CERTIFIED HEALTH & NUTRITION COUNSELOR ONLINE COURSE - SESSION 2:

- **THE CARBOHYDRATES: SUGAR, STARCH, AND FIBER**

The Carbohydrates: Sugar, Starch, and Fiber

Most of us would like to feel good all the time. The enjoyment available in a day, no matter what the day may bring, can be tremendous if our bodies and minds are tuned for it. The feeling of well being that comes with energy, alertness, clear thinking, and confidence is so rewarding that if you know how to produce it, you will probably make the necessary effort.

It would be an exaggeration to say that good eating habits alone produce this feeling of well being. If you try to think of what makes you feel good, you can come up with several answers. Being in love, for example, is certainly one. Facing and solving a personal problem is another. Being well rested helps, and so does exercise. Being clean is still another help; a cold shower after heavy work or exercise can be bracing and exhilarating. Sparkling weather, clean air, beautiful scenery, and pleasant company – all these play a part.

Even among the best of these pleasures, however, some limits are set by your nutritional state. You can feel really good only when your blood sugar (glucose) level is right. If that condition isn't met, neither the most beautiful mountaintop nor the most stimulating companion can compensate.

The health and functioning of every cell in your body depend on blood glucose to a greater or lesser extent. Ordinarily the cells of your brain and nervous system depend solely on this sugar for their energy. The brain cells are continually active, even while you're asleep, so they are continually drawing on the supply of glucose in the fluid surrounding them and it permits them to use other fuels as well. They oxidize glucose for the energy they need to perform their functions. To maintain the supply, a continuous flow of blood moves past these cells, replenishing the glucose as the cells use it up.

Caution

Because the brain and other nerves ordinarily cannot obtain energy without glucose, they are especially vulnerable to a temporary deficit in the blood glucose supply. When the brain is deprived of energy, mental processes are affected. The body's attempts to compensate may lead to other symptoms – weakness, trembling, anxiety, dizziness, and nausea. Hypoglycemia – too little glucose in the blood – can cause these symptoms.

The symptoms of anxiety, dizziness, weakness, and the rest can be caused by a number of conditions other than hypoglycemia, however, such as oxygen deprivation to the brain. They may also be caused psychologically, by an anxiety state. Even such a serious condition as multiple sclerosis can be mistaken for hypoglycemia by the unwary diagnostician. Thus we laypersons, who are not trained in the diagnosis of conditions that present similar symptoms, are extremely unwise if we try to diagnose ourselves. The point of introducing blood glucose by talking about hypoglycemia is not to persuade you that you have the condition, but to show how indispensable glucose is to your feeling of well being. A little knowledge is a dangerous thing. Don't self-diagnose.

Hypoglycemia

(HIGH-po-gligh-SEEM-ee-uh) is when there is a too-low blood glucose concentration. Hypoglycemia may arise briefly in any normal person or can be a symptom of a number of disease conditions.

- Hypo = too little
- glyce = glucose
- emia = in the blood

The body has an amazing ability to adapt to changing conditions by altering its own chemistry to maintain an internal balance. It maintains your temperature within a degree, and your blood glucose level with equal precision. An awareness of how blood glucose is maintained can enable you to cooperate with your body in the best interest of both of you.

Homeostasis

(HOME-ee-oh-STAY-sis) is defined as the maintenance of relatively constant internal conditions in body systems by corrective responses to forces that, unopposed, would cause unacceptably large changes in those conditions. A homeostatic system is not static. It is constantly changing, but within tolerable limits.

- Homeo = the same
- Stasis = staying

The Constancy of the Blood Glucose Level

When you wake up in the morning, your blood probably contains between 70 and 120 milligrams (mg) of glucose in each 100 milliliters (ml) of blood. This range, which is known as the fasting blood glucose concentration, is normal and is accompanied by a feeling of alertness and well being (provided that nothing else is wrong, of course – that you don't have the flu, for example). If you don't eat, the blood glucose level gradually falls as the cells all over your body keeps drawing on the diminishing supply. At 60 or 65 milligrams per 100 milliliters, the low end of the normal range, a feeling of hunger is often experienced. The normal response to this sensation is to eat; then the blood glucose level rises again.

