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K - 12 Outreach

Milk: an example of a mixture

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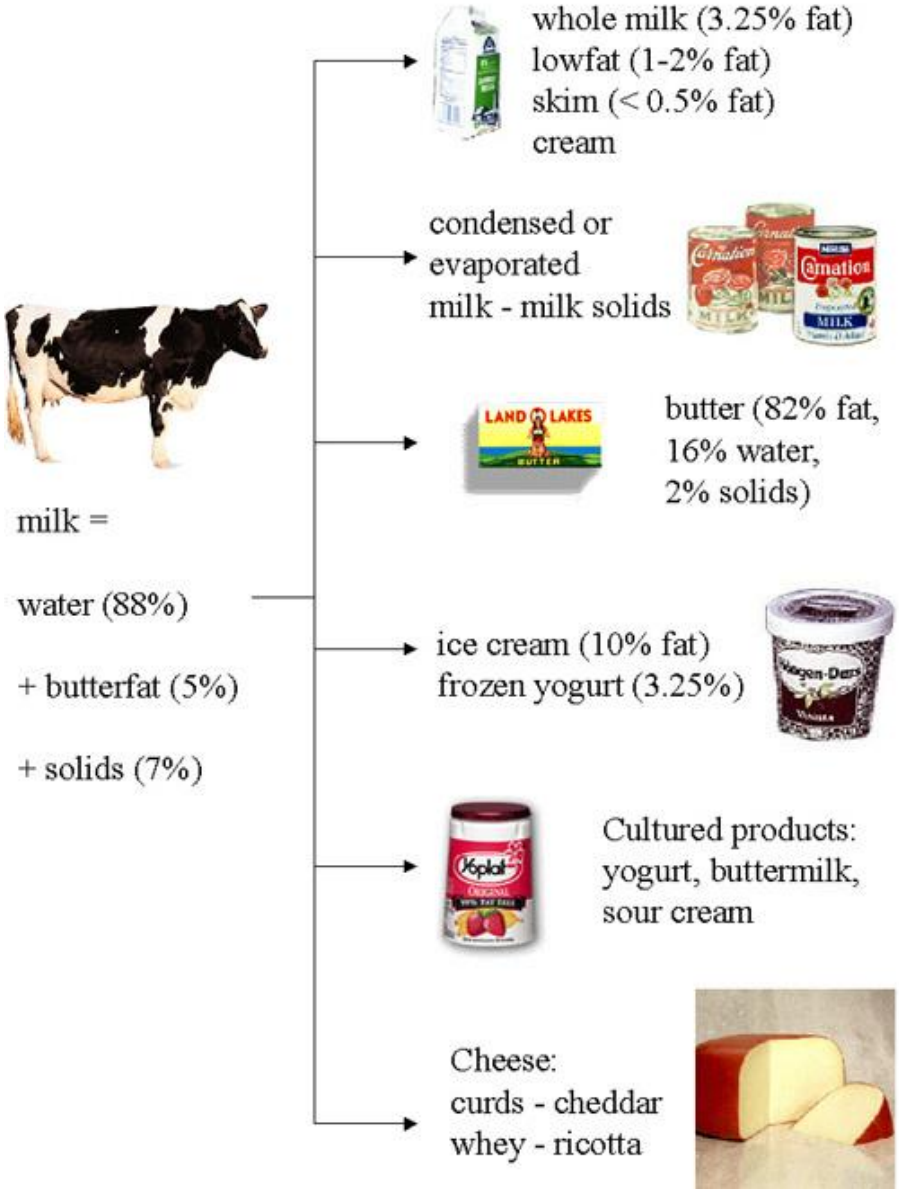

The fresh milk that comes from cows is a mixture of water, fat (also called butterfat or milkfat), and milk solids. The milk solids are made of proteins and carbohydrates. The major milk protein is casein, which is dispersed throughout the milk. Lactose is the primary carbohydrate found in milk. The enzyme lactase is used by the body to break the lactose down to galactose and glucose, two simple sugars that the body can digest. People who do not have this enzyme are "lactose intolerant" and cannot digest the lactose.

Fresh milk is usually pasteurized (heated to at least 145 oF for 30 minutes) to kill any harmful bacteria. To control the amount of fat found in the milk you find in the store, the milk is then separated using a technique called centrifugation. The centrifuge works by spinning the milk at high speeds in a large bowl - the heavier particles and the skim of milk (the more watery part) collect at the outer wall of the bowl while the cream or fat (which is lighter than the water) collects at the center and top of the bowl. Milk sold as whole milk has a fat content of 3.25%. Lowfat milk contains 1-2% fat.

Skim milk contains less than 0.5% fat. If milk is left alone, the fat particles that are suspended in the milk will float to the top - this is sold as cream. If the milk is "homogenized" the fat particles are broken down to very small sizes (diameters of 2 micrometers [a micrometer is one-millionth of a meter]). Homogenized milk will not separate into cream and will taste smoother.

To make evaporated milk or condensed milk, skim milk is often used after separation from the cream. The milk is placed in dryers and the water part of the milk is evaporated off, leaving mostly the milk solids (most of the fat went into the cream).

Butter is a very concentrated form of milk. Butter is composed of 82% fat, 16% water and 2% milk solids. The fat in milk is suspended in the mixture; by churning or agitating unhomogenized milk, the fat breaks out of the mixture in the size of rice grains. The butterfat clumps together and separates from the water - which is known as buttermilk. The buttermilk can also be used to make evaporated milk. The butter is then kneaded to remove more buttermilk. The traditional method of churning butter takes about 40-60 minutes. Modern methods can produce butter in seconds.

Ice cream and other frozen treats can be made from a variety of milks - buttermilk, condensed milk, cream or whey (the liquid part in cheese production). Ice cream must contain at least 10% fat and 20% milk solids to be called ice cream in the United States. Frozen yogurt must contain at least 3.25% milkfat and 8.25% milk solids. Ice cream is a mixture of milk, sugar, cream, flavoring and stabilizer. The stabilizer is used to prevent ice crystals from forming in the ice cream. The ingredients are mixed, pasteurized, then homogenized (to keep a smooth texture). The mix is then quickly cooled to 40o F.

Cultured milk products are another type of dairy product. These include items such as buttermilk, sour cream, and yogurt. Cultured buttermilk used to be made from the watery by-product from butter making (buttermilk). Now, lowfat or skim milk is used. Sour cream starts off as a light 18% cream. Yogurt is made from a mixture of skim milk and condensed milk to get a higher solids concentration. These three items are considered cultured milk products because the addition of a bacterium is required to make them taste the way they do. What is occurring is a chemical reaction (similar to when you add vinegar and baking soda together). The bacterium added reacts with the lactose in the milk and convert it to lactic acid. The lactic acid causes the milk protein, or casein, to coagulate or clump together. The type and amount of bacterium used give each of these items its unique flavor.

Cheese is another type of cultured milk product. In this case, the starting material, milk, is mixed with rennet and bacteria or other microorganisms to help change the lactose to lactic acid. Rennet is a mixture of enzymes that include rennin and pepsin (enzymes are proteins that promote reactions). These enzymes make the milk curdle (clot or coagulate), leaving curds (the solid part) and whey (the liquid part). The curds are cut up and then lightly heated, causing them to shrink. The resulting cheese is allowed to age anywhere from 1 month (for example, brie) to 1 year (like cheddar). Some cheeses can be eaten immediately, for example mozzarella. The whey can also be further processed to make cheeses like ricotta.