How Proper Nutrition Affects
Sports Performance in Adolescent Runners

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Brief Summary of Project: I created and implemented a basic sports nutrition program for a high school cross country team during the fall 2005 season. I taught the team how nutrition will help them in their sport and maximize their efforts and also be of benefit to their health in general.

Area of Emphasis 1: Nutrition

Committee Member from that discipline: Joan Thompson

Area of Emphasis 2: Health Promotion

Committee Member from that discipline: Kim Hyatt

Area of Emphasis 3: Chemistry

Committee Member from that discipline: Don Davies
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<tr>
<td>1,3 BPG</td>
<td>1,3 Bisphosphoglycerate</td>
</tr>
<tr>
<td>2PG</td>
<td>2-Phosphoglycerate</td>
</tr>
<tr>
<td>3PG</td>
<td>3-Phosphoglycerate</td>
</tr>
<tr>
<td>AA</td>
<td>Amino acid</td>
</tr>
<tr>
<td>ADP</td>
<td>Adenosine diphosphate</td>
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<tr>
<td>AMDR</td>
<td>Acceptable Macronutrient Distribution Range</td>
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<tr>
<td>ATP</td>
<td>Adenosine triphosphate</td>
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<tr>
<td>Cal</td>
<td>Calorie</td>
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<tr>
<td>CHO</td>
<td>Carbohydrate</td>
</tr>
<tr>
<td>CoA</td>
<td>Coenzyme A</td>
</tr>
<tr>
<td>CP</td>
<td>Creatine phosphate</td>
</tr>
<tr>
<td>DHAP</td>
<td>Dihydroxyacetone phosphate</td>
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<tr>
<td>EER</td>
<td>Estimated energy requirement</td>
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<tr>
<td>ETC</td>
<td>Electron transport chain</td>
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<tr>
<td>F-1,6 BP</td>
<td>Fructose-1,6-bisphosphate</td>
</tr>
<tr>
<td>F6P</td>
<td>Fructose-6-phosphate</td>
</tr>
<tr>
<td>FAD/FADH₂</td>
<td>Flavin adenine dinucleotide</td>
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<tr>
<td>G1P</td>
<td>Glucose-1-phosphate</td>
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<tr>
<td>G3P</td>
<td>Glyceroldehyde-3-phosphate</td>
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<tr>
<td>G6P</td>
<td>Glucose-6-phosphate</td>
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<tr>
<td>GI</td>
<td>Glycemic index</td>
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<tr>
<td>LAS</td>
<td>Lactic acid system</td>
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<tr>
<td>LBM</td>
<td>Lean body mass</td>
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<tr>
<td>NAD⁺/NADH</td>
<td>Nicotinamide adenine dinucleotide</td>
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<tr>
<td>PA</td>
<td>Physical activity</td>
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<tr>
<td>PEP</td>
<td>Phosphoenolpyruvate</td>
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<tr>
<td>Pro</td>
<td>Protein</td>
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<tr>
<td>RDA</td>
<td>Recommended Dietary Allowance</td>
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<tr>
<td>TCA</td>
<td>Tricarboxylic acid</td>
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<tr>
<td>UDP</td>
<td>Uridine diphosphate</td>
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<tr>
<td>UTP</td>
<td>Uridine triphosphate</td>
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INTRODUCTION

Food provides the body with the fuel needed to engage in the various activities of everyday life, including movement, growth, and tissue repair. The type of food that is eaten has the same effect on the human body as does the type of gasoline that goes into a car. Nutritional needs depend on both the stage of life and the lifestyle of each individual (Mahan & Escott-Stump, 2004). Adolescent athletes in particular have specific needs and must choose with care the type and quality of food they use to fuel their sport in addition to what is required for normal growth and development. Both the timing and amount of nutritional and fluid intake (Ortega, 2004) significantly influence an athlete's performance and his or her rate of recovery (“Nutrition,” 2000). Once this is understood and put into practice, adolescent athletes can eat to their own advantage to maximize their athletic abilities.