Milligram
A milligram (mg) is 1/1,000 of a gram; a milliliter (ml) is 1/1,000 of a liter. Blood concentrations of many substances are measured in milligrams per 100 milliliters (mg/100 ml.).

- Milli = 1,000

It is important that the blood glucose level should not rise too high, and the body protects itself against this eventuality. The first organ to respond to raised blood glucose is the pancreas, which detects the excess and puts out a message about it; then liver and muscle cells receive the message, remove the glucose from the blood, and store it.

Special cells of the pancreas are sensitive to the blood glucose concentration. When it rises, they respond by secreting more of the hormone insulin into the blood. As the circulating insulin bathes the body's other cells, they take up glucose from the blood. Most of the cells can only use the glucose for energy right away, but the liver and muscle cells have the ability to store it for later use; they assemble the small glucose units into long chains of glycogen. The liver cells also convert glucose to fat for export to other body cells. Fat cells can conserve the energy of glucose in this form.

After you have eaten, then, your blood glucose concentration has returned to normal, and any excess glucose has been put in storage. During the hours that follow, before you eat again, the stored liver glycogen (but not the stored fat) can replenish the glucose supply as the brain and other body cells use it to meet their energy needs. Normally, only glycogen from the liver, not from the muscle, can return glucose units to the blood; muscle cells only use them internally.

One of the hormones that can call glucose out of the liver cells is the famous "fight-or-flight" hormone, epinephrine. Epinephrine is produced quickly when you are under stress, ensuring that all your body cells have energy fuel in emergencies. At ordinary times other hormones guarantee that liver glycogen returns glucose to the blood whenever it is needed for maintenance.

Hormone
A hormone is a chemical messenger. Hormones are secreted in response to altered conditions by a variety of glands in the body. Each affects one or more specific target tissues or organs and elicits specific responses to restore normal conditions.

Insulin
Insulin (IN-suh-lin) is a hormone secreted by the pancreas in response to (among other things) increased blood glucose concentration.

Glycogen
Glycogen (GLIGH-co-gen) is a storage form of glucose in liver and muscle.

- glyco = glucose
- gen = gives rise to

Epinephrine
Epinephrine used to be called adrenaline (uh-DREN-uh-lin). Another hormone that brings glucose forth from storage is glucagon (GLOO-kuh-gon). Glucagon is produced by the alpha cells of the pancreas.

Muscle glycogen, too, can be dismantled to glucose, but this glucose is used primarily within the muscle cells themselves, where it serves as an important fuel for muscle action. Long-distance runners know that adequate stores of muscle glycogen can make a crucial difference in their endurance toward the end of a race. Before an event, the athlete is well advised to eat meals high in carbohydrate. If there is an extraordinary need for blood glucose and the liver supply has run low, muscle glycogen can break down to an intermediate product, lactate, which enters the blood. The liver picks it up, converts it to glucose, and releases it once again. Thus muscle glycogen can contribute indirectly to the blood glucose supply if necessary.

The maintenance of a normal blood glucose level thus depends ordinarily on two processes. When the level gets too low, it can be replenished quickly either from liver glycogen stores or from food. When the level gets too high, insulin is secreted to siphon the excess into storage. (There is more to this story. Insulin performs other roles, too. This description is intended only to give you a sense of how the body maintains its blood glucose level.)

The way you eat can help your body keep a happy medium between the extremes. Two guidelines apply. First, when you are hungry, you should eat without waiting until you are famished. Second, when you do eat, you should eat a balanced meal, including some protein and fat as well as complex carbohydrate. The fat slows down the digestion and absorption of carbohydrate, so that it trickles gradually into the blood, providing a steady, ongoing supply. The protein elicits the secretion of glucagon, which is antagonistic to insulin and damps its effect. The protein also provides a more slowly digested alternative source of blood glucose for use in case the glycogen reserves are used up.

Diabetes

A question people often wonder about in relation to blood glucose is, What is diabetes? Diabetes is a disease, most probably hereditary, characterized either by a deficiency of insulin in the circulating blood or by a surplus of ineffective insulin. Either the pancreas becomes unable to synthesize insulin (Type I diabetes) or the cells are not able to respond to the insulin that is supposed to stimulate them to take up glucose (Type II). In either case, blood glucose rises too high when the person with diabetes eats foods or drinks beverages containing carbohydrate.

