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

Human Body Systems

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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:

b. *Students know how blood circulates through the heart chambers, lungs, and body and how carbon dioxide (CO_2) and oxygen (O_2) are exchanged in the lungs and tissues.*

c. *Students know the sequential steps of digestion and the roles of teeth and the mouth, esophagus, stomach, small intestine, large intestine, and colon in the function of the digestive system.*

d. *Students know the role of the kidney in removing cellular waste from blood and converting it into urine, which is stored in the bladder.*

Biological Context: Internal Structures of Organisms

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.

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

Table 1. Hierarchy of internal structures of multicellular creatures. Biologists study the bodies of plants and animals at several levels of biological organization. This table is best used by starting at *organism* and working down through smaller and smaller structures that make up an organism.

Level of Biological Organization	Description	Animal Examples	Plant Examples
ORGANISM	One individual of a species	You!	California Poppy
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 work 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	Small membrane-bound structures 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: Human Body Systems

Like plants and animals, human bodies are composed of many cells living together. Cells are the smallest unit of life in our bodies, and each cell needs a constant supply of food and oxygen. Many organs in our bodies are specialized to transport materials to and from our cells. As we breathe air and eat food, oxygen molecules and food molecules are transported to each one of our cells to keep every cell in our body alive. Four body systems are involved in bringing food and oxygen to our cells and removing waste from our cells: the circulatory system; the respiratory system; the digestive system; and the urinary system.

How Oxygen and Food Molecules Reach Every Cell in the Body

Science Framework[2] for California Public Schools
Grade 5: Standard Set 2. Life Sciences: 2.b. "*Students know how blood circulates through the heart chambers, lungs, and body and how carbon dioxide (CO_2) and oxygen (O_2) are exchanged in the lungs and tissues."*

> *"Structures of the cardiovascular and circulatory systems, including the heart and lungs, promote the circulation of blood and exchange of gas. The left side of the heart is responsible for pumping blood through arteries to all the tissues of the body and delivering oxygen. Oxygen-poor blood returns to the heart through veins; the right side of the heart is responsible for pumping this blood to the lungs, where the blood eliminates its carbon dioxide and receives a fresh supply of oxygen. Exhaling expels the carbon dioxide that was transported to the lungs by the blood; inhaling allows the intake of oxygen, which is picked up by the blood."*

Background for Teachers
Animals have specialized organs to transport materials to and from cells. Food molecules and oxygen molecules are brought to every cell in the human body via vascular tissue (blood) in the *circulatory system*, which is composed of organs, including the heart, lungs, and blood vessels (Figure 1). The tiniest blood vessels (capillaries) bring food molecules and oxygen molecules to each individual cell in the body, and take waste molecules and carbon dioxide molecules away from each cell (Figure 2).

The heart pumps fluid throughout the body.

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

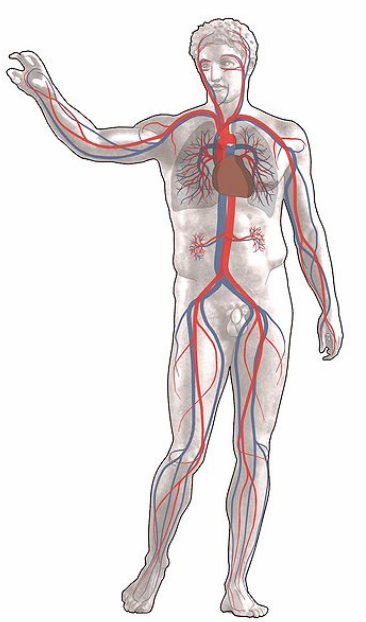

Figure 1. Diagram[3] of circulatory system. The heart (organ) pumps blood (tissue) to the lungs (organs) where the blood absorbs oxygen (molecules), then the heart pumps this freshly oxygenated blood throughout the body in arteries. After going through capillaries, the blood travels through veins back to the heart to be once again pumped into the lungs.