It is well known that good nutrition and regular physical activity during the adolescent years are necessary for optimal growth and development (Iglesias-Gutierrez et al, 2004). When adolescents are seriously involved in sports, meeting nutritional needs is even more challenging. A crucial nutritional requirement for any athlete is to cover the daily energy expenditure with a well-balanced diet (Ortega, 2004). The three energy producing nutrients include carbohydrates, protein and fat. These nutrients all provide different amounts of energy and are used by the body at different times depending on the nature of the work the body is doing (Hansen, Shriver, & Schoeller, 2005) (see Appendix B, lectures 3, 4, 5, and 6). The other essential nutrients, water, vitamins and minerals are also necessary for athletes to maximize their performance (Williams, 2005) (see Appendix B, lectures 2 and 10).

Along with energy needs, athletes are also concerned about recovery. One of nutrition's most important roles is restoring the body after an exercise session in order to prepare it for the next session (Ortega, 2004). The focus of the body turns from providing energy for activity to providing the nutrients for repairing tissue and synthesizing muscle glycogen (Levenhagen et al, 2002). This makes the food eaten after training just as significant as the food eaten before (see Appendix B, lecture 7).
In this study, high school cross country team members were educated about proper sports nutrition and its effect on athletic performance. It is hypothesized that after learning how to eat well as athletes and applying that knowledge to their diets and behaviors, the athletes will experience a positive change in their performance. The aim of this study is to increase the knowledge of sports nutrition and change the eating behaviors of the Viewmont High School Cross Country team members.

BACKGROUND

Energy intake is one of the most important nutritional considerations for athletes. Food energy is provided from the consumption of carbohydrates, proteins and fats (Mahan & Escott-Stump, 2004). The body uses this energy to perform in practice and in competitions, and to facilitate proper recovery. Each nutrient plays a role in energy production. Different nutrients are used to fuel activity of different intensities and therefore, different nutrients are relied on at different times (Williams, 2005). After establishing the nature of each nutrient, the process of generating energy from these nutrients will be presented.

Carbohydrates

Each gram of carbohydrate typically provides four calories of energy. Carbohydrates are the fuel sources an athlete relies on most heavily for working at high intensities (Ortega, 2004). Of the three energy-producing nutrients, carbohydrates are the most efficient at making energy available (Thompson, 2005) and the only one that can be used both aerobically and anaerobically (Hansen, Shriver, & Schoeller, 2005).

Most of the sugars that are ingested are converted into the monosaccharide glucose (see Figure 1). Glucose then remains in the bloodstream as the only available fuel for red blood cells and the central nervous system (Silverthorn, 2004). Glucose can also be stored in muscles and in the liver as glycogen (see Figure 2). Muscle glycogen is used to fuel muscular work. Liver glycogen is used to maintain blood sugar. If calories from carbohydrates are consumed in excess, then glucose can be converted into fat and stored as adipose tissue (Williams, 2005). Athletes
should get about 6-10 grams of carbohydrate per kilogram of body weight daily in order to maximize their muscle glycogen stores (Ray & Fowler, 2004). When adequate carbohydrates are consumed, about 60-70% of the caloric intake is provided from carbohydrates (Garden, 2000).

![Glycogen structure](image_url)

**Figure 2:** Glycogen is made when glucose molecules are linked together. (www2.ufp.pt/~pedros/ bg/glycogen.htm, 2002).

**Protein**

The main role of protein in the body is to maintain lean body mass (LBM). LBM includes vital organs, skin, hair, and muscle tissue (Williams, 2005). Each day, protein is lost from the body and must be replaced by providing protein in the diet. Protein also provides energy, with one gram of protein typically providing four calories. In order for protein to be used for energy, the amino acids must be deaminated (see Figure 3). About 5% of the fuel used during exercise is supplied by protein (Thompson, 2003; Thompson, 2005). An athlete's need for protein varies depending on weight and intensity of training. The general recommendation for adults is 0.8 g/kg, but heavily training athletes may require 1.2-1.8 g/kg to stay in nitrogen balance (Thompson, 2003). However, one study (Rennie & Tipton, 2000) found that regular exercise can improve the efficiency of using protein as an energy source, leading to a decrease in protein requirements. Protein

![Amino acid deamination](image_url)

**Figure 3:** Amino acids must be deaminated before contributing to the generation of ATP. (Berg, Tymoczko, & Stryer, 2002).
supplementation shouldn’t be necessary because dietary protein adequacy is easy to achieve as long as protein rich foods are consumed.