When the blood glucose rises too high, and insulin fails to bring it back down to normal, the body brings a second control mechanism into play. The kidneys, through which blood flows each time it passes through the lower body, serve as a filter to remove unwanted materials from the blood and funnel them into the urinary bladder for excretion. Blood glucose levels above about 170-mg/100 ml trigger a compensatory action of the kidneys that causes the excess glucose to spill into the urine.

An early symptom of diabetes is excessive hunger (perhaps the brain cells don’t get a prompt message when glucose is present in the body). Another is excessive thirst, because the kidneys excrete water to get rid of the excess blood glucose. The person with diabetes who learns to use nutrition knowledge to manage the disease may be able to live a nearly normal life in spite of this defect in carbohydrate metabolism.

Regulation of Blood Glucose Concentration

1. High blood glucose stimulates pancreas to release insulin.
2. Insulin stimulates the uptake of glucose into cells. Liver and muscle cells store it as glycogen. Liver cells also convert it to fat, and fat cells store it in that form.
3. Later, low blood glucose is raised when liver glycogen is reconverted to glucose and released into the blood. (Other hormones are involved as well.)

The Sugars

Practically all your energy comes from the food you eat, about half from carbohydrate and half from protein and fat. In fact, one of the principal roles of carbohydrate in the diet is to supply energy in the form of blood glucose. Starch is the most significant contributor of glucose to people’s diets, but any of the sugars can supply it, too. There are actually six common sugars found in foods:

1. Glucose
2. Fructose
3. Galactose
4. Sucrose
5. Lactose
6. Maltose

A number of other sugars are familiar to the users of special dietary products, notably the sugar alcohols:

1. Maltitol
2. Mannitol
3. Sorbitol
4. Xylitol

Glucose

Glucose is not especially sweet tasting; a pinch of the purified sugar on your tongue gives only the faintest taste sensation. However, it is absorbed with extraordinary rapidity into the bloodstream. If a diabetic person has become unconscious with extreme hypoglycemia (for example, from an overdose of insulin), a quick way to supply the needed blood glucose is to tip his head to one side and to drip a water solution of glucose into his cheek pocket. The glucose will be absorbed directly into his bloodstream.

Fructose
If you have ever sampled pure powdered fructose, you will not be surprised to learn that it is the sweetest of the sugars. Curiously, fructose has exactly the same chemical formula as glucose, but its structure is quite different. The different arrangements of the atoms in these two sugars stimulate the taste buds on your tongue in different ways.

Fructose can be absorbed directly into the bloodstream. When the blood circulates past the liver, the fructose is taken up into the liver cells, where enzymes rearrange the atoms to make compounds indistinguishable from those derived from glucose and sometimes to make glucose itself. Thus the effect of fructose on the body is very similar to the effect of glucose.

Food chemists have studied sweet-tasting substances, such as fructose, and have identified the exact arrangement of atoms that stimulates the sweet-taste receptors in the tongue. All sweet-tasting substances share this structure, including the artificial sweeteners saccharin, cyclamate, and aspartame.

Galactose
Glucose and fructose are the only monosaccharides of importance in foods. A third, galactose, is seldom found free in nature but occurs as part of the disaccharide lactose.

Sucrose
The other three common sugars are disaccharides – pairs of monosaccharides linked together. Glucose is found in all three; the second member of the pair is either fructose, galactose, or another glucose.

Sucrose, table sugar, is the most familiar of the three disaccharides. Sugar cane and sugar beets are two sources from which it is purified and granulated to various extents to provide the brown, white, and powdered sugars available in the supermarket. Because it contains fructose in an accessible position, it is a very sweet sugar.

When you eat a food containing sucrose, enzymes in your digestive tract hydrolyze the sucrose to yield glucose and fructose. These monosaccharides are absorbed, and the fructose may be converted to glucose in the liver. (Alternatively, the fructose may be broken down to smaller compounds identical to those derived from glucose.) Thus one molecule of sucrose can ultimately yield two of glucose.

<u>Caution</u>
You can see from this description that it ultimately makes no difference whether you eat these monosaccharides hitched together as table sugar or already broken apart. In either case they will end up as monosaccharides in the body. People who think that the “natural sugar” honey is chemically different from purified table sugar fail to understand this point.

