Some Background Concerning Life Science Content Standards for Fifth-Grade Teachers:

The Internal Structure of Plants

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Contents

Introduction

The background information for teachers in this document addresses the following life science content standards[1] for fifth-grade teachers:

2. Plants and animals have structures for respiration, digestion, waste disposal, and transport of materials. As a basis for understanding this concept:

a. *Students know many multicellular organisms have specialized structures to support the transport of materials.*

e. *Students know how sugar, water, and minerals are transported in a vascular plant.*

For additional information, see pages 70-72 in the *Science Framework for California Public Schools Kindergarten Through Grade Twelve* and visit the websites listed at the end of this document.

[1] As specified in *Science Framework for California Public Schools Kindergarten Through Grade Twelve.* Sacramento: California Department of Education, 2003, pp 70-72.

Biological Overview: Structure of Organisms

Plants are multicellular creatures. Through observation and experimentation, biologists study and describe how the bodies of plants (organisms) are organized -- organs, tissues, cells, organelles, molecules, and atoms. Figure 1 shows two organs in an unusual tropical plant species.

Figure 1. Photograph[2] of a large flower cluster and specialized leaf. This tropical plant species, *Amorphophallus titanium*, has the largest flower cluster in the world!

Every species of plant and animal has internal structures (organs, tissues, and cells) that perform vital functions. The study of these internal functions is called *physiology.* Life science students sometimes have difficulty remembering what level of biological structure is being discussed in each classroom activity. Therefore, Table 1 is an important reference to reduce student confusion in life sciences.

[2] Photograph available for non-commercial purposes only, from *Explore Kew Gardens.* http://www.explore-kew-gardens.net/engMarch/textMM/princessN.htm

Table 1. Internal structure of multicellular creatures. Biologists study the bodies of plants and animals at several levels of biological organization.

Level of Biological Organization	Description	Animal Examples	Plant Examples
ORGANISM	One individual of a species	You!	Sunflower
Body Systems	Organs that work together within an animal	Circulatory system Respiratory system Digestive system Urinary system	[Not Applicable]
Organs	A part of an organism with a special function	Heart Lungs Stomach	Flower Leaf Stem Root
Tissues	Several types of cells that function together	Blood Muscle Nerve	Epidermis Xylem Phloem
Cells	Smallest independent unit of life	Red blood cell White blood cell Brain cell	Guard cell Vessel Root hair
Organelles	Structure within a cell	Mitochondria	Chloroplasts Mitochondria
Molecules	Chemical compound	Water Sugar Carbohydrate Protein Fat	Water Carbon dioxide Chlorophyll Oxygen gas Sugar
Atoms	Chemical element	Carbon atom Hydrogen atom Oxygen atom	Carbon atom Hydrogen atom Oxygen atom
Subatomic	Particles that make an atom	Electron Proton Neutron	Electron Proton Neutron

Life Science Topic: Internal Structure of Plants

Like animals, the bodies of plants are composed of many cells living together. Cells are the smallest unit of life, and need a constant supply of food and oxygen. Many tissues in plants are specialized to transport materials to and from cells.

How Water and Food Flows through a Plant

Science Framework[3] for California Public Schools

Grade 5: Standard Set 2. Life Sciences: 2.a. "*Students know many multicellular organisms have specialized structures to support the transport of materials."*

> *"Multicellular organisms usually have cells deep within them that need to receive a supply of food and oxygen and, in the case of animals, to have cellular wastes removed. In higher-order animals blood circulation is responsible for transporting glucose sugar to each cell, providing oxygen, and removing cellular wastes and carbon dioxide. To demonstrate the transport of water in a plant, the teacher may cut the bottom end of a stalk of celery and place it in water containing food coloring. After the colored water is taken up into the plant, students can make cross-sections of the celery and observe them under a microscope. Observing the cross-sections is helpful to students in understanding Standard 2.e."*

Grade 5: Standard Set 2. Life Sciences: 2.e. *"Students know how sugar, water, and minerals are transported in a vascular plant."*

> *"The xylem of plants is a woody tissue responsible for water and mineral transport from roots to leaves. Water moving up the plant stem replaces water that has evaporated from the leaves. Plants also transport sugar from the leaves to the roots through a living structure of tubes called the phloem."*

[3] As specified in *Science Framework for California Public Schools Kindergarten Through Grade Twelve.* Sacramento: California Department of Education, 2003, pp 70-72.

Background for Teachers

Plants have specialized vascular[4] tissues to transport materials to and from cells.

Water Transport in Plants

Water and *mineral-nutrients*[5] enter a plant from the soil through organs called *roots*, and flow together (as mineral-laden water) one–way up stems into the leaves. This mineral-water moves through special vascular tissue called *xylem*, which is composed of dead cells (once living, now dead) that transport mineral-water as if each cell were a hollow straw.