Fat

One gram of fat provides an average of nine calories, making fat the most energy dense nutrient (Mahan & Escott-Stump, 2004), but its contribution as a fuel source during high intensity exercise only provides about 25% of total fuel (Williams, 2005). For activity of low to moderate intensity, however, the body relies mainly on fat for energy. Research suggests that fat fuels are used during the recovery period after exercise (Hansen, Shriver, & Schoeller, 2005). The dietary recommendation for fat is that 30% or less of an individual’s daily caloric intake should be provided from fat (Thompson, 2003). Saturated fat should provide less than 10% of total calories (Thompson, 2003). This allows ample opportunity to consume the essential fatty acids and the fat necessary for fat soluble vitamin (A, D, E, and K) absorption (Ray & Fowler, 2004).

Vitamins and Minerals

In addition to carbohydrates, protein and fat, athletes also must obtain adequate amounts of essential vitamins and minerals from their diets. These nutrients are necessary for various physiological processes of the body including metabolism, muscle contraction, and cardiovascular activity, all of which occur at a higher level during exercise (Williams, 2005). The American Dietetic Association (2001) suggests that the best method to get enough of the vitamins and minerals the body needs is by eating a variety of foods, following nutritional guidelines and the new MyPyramid to achieve balance in the diet. MyPyramid has been developed by the U.S. Department of Agriculture to replace the old Food Guide Pyramid. Supplements of vitamins and minerals should not be necessary as long as an adequate amount of energy is consumed ("Nutrition," 2000) and the individual uses MyPyramid to guide food choices.

A number of vitamins and minerals have important roles for athletes. Athletes should obtain adequate levels of these in their diets. Iron is needed in order for hemoglobin in the blood to carry oxygen to working muscles and for myoglobin in the muscle to pick up the
oxygen for use (Berg, Tymoczko, & Stryer, 2002). In teenagers (Hinton, Giordano, Brownlie, & Haas, 2000), aerobic exercise has been found to deplete iron stores, putting these individuals at higher risk for iron deficiency. Young women are especially at risk due to blood loss from menstruation (Ryan, 2004). Without sufficient iron, muscles and tissues may not receive enough oxygen, reducing their capacity to produce energy (Ryan, 2004). Iron supplements have been found to improve this condition when iron is not adequately supplied in the diet (Hinton, Giordano, Brownlie, & Haas, 2000). In order to obtain iron from the diet, foods such as lean meats, dried fruits, broccoli, peas, legumes, and whole grains should be eaten (Williams, 2005).

Calcium is the most abundant mineral in the body, found mainly in the skeleton (Fogelholm, 2003). As exercise places stress on the bones, calcium salts are deposited on the bone in order to support bone structure and reduce damage by increasing bone density (Williams, 2005). A condition known as the female athlete triad can influence bone mass in athletic young women. Due to estrogen deficiency, the female athlete triad is characterized by amenorrhea, low body fat, and loss of bone mass (Mahan & Escott-Stump, 2004). Including more calcium in the diet, in addition to eating a balanced diet and performing weight bearing activities can help reverse the negative impact this has on bones. Furthermore, the ionic form of calcium, Ca++, is required for muscle contraction and the activation of enzymes needed to synthesize and breakdown muscle glycogen (Williams, 2005).

Energy

The macronutrients carbohydrate, protein and fat are all used to produce energy for the body in the form of adenosine triphosphate (ATP) (see Figure 4). The metabolism of the phosphoanhydride bonds of ATP produces a large amount of energy to fuel the body's activities (Berg, Tymoczko, & Stryer, 2002). The macronutrients are the substrates that are fed into the energy production biochemical pathways, ultimately producing energy for the body (Williams, 2005). There are a few different dominant pathways that contribute to ATP production.
The first system makes ATP using adenosine diphosphate (ADP) and creatine phosphate (CP). This is called the phospho-creatine system, or the ATP-PCr system. The energy generated from breaking the bond between the creatine and the phosphate is used to form the phosphoanhydride bond to make ATP from ADP and the free phosphate (Williams, 2005). The ATP-PCr system is the fastest, most immediate way to create energy, but does so anaerobically only, and supports only five to ten seconds of all-out activity (Mahan & Escott-Stump, 2004). The ATP-PCr system fuels activities of sustained power, such as short sprints or weight lifting (Thompson, 2005; Williams, 2005).

