MONOSACCHARIDES

Monosaccharides consist of one basic sugar unit, of which there are three types: glucose, fructose, and galactose. **Glucose**, in dietary form, is a simple sugar found in high concentration in such foods as honey, fruits, fruit juices, sugar soft drinks, sweet corn, pancake syrup, etc. Fructose, or 'fruit sugar,' is found in fruits, which means it is packaged with fiber. The fruits apples, bananas, figs, grapes, and pears are the richest in fructose (Mahnensmith, 2016). Galactose is found in milk, shellfish, eggs, meat, and legumes - the class of vegetables that includes beans, peas, and lentils. **'Blood glucose'** is the storage form of carbohydrate in human blood. It is commonly known as 'blood sugar.' When ingested carbohydrate is converted into blood glucose, it circulates as a quick anerobic energy source for basal metabolism, dietary-induced thermogenesis, and physical activity. (To be further discussed in 'Chapter 6: Energy Expenditure and Obesity, Section 2: Energy Expenditure.') A monosaccharide can also bond with a substrate other than a carbohydrate to form other important compounds needed by humans. For example, glucose and an amino bond to form water-soluble glucosemine, which provides articular cartilage with elasticity to withstand tensile stress during loading conditions, such as running on pavement.

Application to physical therapy (PT): When you treat a patient with diabetes mellitus it is literally his blood glucose, aka **blood sugar**, level that is measured. Fasting readings of 80 to 130 mg/dL are within normal limits (WNL) (Stoppler, 2019), but parameters set by a physician for reporting purposes are typically 70 mg/dL or less (low blood sugar) and 300 mg/dL or more (high blood sugar).

DISACCHARIDES

Simple sugars that consist of just two monosaccharides are known as **disaccharides**, of which there are three: sucrose, maltose, and lactose. **Sucrose**, or table sugar, is the most abundant disaccharide and the main form of carbohydrate in plants. It is composed of one unit of glucose and one unit of fructose. Sucrose is dominant disaccharide in apricots, oranges, pineapples, and peaches (Mahnensmith, 2016). It also comprises over 60% of the sugar in sweet potatoes, about 75% of the sugars in carrots, and more than 95% of the sugar in beets (Mahnensmith, 2016). In contrast, onions, peppers, and yams contain less than 20% sucrose (Mahnensmith, 2016). **Maltose**, or 'malt sugar,' is composed of two glucose units and is found in germinating seeds and foods such as corn syrup and beer. Maltose is only 30% to 60% as sweet as sucrose / table sugar. **Lactose**, which is composed of glucose and galactose, occurs naturally in mammalian milk. Lactose-free milk and other lactose-free dairy products were developed for those who are lactose-intolerant. **Oligosaccharides** consist of at least three, but no more than about 10 monosaccharides, and a lipid or protein. For instance, glycolipids are used in the immune response and promoting healthy bacteria in the gut (Mudgil & Barak, 2013).

COMPLEX CABOHYDRATES

Complex carbohydrate is a broad term to describe substances that contain polysaccharides. The three types are starch, glycogen, and cellulose. (However, cellulose will be discussed separately as a fiber.) **Starch** is the most common carbohydrate in the human diet. It is stored in plants including cereal grains (e.g., wheat, rice, corn, oat, barley, and rye) and tubers (e.g., potatoes and yams). **Glycogen** is the storage from of glucose in the skeletal muscle and livers of animals including humans. As needed for energy, glycogen is converted into glucose via anaerobic processes and with the assistance of the hormone glucagon (discussed more in 'Chapter 6: Obesity, Section 2: Energy Expenditure').

Application to physical therapy (PT): Much of a person's glycogen reserves are stored with water in skeletal muscle. If a person eats little or fasts for even a day, the glycogen stores are utilized and the stored water is released. Excess water is secreted in the urine. This is why there is a significant loss of body after just a few days of a new very low-calorie diet or fast – because there is a loss of total body water. This occurs even if the person consumes large amounts of water.