In non-woody plants, the xylem is in a strand of vascular tissue called a vascular bundle (Figure 2); in trees and shrubs, the xylem is the wood[6] itself (Figure 3).

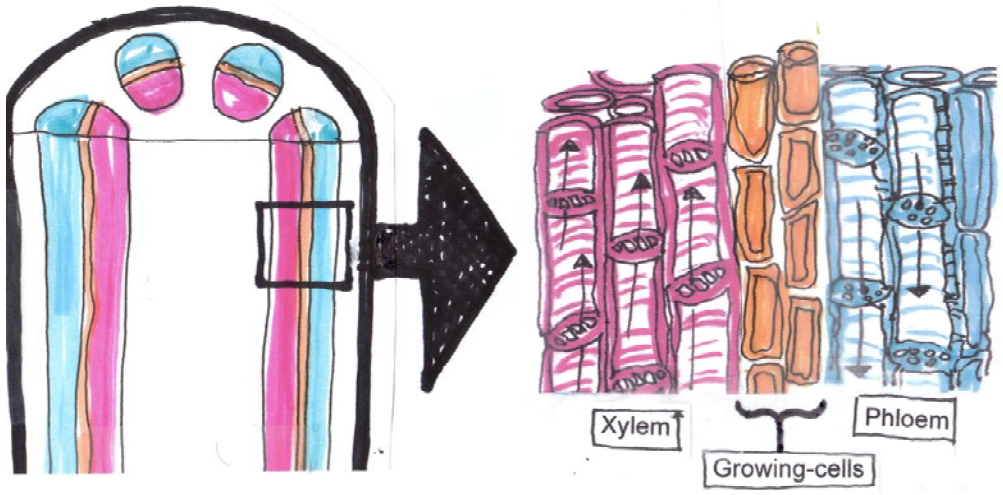

Figure 2. Diagram of non-woody plant stem. Non-woody plants, such as sunflowers and lilies have strands of vascular tissue called *vascular bundles*. This diagram shows four vascular bundles in a cut stem. The side view of one vascular bundle is enlarged to show the cells. Hollow, dead xylem cells (pink) transport mineral-water up the stem; living phloem cells (blue) transport sugar-water down the stem to the root (and/or up the stem to the growing stem tips). The growing-cells (orange) make new xylem and phloem cells as needed.

[4] *Vascular* refers to vessels that transport body fluids, as in blood vessels of the cardiovascular system of animals.

[5] *Mineral-nutrients* are inorganic molecules and atoms that usually come from weathered rock and are taken up by the roots of plants. *Mineral-nutrients* act as fertilizer for plants (e.g., nitrate, phosphate, potassium). *Mineral-nutrients* are not to be confused with *food nutrients*, which animals need. *Food nutrients* are organic molecules (such as: protein, fats, and carbohydrates).

[6] The xylem cells in the sapwood of trees are open and transport mineral-water; the xylem cells in the heartwood of trees no longer transport mineral-water.

Figure 3. Photograph[7] of woody plant stem. Large trees and shrubs do not have vascular bundles; the xylem is the wood, and the phloem is part of the inner bark. Xylem cells in the sapwood (light colored wood) of trees are like open straws that transport mineral-water (sap). Xylem cells in the heartwood (dark-colored wood in the center) of trees no longer transport mineral-water. Note that phloem, which transports sugar-water (also sap) to the roots is between the wood and the bark; phloem is part of the *inner bark* of trees.

Xylem cells are arranged end-to-end to form long, tiny tubes from the tips of the roots, up the stems, and into every leaf. Inside the xylem cells, water molecules form cohesive columns[8] from the roots to the leaves. Leaves have tiny pores (stomata) in them, and every time a water molecule exits a pore (via evaporation) it pulls the other water molecules up behind it. This process (*transpiration*) is how water travels all the way to the top of 200-foot tall trees (Figure 4).

[7] Photograph from website: http://commons.wikimedia.org/wiki/File:Taxus_wood.jpg
[8] Water molecules are charged (polar molecules); consequently, they stick (adhere) together.