The next system to be used for high intensity exercise is the lactic acid system. It is also an anaerobic system and produces ATP rapidly. Under this system, carbohydrates, mostly from the body's muscle glycogen stores, are put through glycolysis. In the absence of oxygen, ATP is formed quickly, but in insufficient amounts (Williams, 2005). Lactic acid is a byproduct which can lead to fatigue (Mahan & Escott-Stump, 2004). The energy produced in this way supports up to about 120 seconds of all-out exercise. An example of a sport event where the lactic acid system supplies most of the ATP is a 400-600 m dash (Thompson, 2005).

The third and most efficient way to create ATP is with the oxygen system. This system is unique in that it is able to use carbohydrates, protein and fat in the process (Williams, 2005). The oxygen system proceeds only under aerobic conditions (Thompson, 2003). Carbohydrates are put through glycolysis, followed by the Tricarboxylic Acid (TCA) cycle, and ATP is created in abundance through the electron transport chain. Although energy is not made as rapidly as in the other two systems, it is made in much higher amounts, and is therefore much longer lasting (Williams, 2005). For this reason, the oxygen system fuels sports aerobics, endurance activities and sports of long duration (Thompson, 2003).
Carbohydrates are the most efficient at creating energy because with them ATP can be generated aerobically or anaerobically. In the oxygen system, carbohydrates are the main nutrients used and provide as much as 80% of total fuel (Williams, 2005). For exercise of moderate to low intensities, as well as those of longer duration, fats are more heavily relied upon, providing up to 60-70% of fuel during ultra endurance events (Mahan & Escott-Stump, 2004). As an energy source, protein plays a small part in ATP production. It does provide some of the fuel for activity, about 5% (Thompson, 2005). During the last stages of endurance exercise, or when the body is under stress, it may contribute up to 15% of total ATP provided (Thompson, 2005).

**Glycolysis**

Glycolysis is the process of breaking down one molecule of glucose to two molecules of pyruvate, forming a net two molecules of ATP. This occurs in the cytosol of the cell. In addition, if oxygen is available, the end products of glycolysis can be fed into the TCA cycle, then into the electron transport chain (ETC), resulting in a net 30-32 molecules of ATP. If oxygen is not present, ATP production stops at the end of glycolysis with pyruvate becoming lactic acid, and only two molecules of ATP available for the body (Berg, Tymoczko, & Stryer, 2002).

In order to create ATP through glycolysis, some ATP must be expended. In the first step, glucose is phosphorylated to form glucose-6-phosphate (G6P). The phosphate comes from breaking one of the phosphoanhydride bonds of ATP which provides the energy to fuel the addition of the phosphate to the glucose. The next step is an isomerization of G6P into fructose-6-phosphate (F6P). One more ATP is broken down to phosphorylate F6P into fructose-1,6-bisphosphate (F-1,6 BP). At this point, two ATP molecules have been expended. F-1,6 BP is then cleaved into two molecules, glyceraldehyde-3-phosphate (G3P) and dihydroxyacetone phosphate (DHAP). The DHAP is isomerized into another molecule of G3P and they each continue through glycolysis (Berg, Tymoczko, & Stryer, 2002).

In the next step, G3P is converted into 1,3-bisphosphoglycerate (1,3BPG) by a dehydrogenation reaction. The hydrogen is picked up by a molecule of nicotinamide
adenine dinucleotide \((\text{NAD}^+)\) to form NADH, the reduced form of \(\text{NAD}^+\). A total of two NADH molecules were formed, since two G3P molecules were dehydrogenated. The NADH will later be cycled through the TCA cycle and the ETC to produce ATP. The first two molecules of ATP are produced in the next step, as both 1,3BPG molecules become 3-phosphoglycerate (3PG), giving up one phosphate each that is picked up by ADP. At this point, a net zero molecules of ATP have been made (Berg, Tymoczko, & Stryer, 2002).

