**Food Chemistry Unit**



**STANDARDS**



**State Standards Addressed:**

The digestive system is made of parts that have specific functions. Matter containing food energy (chemical energy) is transformed in this system into heat energy and energy of motion (kinetic.) Nutrients are essential to human health. Some nutrients promote good health more than others. Foods contain varying amounts of these nutrients: starches, sugars, fats, and/or proteins, among others.

4-5 PS3A Energy has forms, such as heat, light, sound, motion, and electricity

4-5 PS3B Energy can be transferred from one place to another.

**AAAS 2061 Sci Benchmarks**

**By end 2nd:** students should be familiar with variety of ways of making things go and should consider "What makes it go?". Once they learn that batteries wear down and cars run out of gasoline, turning off unneeded appliances can be said to "save on batteries" and "save on gas." The idea that is accessible at this age is that keeping anything going uses up some resource.

**By end 5th:** When two objects are rubbed against each other, they both get warmer. In addition, many mechanical and electrical devices get warmer when they are used. 4E/E1\*;

**By end 8th:** Whenever energy appears in one place, it must have disappeared from another. Whenever energy is lost from somewhere, it must have gone somewhere else. Sometimes when energy appears to be lost, it actually has been transferred to a system that is so large that the effect of the transferred energy is imperceptible. 4E/M1\*

Energy can be transferred from one system to another (electrically, when an electrical source such as a battery or generator is connected in a complete circuit to an electrical device). 4E/M2\*

Energy appears in different forms and can be transformed within a system. Chemical energy is associated with the composition of a substance. Electrical energy is associated with an electric current in a circuit. 4E/M4\*

**EXPLANATION TRACKER – KEY IDEAS**

* Energy can be transferred
* Energy can be transformed and has many forms such as chemical, electrical, heat, and light. (Plants convert light energy into stored chemical energy (glucose) which we consume and convert into heat and motion energy.)
* Systems work when subsystems properly function (digestive system and parts)
* Some nutrients promote good health – in excess they do not



***Phenomena***: The Jonas Brothers eat cupcakes to celebrate their best concert ever. Joe and Kevin feel fine and get a quick boost of energy from the sugar but then feel tired. Nick, however, gets no boost, and immediately feels more tired and sluggish. Why do you think Nick might have a different reaction to the nutrients in the cupcake than his brothers?

***Essential question****:* How do our bodies use nutrients for energy?

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**Explanatory Model: (Teacher understanding)**

Foods we eat are made up of different components we call **nutrients**. Some nutrients are more helpful to the body than others and the body can convert the chemical energy from food into heat or motion (kinetic) energy. The digestive system provides the mechanism through which the body is able to break down food and use it for energy (or other purposes).

Organs that make up the **digestive system** are the mouth, esophagus, stomach, small intestine, large intestine—also called the colon—rectum, and anus. Inside these hollow organs is a lining called the mucosa. In the mouth, stomach, and small intestine, the mucosa contains tiny glands that produce juices to help digest food. The digestive tract also contains a layer of smooth muscle that helps break down food and move it along the tract. Two “solid” digestive organs, the liver and the pancreas, produce digestive juices that reach the intestine through small tubes called ducts. The gallbladder stores the liver's digestive juices until they are needed in the intestine.

Digestion involves mixing food with digestive juices, moving it through the digestive tract, and breaking down large molecules of food into smaller molecules. Digestion begins in the mouth, when you chew and swallow, and is completed in the small intestine. The first major muscle movement occurs when food or liquid is swallowed. The digestive glands that act first are in the mouth—the salivary glands. Saliva produced by these glands contains an enzyme that begins to digest the starch from food into smaller molecules. An enzyme is a substance that speeds up chemical reactions in the body. Although you are able to start swallowing by choice, once the swallow begins, it becomes involuntary and proceeds under the control of the nerves. Swallowed food is pushed into the esophagus, which connects the throat above with the stomach below. At the junction of the esophagus and stomach, there is a ringlike muscle, called the lower esophageal sphincter, closing the passage between the two organs. As food approaches the closed sphincter, the sphincter relaxes and allows the food to pass through to the stomach.