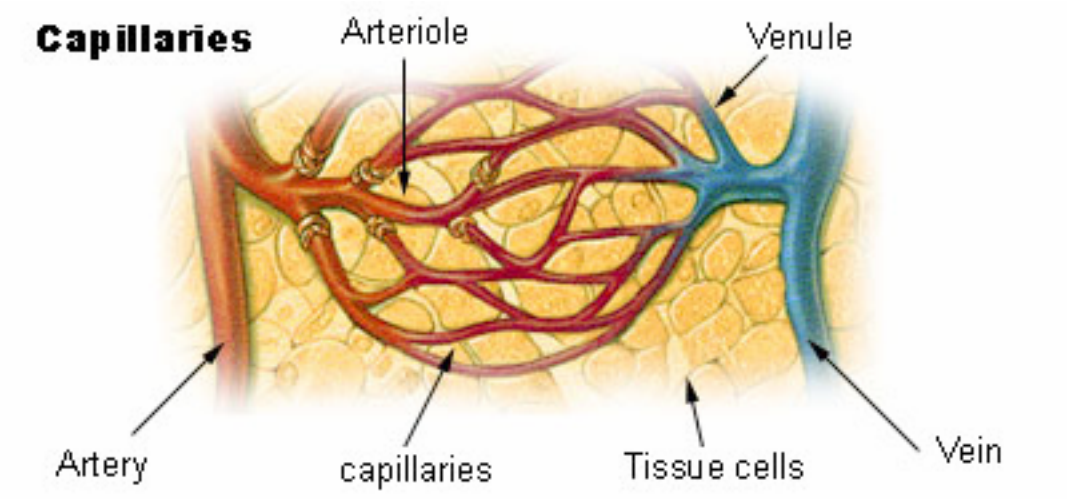

Figure 2. Diagram[4] of capillaries and tissue cells. Oxygen-enriched blood flows from arteries into smaller (arterioles) and smaller (capillaries) blood vessels, bringing food and oxygen to individual tissue cells. Oxygen-depleted blood carries wastes and carbon dioxide away from the tissue cells via capillaries (through venules) to a vein.

[3] From Wiki-educator: http://commons.wikimedia.org/wiki/File:Grafik_blutkreislauf.jpg
[4] Website: http://upload.wikimedia.org/wikipedia/commons/d/da/Illu_capillary.jpg

How do oxygen molecules enter the blood vessels of humans?

- Air, which contains oxygen molecules, is inhaled via the *respiratory system*, which is composed of organs, including the nose, trachea, and lungs (Figure 3).
- The oxygen molecules are absorbed into red blood cells in the blood tissue and delivered to individual cells in the body.

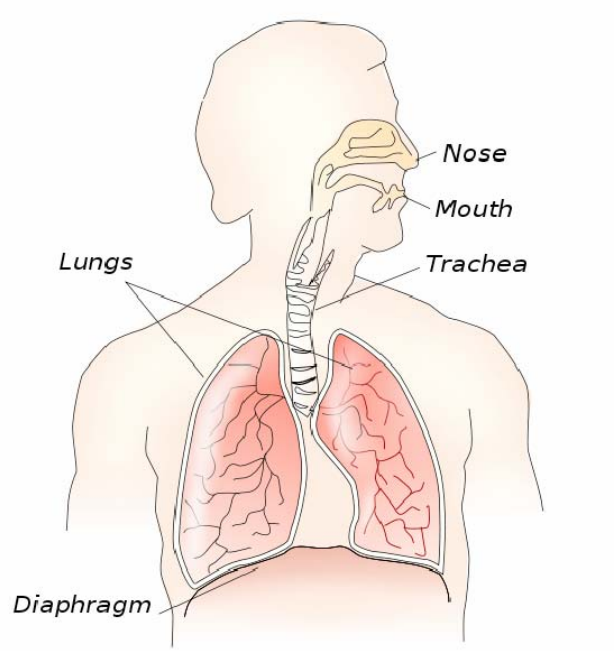

Figure 3. Diagram[5] of the respiratory system. The lungs (organs) take in air that contains oxygen molecules. The oxygen molecules pass from tiny air sacs (deep in the lungs) into the blood. The oxygenated blood then travels via arteries to all cells in the body.

[5] From Wiki-educator: http://commons.wikimedia.org/wiki/File:Respiratory_system.svg

How Food is Broken Down into Molecules to Enter the Blood

Science Framework[6] for California Public Schools

Grade 5: Standard Set 2. Life Sciences: 2.c. "*Students know the sequential steps of digestion and the roles of teeth and the mouth, esophagus, stomach, small intestine, large intestine, and colon in the function of the digestive system."*

> *"Digestion starts in the mouth, where chewing breaks down food into smaller pieces that can be easily swallowed and digested. Saliva contains compounds that are also important in breaking down food. The esophagus is a tube that moves food from the mouth to the stomach after swallowing. In the stomach the food is mixed with stomach acids that help to break down the food into parts that can be absorbed. Once food reaches the small intestine, it is neutralized and processed into molecules that can be absorbed into the blood supply. The large intestine recovers water from food, and the colon collects fecal waste (indigestible parts of food) and stores it prior to elimination from the body."*

Background for Teachers

Animals have specialized organs to break food down into tiny molecules, which can then travel in the blood to all cells in the body.

How do food molecules enter the blood vessels of humans?

- Food is broken down into molecules through the action of the *digestive system*, which is composed of several organs, including: mouth, esophagus, stomach, small intestine, large intestine (colon), rectum, and anus (Figure 4).
- The food molecules are absorbed into the blood stream and delivered to individual cells.
- Solid material that is not digested exits the body via the rectum and anus.