3PG undergoes a phosphoryl transfer to become 2-phosphoglycerate (2PG). The 2PG then loses a molecule of water through an elimination reaction and becomes phosphoenolpyruvate (PEP). As each molecule of PEP transfers a phosphate to ADP, two molecules each of pyruvate and ATP are formed, reaching a net two molecules of ATP. At this point, if oxygen is not available, pyruvate is hydrogenated to form lactic acid, expending an NADH molecule. The \(\text{NAD}^+\) that is left over gets recycled back into glycolysis so ATP can continue to be made. In the presence of oxygen, however, pyruvate is converted into acetyl Coenzyme A (acetyl-CoA), with the formation of two more molecules of NADH. Acetyl-CoA goes on to complete the TCA cycle (Berg, Tymoczko, & Stryer, 2002; Thompson, 2005).

Fat and protein can also be fed into glycolysis. Fats can undergo beta oxidation, catabolizing the fatty acid two carbons at a time to form acyl units. The acyl units become acetyl CoA molecules that are then put through the TCA cycle (Silverthorn, 2004). In order for proteins to be used, the amino acids must first be deaminated. First, the protein is hydrolyzed into the individual amino acids. Each amino acid is then deaminated, creating ammonia \((\text{NH}_3)\) and an organic acid. The \(\text{NH}_3\) is converted to urea and excreted by the body. The organic acid is either converted to pyruvate, or to one of the substrates of the TCA cycle (Silverthorn, 2004; Thompson, 2005) (see Figure 5).

**TCA Cycle**

At the end of glycolysis, pyruvate crosses the mitochondrial membrane as it becomes acetyl CoA, and the rest of energy production occurs in the mitochondria. In the TCA cycle, a number of oxidative reactions occur, resulting in the formation of six NADH molecules, two reduced forms of flavin adenine dinucleotide \((\text{FADH}_2)\), which are used in the ETC, and two
Figure 5: Through the process of glycolysis, glucose is turned into ATP. (http://www.humboldt.edu/~rap1/BiochSupp/PathwayDiagrams/GlycolPath.gif, 1997).

more ATP molecules. The TCA cycle starts with the acetyl CoA from glycolysis, and oxaloacetate condensing to form citrate. A water molecule is lost from citrate to form cis-aconitase, then water is added back to make isocitrate. Isocitrate loses a molecule of carbon dioxide and a hydrogen to become α-ketoglutarate. The hydrogen is picked up by NAD⁺ to form NADH (Berg, Tymoczko, & Stryer, 2002; Thompson, 2005).

In the next step, as α-ketoglutarate becomes succinyl-CoA, another molecule of NADH is created. The formation of one molecule of ATP occurs in the following step when succinyl-CoA becomes succinate. As succinate is then dehydrogenated to form fumarate, one FADH₂ molecule is made. Water is added to fumarate, which then becomes malate. A
final dehydrogenation reaction turns malate into oxaloacetate, with the formation of another
NADH molecule. The oxaloacetate begins the TCA cycle again. Since two molecules of
acetyl-CoA started the TCA cycle, a total of six NADH, two FADH₂, and two ATP were
created. In combination with glycolysis, the totals are eight NADH, two FADH₂, and four ATP
(Berg, Tymoczko, & Stryer, 2002; Thompson, 2005).

Within the TCA cycle, the importance of vitamins becomes obvious in their roles as
cofactors. The B vitamins especially contribute to the effectiveness of energy production.
Niacin (B3) is part of the NAD and NADH molecules. Thiamin (B2) is found in a molecule called
thiamin pyrophosphate (TPP) used in the reactions converting pyruvate to acetyl-CoA, and α-
ketoglutarate to succinyl-CoA. FAD molecules require riboflavin (B3). The coenzyme A used in
acetyl-CoA is made with pantothenic acid (B5). In order for the production of energy to
proceed, athletes must get adequate amounts of these vitamins in their diets (Berg,
Tymoczko, & Stryer, 2002; Thompson, 2005) (see Figure 6).