It so happens that honey, like table sugar, contains glucose and fructose. The only difference is that in table sugar, they are hitched together while in honey they are not. Like table sugar, honey is concentrated to the point where it contains very few impurities, even such desirable ones as vitamins and minerals. In fact, being a liquid, honey is denser than its crystalline sister and so contains more kcalories per spoon.

To say that honey is no more nutritious than sugar, however, is not to say that there are no differences among sugar sources. Consider a piece of fruit, like an orange. From the fruit you could receive the same monosaccharides and the same kcalories as from sugar or honey. But the packaging is different. The fruit’s sugars are diluted in a large volume of water, which contains valuable trace minerals and vitamins, and the flesh and skin of the fruit are supported by fibers that also offer health value.

From these two comparisons you can see that the really significant difference between sugar sources is not between “natural” and “purified” sugar but between concentrated sweets and the dilute, naturally occurring sugars that sweeten nutritious foods. You can suspect an exaggerated nutrition claim when you hear the assertion that a product is more nutritious because it contains honey.

A popular fad diet, the fructose diet, claims to be a wonderfully effective means of losing weight. Purified fructose, according to its proponents, is a “natural sugar” that gives you energy without accumulating as body fat. The diet plan requires that you buy packages of purified fructose and use this sugar in place of the “unnatural sugar” sucrose, which causes ugly weight gain. In light of what has just been said about honey versus oranges, it should be clear that there is nothing more natural about purified, crystalline fructose than about purified, crystalline sucrose. Be skeptical whenever you hear the assertion that purified fructose (or any other sugar, for that matter) is more natural than table sugar.

Sucrose is the principal energy-nutrient ingredient of carbonated beverages, candy, cakes, frostings, cookies, and other concentrated sweets.

Vitamins and Minerals Supplied by Some Sugar Sources

	Calcium (mg)	Iron (mg)	Vitamin A (IU)	Thiamin (mg)	Riboflavin (mg)	Vitamin C (mg)
1 tbsp sugar (white granulated)	0	Trace	0	0	0	0
1 tbsp honey (strained or extracted)	1	0.1	0	Trace	0.01	Trace
Possible Daily nutrient need	**1,000**	**18**	**5,000**	**1.5**	**1.7**	**60**

Lactose
Lactose is the principal carbohydrate found in milk, comprising about 5 percent of its weight. A human baby is born with the digestive enzymes necessary to hydrolyze lactose into its two monosaccharide parts, glucose and galactose, so that they can be absorbed. The galactose is then converted to glucose in the liver, so each molecule of lactose yields two molecules of glucose to supply energy for the baby's growth and activity. Babies can digest lactose at birth, but they don't develop the ability to digest starch until they are several months old. This is one of the many reasons why milk is such a good food for babies; it provides a simple, easily digested carbohydrate in the right amount to supply energy to meet their needs.

Some individuals lose the ability to digest lactose and become lactose-intolerant. When such a person drinks milk, the unhydrolyzed lactose in the intestine becomes food for intestinal bacteria instead. The multiplying bacteria produce gas and irritate the intestine, making the person sick with nausea and diarrhea. Lactose intolerance arises predictably at around the age of four in certain races – in fact, in the majority of the world's people: Native American, Asian, African, Mediterranean, and Middle Eastern peoples. It can also appear temporarily in anyone who is ill, making the person unable to tolerate milk for a while. Lactose intolerance is not the same as the commonly observed milk allergy, which is caused by an immune reaction to the protein in milk.

Maltose
The third disaccharide is found at only one stage in the life of a plant. When the seed is formed, it is packed with starch – glucose units strung together in long arrays – to be used as fuel for the germination process. When the seed begins to sprout, an enzyme cleaves the starch between pairs of glucose units, making maltose. Another enzyme then splits the maltose units into glucose units, and other enzymes degrade these still further, releasing energy for the sprouting of the plant's shoot and root. By the time the young plant has put forth leaves, all the starch in the seed has been used up, but the leaves can now capture the sun's light to garner additional energy for growth. Thus the sugar maltose is present briefly during the early germination process, as the starch is being broken down. The malt found in beer contains maltose formed as the starch in the grains breaks down. (The alcohol is produced by yeast in a process known as fermentation.)