The stomach has three mechanical tasks. First, it stores the swallowed food and liquid. To do this, the muscle of the upper part of the stomach relaxes to accept large volumes of swallowed material. The second job is to mix up the food, liquid, and digestive juice produced by the stomach. There are digestive glands in the stomach lining. They produce stomach acid and an enzyme that digests protein. A thick mucus layer coats the mucosa and helps keep the acidic digestive juice from dissolving the tissue of the stomach itself. In most people, the stomach mucosa is able to resist the juice, although food and other tissues of the body cannot. After the stomach empties the food and juice mixture into the small intestine, the juices of two other digestive organs mix with the food. One of these organs, the pancreas, produces a juice that contains a wide array of enzymes to break down the carbohydrate, fat, and protein in food. Other enzymes that are active in the process come from glands in the wall of the intestine. The second organ, the liver, produces yet another digestive juice—bile. Bile is stored between meals in the gallbladder. At mealtime, it is squeezed out of the gallbladder, through the bile ducts, and into the intestine to mix with the fat in food. The bile acids dissolve fat into the watery contents of the intestine, much like detergents that dissolve grease from a frying pan. After fat is dissolved, it is digested by enzymes from the pancreas and the lining of the intestine. The lower part of the stomach mixes these materials by its muscle action. The third task of the stomach is to empty its contents slowly into the small intestine. Several factors affect emptying of the stomach, including the kind of food/nutrients and the degree of muscle action of the emptying stomach and the small intestine. Carbohydrates, for example, spend the least amount of time in the stomach, while protein stays in the stomach longer, and fats the longest. As the food dissolves into the juices from the pancreas, liver, and intestine, the contents of the intestine are mixed and pushed forward to allow further digestion.

Finally, the digested nutrients are absorbed through the intestinal walls and transported throughout the body. The waste products of this process include undigested parts of the food, known as fiber, and older cells that have been shed from the mucosa. These materials are pushed into the colon, where they remain until the feces are expelled by a bowel movement. Most digested molecules of food, as well as water and minerals, are absorbed through the small intestine. The mucosa of the small intestine contains many folds that are covered with tiny fingerlike projections called villi. In turn, the villi are covered with microscopic projections called microvilli. These structures create a vast surface area through which nutrients can be absorbed. Specialized cells allow absorbed materials to cross the mucosa into the blood, where they are carried off in the bloodstream to other parts of the body for storage or further chemical change. This part of the process varies with different types of nutrients. The digestible carbohydrates—starch and sugar—are broken into simpler molecules by enzymes in the saliva, in juice produced by the pancreas, and in the lining of the small intestine.

Starch is digested in two steps. First, an enzyme in the saliva and pancreatic juice breaks the starch into molecules called maltose. Then an enzyme in the lining of the small intestine splits the maltose into glucose molecules that can be absorbed into the blood. Glucose is carried through the bloodstream to the liver, where it is stored or used to provide energy for the work of the body.

Sugars are digested in one step. An enzyme in the lining of the small intestine digests sucrose, also known as table sugar, into glucose and fructose, which are absorbed through the intestine into the blood. Milk contains another type of sugar, lactose, which is changed into absorbable molecules by another enzyme in the intestinal lining.

Fiber is undigestible and moves through the digestive tract without being broken down by enzymes. Many foods contain both soluble and insoluble fiber. Soluble fiber dissolves easily in water and takes on a soft, gel-like texture in the intestines. Insoluble fiber, on the other hand, passes essentially unchanged through the intestines. Foods such as meat, eggs, and beans consist of giant molecules of protein that must be digested by enzymes before they can be used to build and repair body tissues.

An enzyme in the juice of the stomach starts the digestion of swallowed protein. Then in the small intestine, several enzymes from the pancreatic juice and the lining of the intestine complete the breakdown of huge protein molecules into small molecules called amino acids. These small molecules can be absorbed through the small intestine into the blood and then be carried to all parts of the body to build the walls and other parts of cells.

Fat molecules are a rich source of energy for the body. The first step in digestion of a fat such as butter is to dissolve it into the watery content of the intestine. The bile acids produced by the liver dissolve fat into tiny droplets and allow pancreatic and intestinal enzymes to break the large fat molecules into smaller ones. Some of these small molecules are fatty acids and cholesterol. The bile acids combine with the fatty acids and cholesterol and help these molecules move into the cells of the mucosa. In these cells the small molecules are formed back into large ones, most of which pass into vessels called lymphatics near the intestine. These small vessels carry the reformed fat to the veins of the chest, and the blood carries the fat to storage depots in different parts of the body.

There are many organs and enzymes that play roles in the digestion of food and also in how those nutrients are made accessible to the body. In the case of the Jonas Brothers they all digest the cupcake normally, releasing glucose into the blood stream from the small intestine. Nick has Type I diabetes which means his pancreas cannot produce insulin, a hormone which helps cells absorb glucose from the bloodstream. So Kevin and Joe have insulin which allow the glucose, broken down from the cupcake through digestion to enter muscle c ells and give them a quick burst of energy. Nick does not naturally produce insulin so there is no helper hormone to let glucose get into the cells to give them energy. Nick does not feel a burst of energy because the glucose cannot get inside the cells. His blood glucose level spikes and he is more tired until he uses an insulin pump or shot.