Figure 6: In the mitochondria, the TCA cycle results in the formation of many high energy protons that then go through the electron transport chain to produce ATP.
(http://www.humboldt.edu/~rap1/BiochSupp/PathwayDiagrams/TCACycle.gif, 2000)
**Electron Transport Chain**

In the ETC, which occurs in the mitochondria, NADH and FADH$_2$ molecules transfer their energy to ATP. In this process, NADH and FADH$_2$ release the high energy electrons they picked up, which then pass through a number of protein complexes. As the electrons move through the complexes, energy gets released that powers the transport of H$^+$ ions from the mitochondrial matrix, across the inner mitochondrial membrane into the intermembrane space. These ions move back into the matrix by passing through the ATP synthase protein. For every three H$^+$ ions that pass through, one ATP molecule is made. At the end of the ETC, in combination with glycolysis and the TCA cycle, there is total of 30-32 ATP molecules available to fuel muscular work (Berg, Tymoczko, & Stryer, 2002; Silverthorn 2004).

**Fueling for Activity**

The meals leading up to an athlete's practice or competition session must be carefully planned. In order to provide athletes with the energy needed to sustain their bodies through the activity, the timing, size, and composition of the pre-competition meal must be carefully considered (Hale & Amato, 2001). The goal of the pre-competition meal is to fill up glycogen stores for the body to use during exercise. Careful meal management will minimize the discomfort in the gastrointestinal tract, stave off hunger during the event, maintain adequate fluid levels, and prevent muscle fatigue (Hale & Amato, 2001; DeMarco, 2002).

The last meal should be eaten about one (Thompson, 2003) to four (Ortega, 2004) hours before exercising. Since bigger meals require more time to empty out of the stomach the size of the meal should get smaller as the time to compete approaches. For example, a meal four hours prior to exercise could have 700-800 calories, whereas a meal one hour prior should only have 300-400 calories (Hale & Amato, 2001). Since carbohydrates are the best fuel for athletes, they should make up the bulk of the pre-competition meal. About 60-70% of the calories in the meal should be from carbohydrates (Hale & Amato, 2001). As the competition gets closer, the amount of carbohydrates should decrease, from 4-5 g/kg four hours before, to 2 g/kg one to two hours before (Thompson, 2003). Protein and fat should make up about 10-15% and 15-20%, respectively, of total calories consumed (Hale & Amato,
2001). Foods high in fiber or carbonated beverages should be avoided as they may cause discomfort during the event (DeMarco, 2002).

The type of carbohydrates ingested prior to an event is just as critical as the amount and timing of eating them. The glycemic index (GI) measures on a relative scale how different foods affect blood glucose levels and, consequently, insulin secretion (Thompson, 2005). The standard is usually either white bread or glucose, and is assigned the value of 100 on the glycemic index. Other foods are ranked below that according to how much of an increase they cause in blood glucose levels after consuming them (Hale & Amato, 2001). Foods with a high GI are broken down quickly and result in a fast increase in blood sugar. Low GI foods break down more slowly and their sugars are released into the bloodstream at a steady rate (Garden, 2000). For athletes, the goal before exercising is to fill glycogen stores and have that energy available throughout the duration of the exercise. To achieve this, foods with a low GI of about 30-60 should be included in the pre-competition meal (Thompson, 2003). This is optimal to maintain blood glucose levels and to decrease the insulin response, thus energy needs can be met throughout the event (Hale & Amato, 2001).