As you might predict, when you eat or drink a food source of maltose, your digestive enzymes hydrolyze the maltose into two glucose units, which are then absorbed into the blood. Thus, maltose, like the other disaccharides, contributes glucose to the body.

In summary, then, the major simple carbohydrates, or sugars, are found in the following table. Glucose, fructose, maltose, and sucrose are from plants; lactose and its component galactose, from milk.

The Major Simple Carbohydrates

Monosaccharides	**Disaccharides**
Glucose	Maltose
Fructose	Sucrose
Galactose (found only in lactose)	Lactose

The Chemist's View of Complex Carbohydrates
While the sugars contain three monosaccharides in different combinations, the polysaccharides are composed almost entirely of only one – glucose. The differences between them have to do with the ways glucose is combined into the large molecules of starch, glycogen, and cellulose.

Starch
In the plant, starch serves a function similar to that served by the glycogen in your liver. It is a storage form of glucose needed for the plant's first growth. (When you eat the plant, of course, you get the glucose to use for your own purposes.)

All starchy foods are in fact plant foods. Seeds are the richest food source; 70 percent of their weight is starch. Many human societies have a staple grain from which 50 to 80 percent of their members' food energy is derived. Rice is the staple grain of Asia. In Canada, the United States, and Europe the staple grain is wheat. If you consider all the food products make from wheat – bread (and other baked goods made from wheat flour), cereals, and pasta – you will realize how all pervasive this grain is in the food supply. Corn is the staple grain of much of South America and of the southern United States; the Mexicans use corn in their tortillas. The staple gains of other peoples include millet, rye, barley, and oats. In each society a bread, meal, or flour is made from the grain, then used for many purposes. These staple foods are the major source of food energy for the world's people supporting human life and activity.

A second important source of starch is the bean and pea family, including such dry beans found in the supermarket as butter beans, kidney beans, "baked" beans, black-eyed peas (cowpeas), chickpeas (garbanzo beans), and soybeans. These vegetables are about 40 percent starch by weight and also contain a significant amount of protein. A third major source of starch is the tubers, such as the potato, yam, and cassava. These serve as the primary starch sources in many non-Western societies.

When you eat any of these foods, the starch molecules are taken apart by enzymes in your mouth and intestine. The enzymes hydrolyze the starch molecules to yield glucose units, which are absorbed across the intestinal wall into the blood. One to four hours after a meal, all the starch has been digested and is circulating to the cells as glucose.

Glycogen
Glycogen is not found in plants and is stored in animal meats only to a limited extent. It is not, therefore, of major importance as a nutrient, although it performs an important role in the body, as already described. Glycogen is more complex and more highly branched than starch, a structure permitting rapid breakdown. When the hormonal message "Break down glycogen" arrives at a liver or muscle cell, enzymes can attack all the branches simultaneously, producing a surge of energy for emergency action.

Cellulose
The third polysaccharide of importance in nutrition is cellulose. Cellulose, like starch, is found abundantly in plants and is composed of glucose units connected in long chains. However, the bonds holding its glucose units together are different. This difference is of major importance for humans, because each type of bond requires a different enzyme to hydrolyze it. The human digestive tract is supplied with abundant enzymes to hydrolyze the bonds in starch, but has none that can attack the bonds in cellulose. As a result, starch is digestible for humans and cellulose is not. Cellulose passes through the digestive tract largely unchanged, which explains the different roles of these two major plant polysaccharides. Starch is the most abundant energy source in the staple foods of the world, whereas cellulose provides no energy for humans at all.

Cellulose is, however, one of the fibers, and the fibers are important to health in their own right. In recent years, cellulose and other plant fibers have received increasing attention as the public has learned of their value. Researchers are still actively trying to determine what they do and do not do, and there is much disagreement about their role, but clearly they are important.

Alternative Sweeteners
Among alternative sweeteners familiar to people who use special dietary products are the sugar alcohols – among them, mannitol, sorbitol, xylitol, and maltitol. These carbohydrates are either absorbed more slowly or metabolized differently than the sugars and so may be suitable for use by people who must restrict their intakes of ordinary sweets.