ALTERNATIVE PHENOMENON: DIET COKE VS REGULAR COKE

Similar explorations help students understand how diet cola and regular cola affect our bodies with regard to sugar specifically. Instead of a cupcake the Jonas brothers could also drink a soda and students could explain why it would be better for Nick to drink a diet coke instead of a regular coke – or leave the Jonas Bros out entirely, they were so 10 years ago! ☺

**ACTIVITY PLANNER – DRAFT** (Add activities and fill out boxes to continue planning)

These activities are not all encompassing but provide a starting place. Each activity may span multiple lesson periods depending on the level of detail your students want to pursue. Listen for and follow up with personal connections students have to nutrition and health questions, particularly related to diabetes, though any related issues could be explored that connect to students’ lives.

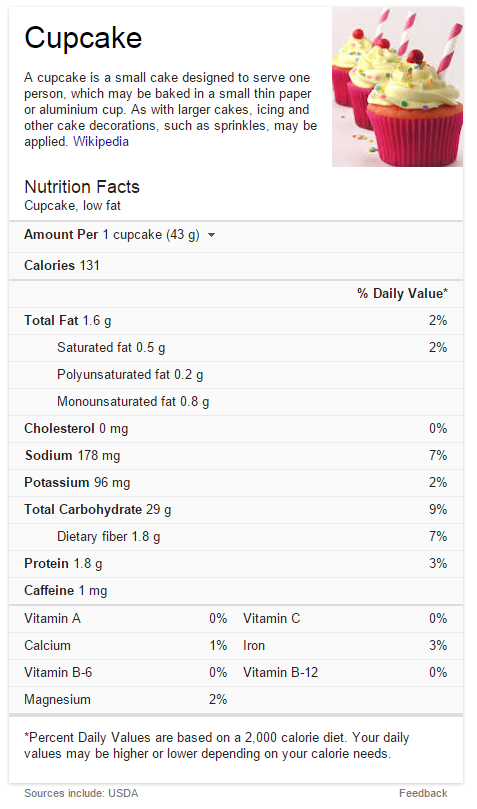
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| Activity | Learning | Connection to Explain Jonas Bros Phenomenon |
| **NUTRITION LABELS**  Students bring in, observe Nutrition Labels on foods from home – What are foods made of? What information does the labelling give us? What do we notice about the ingredients? Which items do we think are healthy? Which aren’t? How do we know? Or why do we think so? (Teacher also brings in cupcake labels to connect with phenomena – what ingredients in cupcakes could make us have energy? Or feel tired?)  *Reading* <http://kidshealth.org/kid/stay_healthy/food/labels.html>  *After exploring labels, watch one label video:*  basics: <https://www.youtube.com/watch?v=zt_ko5QvGRc>  detailed: <https://www.youtube.com/watch?v=MrdCBqFYDyo> | Students learn the parts of a nutrition label and what information is included. Beginning understanding of how we determine what is healthy (or not) for us.  Start a question list that students can research and answer on their own.  Also, students bring in many experiences related to these nutrients like “My dad has high blood pressure so he has to avoid sodium.” “My grandma has to watch her sugar cuz she’s diabetic.” “My mom has high cholesterol so she takes medicine for it.” | Examining the cupcake label (provided by teacher) gives students some info about what’s in cupcakes that could affect the Jonas Bros. Likely the cupcake label will show a substantial amount of carbohydrates and sugars and not much fiber or protein. |
| **NUTRIENTS – PROTEINS, CARBS, FATS**  Jigsaw readings about proteins, carbs, fats, calories   * Proteins<http://kidshealth.org/kid/stay_healthy/body/protein.html?tracking=K_RelatedArticle> * Fats<http://kidshealth.org/kid/stay_healthy/food/fat.html?tracking=K_RelatedArticle> * Carbs<http://kidshealth.org/kid/stay_healthy/food/carb.html?tracking=K_RelatedArticle> * Calories<http://kidshealth.org/kid/stay_healthy/food/calorie.html?tracking=K_RelatedArticle>   Return to “How do we know what foods are healthy?” question How do we get energy from our food? How do we know how much energy is in our food? Then, connect to Jonas Bros about cupcakes. Is there a particular nutrient that could cause this difference? Why or why not? | As students read make an index card with 3 important facts from the reading:  (1) What are …  (2) Why we need …  (3) an interesting fact.  Students use index card when they have to share with mixed groups. When sharing info, all students fill in matrix in sci NB notes for each.  Students learn the purpose of each of the 3 basic nutrients and also what calories are. | Use what students observed about cupcake labels from the nutrition label activity to inquire more about carbohydrates (which is the main component of cupcakes) – Though we don’t have the whole story yet, we are building our understanding of what’s in the cupcake. |
| **IDENTIFYING NUTRIENTS IN FOOD**  You may have access to particular chemicals to test for starches and glucose in food samples. This testing will likely span over several lessons to test for each type of nutrient.  Specific chemical and physical tests can be used to determine whether a food contains starches, glucose (a type of sugar), fat, or protein. Iodine can be used to test for starches, glucose test strips for glucose, colored paper for fats, and coomassie blue test strips for proteins. | Students learn that nutrients in their food can be detected using various chemical tests.  Students confirm presence of nutrients shown on nutrition labels using chemical tests on food samples in the district science kit (if you have one). | Different foods are made of different nutrients. Could we test a mushed up sample of a cupcake using our chemical indicators? What nutrient does it test positive for?  Cupcakes definitely have glucose.  (If using the diet vs regular soda phenomenon, then test each soda and find out that regular soda tests positive for glucose, compare to presence of sugar on nutrition label.) |