Proper hydration is also essential prior to any event. Water is the most essential nutrient (Williams, 2005) and is needed by the body to maintain blood volume and regulate temperature (Mahan & Escott-Stump, 2004), both of which are concerns for athletes. Sweat is 99% water and as it is evaporated from the skin, it prevents body temperature from rising to dangerous levels (Williams, 2005). Intense exercise with heavy sweating can cause athletes to lose up to one liter of fluid each hour (Thompson, 2003). The best way to counteract this is to begin exercising in a well-hydrated state by drinking 17-20 oz. of fluid two to three hours before the event, and another 7-10 oz. ten to twenty minutes before (Casa, Armstrong, Hillman, Montain, Reiff, Rich, et al, 2000). Thirst mechanisms are stimulated when the body has only lost 2% of its water, but by then performance has already been compromised (Casa, et al., 2000; Thompson, 2003). If dehydration occurs, athletic performance suffers and athletes are at risk for problems such as fatigue, cramps, heat exhaustion, and heat stroke (Opplinger & Bartok, 2002). Sweat also contains the electrolytes sodium (Na+), chloride (Cl−), and
potassium (K+) in their ionic forms. These elements have strong influences on water balance both inside and outside of cells. Salts (Na+, Cl-) are needed for blood volume maintenance and need to be consumed in adequate amounts (Mahan & Escott-Stump, 2004).

The best meal combination to ensure adequate fueling prior to an event would be low in fat, moderate in protein, and high in carbohydrates, as well as providing enough water to protect against any losses from sweating. Water is best absorbed when it is cold and is taken in small amounts (Thompson, 2003).

Recovery

The food eaten after exercise is just as important as that eaten before. Performance relies heavily on how adequately energy stores are refilled and how well the body repairs for the next day. One of the main goals of recovery is to replenish the muscle glycogen stores that have been depleted while fueling the exercise (Thompson, 2005). There is also a need to rehydrate and replace the electrolytes that were lost through sweating (Mahan & Escott-Stump, 2004). In order to repair muscle fiber, protein should be included as well (Thompson, 2003). These nutrients can be supplied with proper nutrition and by combining the right nutrients.

The first two hours immediately after exercise should be devoted to replenishing muscle glycogen stores (Fogelholm, 2003). The importance of this step to the recovery process is emphasized by the fact that during this time intramuscular triglycerides, rather than glycogen, are broken down to fuel the body’s activities (Johnson, Stannard, & Thompson, 2004). The glucose used to form glycogen must be obtained from the consumption of carbohydrates following exercise. Glucose can be made via gluconeogenesis but the rate is very slow (Jentjens & Jeukendrop, 2003). Because of the small time frame during which glycogen resynthesis is occurring at maximal speed, the timing of food intake, and the quantity and availability of carbohydrates are important to consider. Foods with a high GI are best to eat since they will most rapidly provide the glucose the body needs (Thompson, 2005) and cause the insulin effect, thus driving the nutrients into the cells. It is recommended that
75-90 grams of carbohydrate, or about 1.2 g/kg (Jentjens & Jeukendrop, 2003), be eaten within the first thirty minutes after exercising (Mahan & Escott-Stump, 2004).

Protein is also necessary after exercising. One study (Levenhagen, Carr, Carlson, Maron, Borel, & Flakell, 2002) suggests that it takes priority over the availability of energy. Not only does the presence of protein help improve muscle glycogen recovery (Thompson, 2003), it is also needed to help repair muscle tissue. Any protein that was broken down for energy needs must be replaced and amino acids must be provided for muscle protein synthesis to take place (Layman, 2002). When carbohydrates and protein are combined in a post-exercise meal, glycogen repletion and muscle fiber repair are supported. The insulin released in response to high GI carbohydrates drives glucose and amino acids into the cells. The synthesis of muscle protein is stimulated by the influx of amino acids into muscle tissue, and the influx of carbohydrates leads to glycogen synthesis (Rennie & Tipton, 2000).

The loss of water and electrolytes through sweat must also be restored after exercising, ideally within two hours (Casa, et al, 2000) as well. One way to determine how much water was lost during exercise is to measure weight both before and after exercising. The difference in the measurements needs to be made up with fluids: for every pound that was lost, two cups of water should be drunk (Thompson, 2005). Sodium and chloride could also be included, especially if athletes don’t obtain enough salt from their diets (Casa, et al, 2000). Caffeine, however, should be avoided, because it is a diuretic and can interfere with glycogen synthesis (Thompson, 2003).