Mannitol
Mannitol is the least satisfactory of the alternative sweeteners just named. It is considerably less sweet than sucrose, so sizable amounts have to be used when it is substituted for sucrose. Because it lingers unabsorbed in the intestine for a long time, it is available to intestinal bacteria for their energy. As they use it, they multiply, attracting water, and produce irritating waste, causing diarrhea. It is therefore not much used as an alternative sweetener.

Sorbitol
Sorbitol has been popular as a sweetener for sugar-free gums and candies, but it too, has drawbacks.

It is only half as sweet as sucrose, so twice as many kcalories have to be used to deliver a given amount of sweetness. Also, like mannitol, it causes diarrhea. Advantages are that it is absorbed very slowly, so that it has little or no effect on blood glucose; and little or no insulin is needed to make it available to the body's cells. Thus people with diabetes, who have either no insulin or ineffective insulin, may benefit from using small amounts of sorbitol. Its threshold for causing diarrhea is higher than mannitol's; so of the two, sorbitol is preferred.

Xylitol
Xylitol has also been popular, especially in chewing gum, because it has been reported to help prevent dental caries. (It not only doesn't support caries-producing bacteria; it actually inhibits their growth.) Like all the sugar alcohols, it has as many kcalories per gram as sucrose, but it is as sweet as fructose, so that less can be used. Xylitol occurs in foods, and some xylitol is produced in the body during normal metabolic processes; so it is not a foreign substance. Xylitol is widely used in many western European countries and in Canada; however, reports that is may cause tumors in animals have led to the voluntary curtailing of its use by U.S. food producers.

Maltitol
Maltitol has a sweetness equal to about 90 percent that of sucrose. It is used in some carbonated beverages and canned fruits, and in Japanese bakery products and other sweets intended not to cause tooth decay. At first thought not to be absorbed from the GI tract, maltitol was recommended for use in food products for dieters and people with diabetes. This claim is doubtful; the sugar probably does have kcalorie value. Manufacturing maltitol from maltose is expensive and limits its use; using maltose directly costs less.

Caution
The person who wishes to cut kcalories should be aware that the sugar alcohols do contain kcalories, just as many per gram as sucrose. In spite of this fact, products that contain them are labeled "sugar-free." The reason they are suitable for people who must limit their intakes of ordinary sweets is because the body handles them differently, not because they are kcalorie-free. The person who is limiting kcalories must limit sugar alcohols just as carefully as sugars.

Fructose
Another sweetener of possible usefulness to people with abnormal carbohydrate metabolism is fructose, already discussed. It is twice as sweet as sucrose, and it neither requires nor stimulates insulin secretion, so it has been advocated as an alternative sweetener for use by people with diabetes and hypoglycemia. Many authorities oppose the use of fructose by people with diabetes, however, because it may tend to increase their already raised blood lipid levels. Because fructose, like sucrose, contains 4 kcalories per gram, however, it is not useful as a weight-loss aid.

Artificial Sweeteners
The artificial sweeteners are compounds, developed or discovered by chemists, that "fool" the taste buds into conveying a sweet taste to the brain, but convey negligible or no kcalories the body can use. Foremost among those in present use in the United States and Canada are aspartame, cyclamate, and saccharin.

Cyclamate's use was banned some years ago in the United States because of a possible threat of cancer; but cyclamate is still used in Canada. The reverse is true of saccharin; it is no longer available over the counter in Canada because of a possible link to cancer, but is still in wide use in the United States, though it must carry a warning label. Aspartame ("Nutra Sweet" or "Equal") is a relative newcomer among the artificial sweeteners and has an unsullied reputation so far.

Miniglossary of Artificial Sweeteners

- **Aspartame (aspartyl-phenylalanine methyl ester) -** Aspartame is a dipeptide that tastes remarkably like sugar but is 200 times sweeter than sucrose. Aspartame, also called "Nutra Sweet," is blended with lactose and with an anticaking agent and is sold commercially as "Equal." It turns sour when heated and so cannot be used for cooking or baking, but is effective in warm and cold beverages and in and on warm and cold foods. Unlike saccharin, it has no bitter aftertaste, and so may prove more acceptable to consumers.