| **CALORIES AS ENERGY**  Burning demonstration (or video) of burning different kinds of food (cereals work best) and identifying the length of burn to the nutrition label. Prior to lesson, acquire nutrition labels for each food burned and make a set for each pair of students to use to identify a pattern between the length of burn and the amount of calories/energy  Burning foods to measure calories  <https://www.youtube.com/watch?v=UDgeaAMdYIY> | Calories are a measure of energy. Food energy is also called “chemical energy.” Our body uses food as energy (more in digestive system lessons). The longer the food burns the more energy is stored in that food (and transformed into heat/light when burned). | This particular lesson doesn’t directly explain Nick’s reaction to the cupcake BUT cupcakes do have calories.  (If using the diet vs regular soda phenomenon, then diet coke has 0 calories and regular coke has 240 per 20 oz. If we could burn a liquid, which would burn longer? Why? Why doesn’t diet soda have calories?) |
| **DIGESTIVE SYSTEM**  What parts are in our digestive system? How do these parts work together as a system? How are carbs, proteins, and fats processed? Which nutrients give quick energy? Which nutrients keep us feeling full longer? How does digestion help us use energy and/or store energy from food? How does this system help our body transfer or transform energy?  Cartoon (start at 1:01) <https://www.youtube.com/watch?v=VwrsL-lCZYo>  Tour: <http://kidshealth.org/kid/interactive/digestive_it.html>  Pancreas video:  <https://www.youtube.com/watch?v=rV9c_CRNVNY>  Song (for fun – more detail than needed – HS level) <https://www.youtube.com/watch?v=9FEACJ-cXsY> | Students learn the names and roles of each part of the digestive system, paying special attention to how each of the 3 main nutrients (fats, carbs, proteins) get broken down and distributed to the body during digestion.  In the food testing students found glucose in certain foods, in the videos/tour in the digestive system lesson(s) look for more information about glucose and what the body needs to do in order to use it. | In the virtual tour and readings point student attention to pancreas to connect to glucose in phenomenon – most students may know main structures in system but not smaller ones like the pancreas. The function of the pancreas secreting insulin helps us break down glucose for quick energy. People with diabetes have problems creating or regulating insulin which in turn affects how quickly (or not) sugars are broken down.  This is a key piece for the Jonas Bros Explanation and may need further revisiting than just this one day – tie into students experiences with diabetes or knowing family members with diabetes and how to manage Type I and Type II – could result in additional 2 or 3 lessons going further into this.  <https://www.youtube.com/watch?v=_OOWhuC_9Lw>  Jonas Interviews:  <http://diabeteshealth.com/read/2007/04/26/5150/type-1-pop-star-nick-jonas-tells-his-story/>  <http://kidshealth.org/kid/diabetes_basics/what/nick_madi.html> |
| **Add additional activities based on standards, students’ experiences they’ve mentioned and answering other important lingering questions students have had…** |  |  |
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**Why do you think Nick has a different response to the cupcake than his brothers?**

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| **Kevin and Joe eat a cupcake and get a burst of energy.** Why do you think the cupcake might make them feel that way? Use the nutrition label.  http://lrt.ednet.ns.ca/PD/ict_projects/body_systems/sheets/digest.jpg | **Nick eats a cupcake and feels tired and sluggish.** Why do you think the cupcake might make him feel differently? Use the nutrition label.  http://lrt.ednet.ns.ca/PD/ict_projects/body_systems/sheets/digest.jpg |
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**Regular Coke vs Diet Coke**

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| **Marissa drinks a regular coke.** How do you think she feels after he drinks it? Why do you think the regular coke might make her feel that way? Use the nutrition label.  http://lrt.ednet.ns.ca/PD/ict_projects/body_systems/sheets/digest.jpg  **REGULAR COKE** | **Max drinks a diet coke.** How do you think he feels after he drinks it? Why do you think the diet coke might make him feel that way? Use the nutrition label.  http://lrt.ednet.ns.ca/PD/ict_projects/body_systems/sheets/digest.jpg  **DIET COKE** |
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