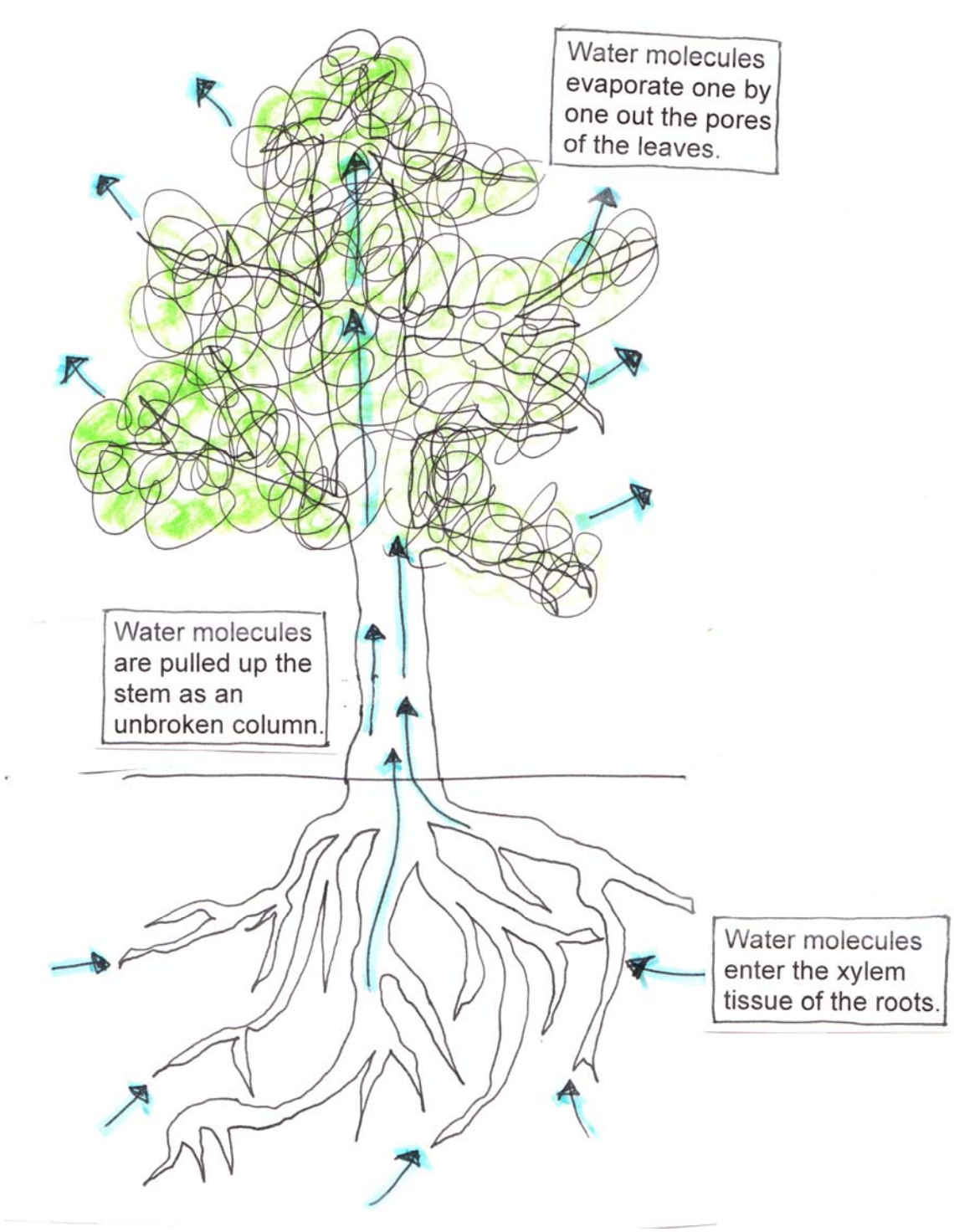

Figure 4. Diagram of water traveling up the xylem of a tree. Water molecules enter into the xylem of the root, travel up the trunk in an unbroken column, and exit from the pores (stomata) in leaves.

Food Transport in Plants

Unlike animals, plants make their own food. Food is made in organs called leaves, and flows (as sugar in water) either down stems into the roots or up stems to growing stem-tips. This sugar-water moves through special vascular tissue called *phloem*, which is composed of living cells that transport sugar-water through them as if each cell were a living tube. Phloem cells are arranged end-to-end, and the sugar-water moves from cell to cell in the phloem through tiny connections between the cell membranes.

In non-woody plants, the phloem is in a strand of vascular tissue called a vascular bundle (Figure 2); in trees and shrubs, the phloem is part of the inner bark[9] (Figure 3).

[9] The inner bark of trees includes phloem and growing-cells (vascular cambium).

Websites

Plants

Biology 4 Kids Educational Site
This website contains simple descriptions and diagrams about plant biology.

http://www.biology4kids.com/files/plants_main.html
This page presents the basic biology of plants.

http://www.biology4kids.com/files/plants_structure.html
This page describes plant organs and their functions.

http://www.biology4kids.com/files/plants_xylemphloem.html
This page explains how plants feed every cell in their body.