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

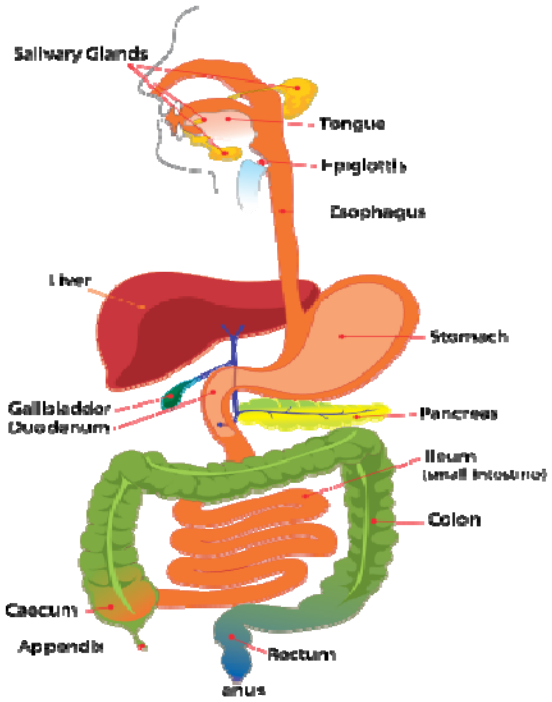

Figure 4. Diagram[7] of the digestive system. The process of digestion begins in the mouth through chewing and salivary enzymes. The food then travels down the esophagus to the stomach for more digestion. Digested material enters the small intestine, where food molecules enter the circulatory system. In the large intestine (colon), bacteria help break down some of the food; thereby releasing vitamins into the blood stream. The remaining undigested matter then passes to the rectum and out the anus.

[7] From Wiki-educator: http://commons.wikimedia.org/wiki/File:Digestive_system_simplified.svg

How Waste Molecules from Cells are Removed from the Blood

Science Framework[8] for California Public Schools

Grade 5: Standard Set 2. Life Sciences: 2.d. "*Students know the role of the kidney in removing cellular waste from blood and converting it into urine, which is stored in the bladder."*

> *"Cells in living organisms produce waste products that they cannot recycle into other compounds. The focus of this standard is on the systems that remove waste from the cells to prevent it from accumulating and eventually poisoning the organism. Cellular waste products (in the form of molecules) are separated from the bloodstream by the kidneys, stored in the bladder as urine, and removed from the body by urination. In plants many such waste products are stored in a large central vacuole in each plant cell—a kind of garbage dump that is gradually filled as the cell ages."*

Background for Teachers

Animals have specialized organs to transport waste materials from cells.

How do waste molecules and carbon dioxide molecules leave the bodies of humans?

- Waste molecules and carbon dioxide molecules are released by individual cells and absorbed by the blood in capillaries.
- Carbon dioxide molecules are released from the body via the *respiratory system* when we exhale.
- Waste molecules are released from the body via the *urinary system*, which is composed of several organs, including kidneys, bladder, and urethra (Figure 5).

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

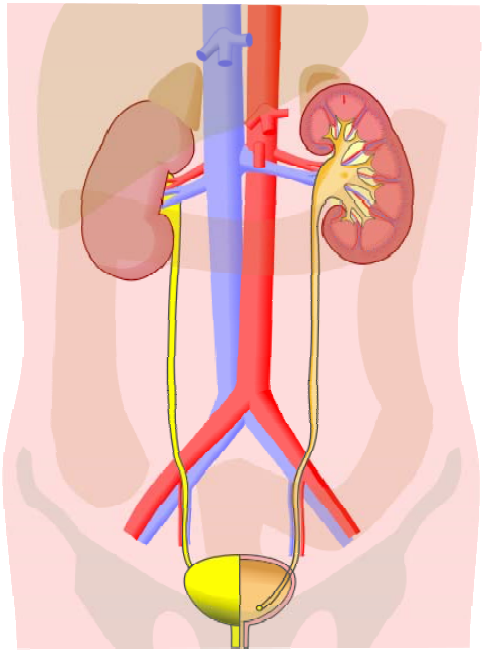

Figure 5. Diagram[9] of the urinary system. The kidneys receive waste molecules from the blood. The waste molecules travel in fluid to the bladder, and the waste fluid is released out the urethra.

[9] From Wiki-educator: http://commons.wikimedia.org/wiki/File:Urinary_system.svg

Websites

http://www.biology4kids.com/files/systems_main.html
This page presents the concept of body systems in animals.

1. Circulatory System

http://www.biology4kids.com/files/systems_circulatory.html
http://kidshealth.org/PageManager.jsp?lic=1&article_set=54036&cat_id=20607
http://yucky.discovery.com/noflash/body/pg000131.html
http://www.kidcyber.com.au/topics/bodyblood.htm

2. Respiratory System

http://kidshealth.org/PageManager.jsp?lic=1&article_set=54039&cat_id=20607
http://yucky.discovery.com/noflash/body/pg000138.html
http://www.kidcyber.com.au/topics/body_lungs.htm

3. Digestive System

http://kidshealth.org/kid/cancer_center/HTBW/digestive_system.html
http://kids.lovetoknow.com/wiki/Digestive_System_for_Kids
http://yucky.discovery.com/noflash/body/pg000126.html
http://www.kidcyber.com.au/topics/bodydigest.htm

4. Urinary System

http://kidshealth.org/PageManager.jsp?lic=1&article_set=54027&cat_id=20607
http://yucky.discovery.com/noflash/body/pg000128.html
http://www.kidcyber.com.au/topics/waterbody.htm