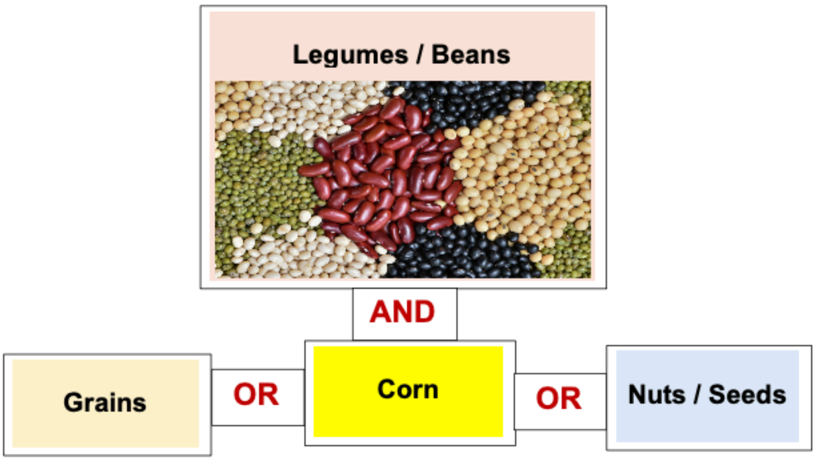
FIBER

Dietary fiber is a non-starch polysaccharide consisting of cellulose and hemicellulose. Although structurally different, both cellulose and hemicellulose keep plant cell walls strong. Unlike other carbs we've discussed, dietary fiber cannot be completely broken down by human digestive enzymes. As such, they cause a person to feel full longer and might help a person to eat less and lose body fat. There are two types of dietary fiber: water soluble fiber and water insoluble fiber. **Soluble fiber** dissolves in water, slows the digestive process, and can prevent or minimize a spike in blood glucose. Soluble fiber reduces absorption of dietary fat and cholesterol, which can lower low-density lipoproteins (LDSs) and cholesterol in the blood (Brown et al, 1999). It may also produce beneficial fermented compounds in the colon (Eastwood & Krichevsky, 2005). Soluble fiber is primarily found in legumes and fruit skin (Arnarson,2020). **Insoluble fiber** does not dissolve in water. Because it is essentially indigestible in the human GI tract, it moves food and waste through the digestive system, provides bulk for stool formation, improves fecal mobility, and prevent **constipation**. For a list of high fiber foods and their grams of soluble, insoluble, and total fiber refer to the table provided in the **Textbook Supplement** at WellnessSociety.-org.

PROTEIN COMPLEMENTATION

Of the 20 amino acids required by the human body to maintain good health - 21 if selenocysteine is recognized it can self-manufacture 11 and the remaining nine (histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, trypotphan, and valine) must be obtained in the diet (Welegedara et al, 2018), Respectively, these two groups are referred to as **non-essential amino acids** and **essential amino acids**. Animal sourced foods, such as cow muscle and certain organs, and certain plant-based foods, such as buckwheat, chia seed, hemp, quinoa, soy (tofu) and soy milk, and tempeh, provide all essential amino acids and are referred to as **complete proteins**. Plant-based foods that are missing one or more essential amino acids are **incomplete proteins**. **Protein complementation** is the process of two or more items from the plant kingdom (e.g., beans and grains) to obtain all essential amino acids, or complete protein (ASN, 2011). According to the **American Society for Nutrition (ASN)** (2011), complementary plant proteins are: (1) **legumes** (e.g., black-eyed pea, chickpea, cowpea, green pea, kidney bean, lentil, lima bean, and navy bean) and *either* grains, corn *or* nuts/seeds; (2) **grains** and *either* vegetables *or* nuts/seeds; and (3) **vegetable**s and *either* whole grains or nuts/seeds; because grains, corn, nuts and seeds each provide the amino acid methionine, which is limited in legumes / beans; vegetables, nuts, and seeds provide the amino acids lysine and threonine, which is limited in grains; and grains, nuts, and seeds provide the amino acid methionine, which is limited in vegetables. Refer to **Figure 4-3.11. Protein Complementation with a Legume/ Bean Base, Figure 4-3.12. Protein Complementation with a Grain Base**, and **Figure 4-3.13. Protein Complementation with a Vegetable Base.** Examples of complete protein meals are: beans and rice; peas and corn; peanuts and pumpkin seeds trail mix; chick peas and sunflower seeds, plant-based burger with lentils and walnuts, and a peanut butter sandwich. Protein complementation does not need to completed during one meal (ASN, 2011). For example, you can eat beans for lunch and then later eat raw almonds as a snack.

Figure 4-3.11. Protein Complementation with a Legume / Bean Base



***Application to physical therapy*:**

If a patient is iron deficient, her ability to physically participate in therapy is reduced – sometimes dramatically. During my career has a home health physical therapist, I have encountered many instances in which a patient has presented with lethargy and fatigue, has had a diagnosis of **iron-deficiency anemia**, but was not prescribed an iron medication. Very soon after an iron supplement was added (because of my call to the patient's physician), the patient's ability to engage in physical activity including physical therapy significantly increased. This is a strong example of holistic physical therapy. Frankly, some physical therapists may be hesitant about calling a physician and suggesting the change in the patient's treatment plan, especially a medication, but the value to the patient must outweigh the physical therapist's concern the physician will be 'annoyed.' In my experience, the physician has been appreciative of my input.

It is also important physical therapists bear in mind that a significant adverse effect of iron supplementation is **constipation** While a diet high in fiber may help, an over-the-counter (OTD) laxative, such as Fiber-all, is sometimes required. When this situation arises, the physical therapist should Brief Teach the patient the relationship between iron supplementation, constipation, fiber intake, and fiber supplementation. If the patient has not had a bowel movement in four to five days and/or if the physical therapist wants to directly recommend the patient take a fiber supplement, the physician must be notified.

TRACE MINERAL: MOLYBDENUM

Molybdenum is a cofactor required for the function of several important enzymes, one of which is required to metabolize drugs and toxins (NIH, 2021m). The daily RDA of molybdenum is 45mcg for adults and the UL is 2mg (NIH, 2021m). The average daily intake of molubdenum is 109mcg and 76mcg for men and women, respectively (NIH, 2021m). Refer to **Figure 4-3.20. Minerals.** Rich sources of molybdenum include many types of beans (garbonzo, kidney, lima, black, pinto, soy), cucumber, romaine lettuce, oats, tomatoes, and lentils (NIH, 2021m). Excessive molybdenum is rare, but can occur by long-term industrial exposure, such as welders (Eng, 2021). Molybdenum has no known clinically relevant interactions with medications (NIH, 2021m).