. Molecules are organized into the many cellular organelles such as: plasma membrane, vacuoles, mitochondria, ribosomes, and the chloroplasts of plant cells, etc. Similarly, groups of cells with similar structure and function compose tissues; and finally, tissues serving a particular function form organs including the heart, striated muscles, lungs, stomach, etc.

The video also includes a discussion of mitosis and meiosis. This may be enhanced by introducing the idea that the reproductive organs are made of cells and tissues. These tissues produce gametes such as egg and sperm, each being a haploid cell with half the number of chromosomes as in a diploid parent cell. Remind the students that reproduction involves the union of egg and sperm (each haploid) to produce a zygote (diploid) that gives rise to a new individual of the species.

CONTENT OF THE VIDEO:

The video contains the following key concepts. To play only concepts 2 or 3, simply fast forward to its title.

	running time min:sec
1. Animal Cells: Structure and Tissues	**4:00**
2. Plant Cells: Structure and Tissues	**5:18**
3. Cell Division: Mitosis and Meiosis	**5:00**

These concepts of plant and animal cells are illustrated with live photography, microscopy of living cells, scanning electron very high magnifications of cell and tissue sections, computer graphic models of cell interiors, and clarifying positioned captions

1. Animal Cells: Structure and Tissues

A student takes a swab of the inside of his cheek, brushes the swab on a slide, and we see the microscopic enlargement of a human cheek cell. Cell membrane, nucleus, cytoplasm, and mitochondria are pointed out, and their functions explained. How cell form follows its function is shown with red blood cells, nerve cells, and sperm cells. The examples shown of how cells combine into tissues to carry out a common function are: muscle cells and tissue, and the interior lining of the large and the small intestines.

2. Plant Cells: Structure and Tissues

Plants convert the sun's light energy into food energy by photosynthesis. The cut edge of a leaf under a scanning electron microscope shows epidermal, protective hair, palisade, and spongy mesophyll cells, each quite different structures for different functions. Computor animation reveals the structure of a typical plant cell: nucleus, cytoplasm, vacuole, cell membrane, and cell wall for support. Microscopy shows the interior of a live onion cell: vacuole, cytoplasm, and nucleus. The magnified edge of a moss leaf shows chloroplast cells. The surface magnified shows stomata and guard cells which control the size of the stomata opening, thereby regulating gas exchange and so the rate of photosynthesis. Hair cells on roots increase the area for absorbing water and minerals. Stems transport water and minerals to the leaves through tubes called xylem.

Cell Division: Mitosis and Meiosis

Plants grow and maintain themselves by cell division in which the two daughter cells are identical to the mother cell in a process called mitosis. The duplication and separation of chromosomes in the nucleus as it occurs in mitosis, is seen both in computer animation, and in live microscopy. Meiosis only happens in the reproductive organs of plants and animals. In a plant's flower, the male reproductive organ is the anther, which produces pollen, the equivalent of an animal's sperm. The pollen is deposited on the plant's female reproductive organ, the carpel, germinates, and descends the carpel tube to egg cells inside the ovary. The initial duplication of chromosomes in meiosis is like mitosis, except that some chromosomes came from a mother, and others from a father. The chromosomes are separated and randomly go to one side or the other, then split into two cells, each with a new mix of the parents chromosomes, then separate again into two cells, each containing half the normal number of chromosomes. When a female sex cell merges with a male sex cell, the resulting fertilized egg will again have the full number of chromosomes.

AFTER SHOWING THE VIDEO:

Students often prefer to be actively engaged through role playing in their learning. You can simulate the merits of specialization and tissue organization in living things as follows. Prepare an outline of the human head and torso and reproduce it for distribution to the class. Ask each student to illustrate all of the following: the esophagus, stomach, small intestine, large intestine, heart, and lungs, by drawing it on the outline. Tell them they have one minute to do it. After one minute have them display their individual drawings, or whatever part was finished. Then create small groups and assign each group a particular organ to draw. Give each group a clear acetate overhead containing a tracing of the human head and torso, and also a felt-tip pen to make their drawing. Give them each one minute for the work. Then, have them compile their drawings into one on the overhead projector, or lay them on top of one another on a white paper as a display for all to see. Ask the

students which way was the easiest to get a good drawing? Which way produced the most carefully produced drawing? How does this activity represent what happens when a multicellular organism has tissues and organs? The students should see that by specializing in one task and coordinating their efforts across tasks as do tissues and organs, a more efficient and effective way was found to produce the drawing of the human torso and its organs.

With the drawing in hand and after reviewing the function of each organ, ask students to describe what they think the cells would look like in each of the tissues composing the heart muscle, lining of the esophagus, inner surface of the lung, and lining of the small intestine. Display actual photographs or scientific illustrations of cells from these tissues and compare them to the students' descriptions. How are they similar and how different? How does the structure of the cell help us understand its function within the tissue where it occurs? What are the misconceptions that the students held based on their description compared to the scientific illustrations? Do the students comprehend why their views were not scientifically correct? Have they revised their understanding to be more scientific after discussing the scientific photographs or illustrations of the cells from the various tissues?

EXPLORING AND INVESTIGATING:

Encourage students to compare some animal and plant tissues for different cell types. Dilute iodine or very dilute toluidine blue solution can be used as a stain when making the wet mounts for light microscopic observations. Peels can be made of onionskin as shown in the video, purple onions containing purple cytoplasm are very effective. Leaf peels from green plants, and samples of soft tissue from pears, orange segments, etc. also can be examined with the microscope. The students should note that in all cases there is a cell wall, though varying in thickness, surrounding the cells. If you have sections of herbaceous stems, the students can examine them to see the thickened epidermis cells, soft parenchyma tissue and the hardened vascular conducting tissue composed of tracheids and vessels, the latter two with especially thickened cell walls. Obtain small pieces of very fresh skeletal muscle, liver, and brain from the butcher. Help the students carefully tease apart small segments of each, prepare a slide, perhaps stained with some iodine, and observe it with the light microscope. Discuss how the cells of each tissue type are different. Why are the muscle cells elongated while liver cells tend to be rounded, etc.

INTERNET WEB SITES FOR FURTHER INFORMATION ON:

Plant and animal tissues

www.sajc.moe.edu.sg/sajc_subject/biology/web/index.htm

Human Histology

http://www.anatomy.wisc.edu/histology/histo.html

http://vhp.nus.sg/HIS/

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The complete Science Key Concepts Series includes:

Biology: Cellular Energy and Metabolism, Cells and Tissues, Energy transfer and Biogeochemical Cycles

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