- **Cyclamate -** Cyclamate is a zero-kcalorie sweetener used in Canada but banned in the United States.

- **Saccharin (sodium saccharine) -** Saccharin was discovered in 1879 and used in the United States since that time, a zero-kcalorie sweetener that is at least 200 times sweeter than sucrose; banned in Canada.

The Fibers
Many of the fibers are carbohydrates. Besides cellulose, already mentioned, two other carbohydrates – pectin and hemicellulose – are classed as fibers. Another material classified as fiber is lignin, a noncarbohydrate. Still others are the gums and mucilages often used as thickening agents in prepared foods.

Although cellulose and other fibers are not attacked by human enzymes, some fibers, notably hemicellulose, can be digested by bacteria in the human digestive tract, and can yield products similar to those the body obtains from the so-called available carbohydrates. These products may be absorbed by the body or excreted as waste. Food fibers are therefore not all kcalorie-free.

Beneficial Effects of Fiber
Based on the experience of researchers in Africa, the "fiber hypothesis" suggests that consumption of unrefined, high-fiber carbohydrate foods protect against many Western diseases. Rural Africans naturally consume a diet very high in fiber and show a low incidence of these chronic conditions. Some researchers, however, stress that it may be the higher Eastern intake of salt, sugar, and animal fat rather than the absence of fiber that is responsible for these conditions.

Fiber may also play a role in weight control. According to the "fiber hypothesis," obesity is not seen in those parts of the world where large amounts of fiber are eaten. Foods high in fiber tend to be low in fat and simple sugars. High-fiber breads have fewer kcalories per pound than refined breads. High-fiber foods, because of their water-holding capacity, satisfy hunger readily. Many of the diet aids on the market today are composed of bulk-inducing fibers such as methylcellulose.

Fiber in the gastrointestinal tract functions like a sponge, holding water, binding minerals, and binding acidic materials such as the bile salts used by the body to prepare fat for digestion. The major impact of dietary fiber is on the colon, the last part of the gastrointestinal tract, where colon cancer and diverticular disease can arise, but the addition of fibrous foods to the diet increases the bulk of food all along the intestine.

Some of the ways in which food fibers are thought to prevent disease states are:

1. By promoting weight loss.
2. By attracting water into the digestive tract.
3. By preventing increased abdominal pressure.
4. By preventing formation of small fecal stones.
5. By exercising the muscles of the digestive tract.
6. By speeding up the passage of food materials through the digestive tract.
7. By binding lipids such as cholesterol and carrying them out of the body.
8. By binding the bile salts.
9. By modulating the body's response to glucose.

However, not all the fibers have similar effects. For example, wheat bran, which is composed mostly of cellulose, has no cholesterol-lowering effect, whereas oat bran and the fiber of apples (pectin) do lower blood cholesterol. On the other hand, wheat bran seems to be one of the most effective stool-softening fibers, especially if a certain particle size is used. Fibers that form gels in water (pectin, guar) prolong the time of transit of materials through the intestine, whereas insoluble fibers (cellulose) tend to decrease the time.

Diverticular disease is very common in Europe and North America but relatively rate among rural Africans. In this disease there is usually high pressure in the intestine and a prolonged transit time. Fiber has recognized medical value in treating diverticular disease because it reduces both pressure and transit time.

Although fiber is considered to be a nonnutritive substance, it does influence the metabolism of certain nutrients.

CERTIFIED HEALTH & NUTRITION COUNSELOR ONLINE COURSE - SESSION 2 **– QUESTION & ANSWERS**

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Please be sure to fill out the information above, complete the test and e-mail or fax it back to us at joyful@best.com or 425-955-4639. We will grade your question & answer session and will let you know if we have any questions or concerns.

1. Define **Homeostasis:**

2. **List the 6 types of sugars:**

3. **Which sugar** is the principal energy-nutrient ingredient of carbonated beverages, candy, cakes, frostings, cookies, and other concentrated sweets?

4. Sucrose is a disaccharide. T/F

5. The person who is limiting kcalories must limit sugar alcohols just as carefully as sugars. T/F

6. A milligram (mg) is 1/10,000 of a gram. T/F

7. A homeostatic system is static. T/F

8. What is the difference between Type I diabetes and Type II diabetes?