**Glycogenesis**

Glycogen is made up of glucose molecules linked with α1,4 and α1,6 glycosidic bonds (Jentjens & Jeukendrop, 2003) (see Figure 7). After exercise, the glucose obtained from eating carbohydrates is used to replenish the glycogen stores that were used to fuel the exercise, a process called glycogenesis. Glucose is transported across the muscle cell

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**Figure 7:** The glucose molecules making up glycogen are held together with α1,4 and α1,6 glycosidic bonds. (http://dwb.unl.edu/Teacher/NSF/C11/C11Links/www.fordham.edu/Biochem_3521/lect14/lect14.html, 1999)
membrane by glucose transporter carrier proteins. As glucose enters the cell, it is phosphorylated to G6P. A phosphoryl shift turns G6P into glucose-1-phosphate (G1P). The nucleotide uridine triphosphate (UTP) is then combined with G1P to form UDP-glucose. From there, the glucose is added onto an already existing glycogen molecule with the α1,4 glycosidic bond, and the UDP is released (Berg, Tymoczko, & Stryer, 2002; Jentjens & Jeukendrup, 2003).

**Summary**

An athlete’s reliance on energy in turn becomes a reliance on the proper foods from which that energy can be most efficiently derived. By eating the right types of foods before and after exercising, sports performance can be maximized, and recovery facilitated in a timely and efficient manner. Eating carbohydrates with a low glycemic index and reaching a proper hydration state before an event can insure the athletes’ fuel stores will sustain them throughout the event. Consuming protein, carbohydrates of high glycemic index, and fluids after the event, will help speed their recovery time and prepare their bodies’ stores of energy for what the next session of exercise will need. By eating a balanced diet with a variety of foods, the vitamins and minerals needed for the body to perform the tasks of energy production and muscular activity will be provided in adequate amounts.

**METHODS**

Permission was obtained from both the Viewmont High School cross country coach and the Institutional Review Board for the team to participate in the research study. Before the study began, the researcher met regularly with the team during pre-season practices. During this time, the researcher simply got to know the team members and spent time with them before the study took place. It also allowed the participants to become familiar with the researcher prior to the study. Study participants were members of the Viewmont High School Cross Country team in Bountiful, Utah. There were nine females, 14-18 years old in grades 10-12. There were twelve males, 15-18 years old in grades 10-12.

When the actual season started, the participants were told they had the opportunity to be involved in a research study whose purpose was to determine the change in eating
behaviors and attitudes after exposure to presentations on proper sports nutrition. Informed consent was obtained from both the participants and their parents/guardians and confidentiality was assured. After informed consent had been obtained, the participants completed the Pre-Season Survey (see Appendix A).

The researcher met with the team three or four days a week to give presentations. Each presentation was five to ten minutes long and was made either before or after the team’s daily practice run. The presentations followed an interactive lecture format. The presentations were all made in an informal, outdoor setting, rather than a classroom setting so as to impose less on the normal dynamics of the team.

The topics that were covered in the presentations and the order in which they were presented is as follows: hydration and electrolytes; energy systems; carbohydrates; protein; fat; meal combinations; food guide pyramid; fruits and vegetables; and vitamins and minerals. Most topics were divided into two parts and were covered in the presentations of two consecutive days. Some presentations included handouts that were available for the participants (see Appendix B).

After all the presentations had been made, the participants completed the Post-Season Survey (see Appendix A).

RESULTS

Pre-Season Survey

Table 1 displays the overall percentages and gender breakdown for each attitude and behavior item on the pre-survey. The percentages reflect the sum of those who answered "strongly agree" or "agree" to those items. The results of the knowledge items are in Table 2, with the percentages showing those who answered the multiple choice questions correctly (see also Appendix A).
Table 1: Pre-Season Survey Results for Attitude and Behavior Items
Percentages of participants who answered "strongly agree" or "agree" to the attitude and behavior items on the pre-survey, given in overall percentages, and broken down by gender.

<table>
<thead>
<tr>
<th>Item</th>
<th>Total</th>
<th>Males (n=12)</th>
<th>Females (n=9)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attitude</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutrition plays an important role in my athletic performance.</td>
<td>90%</td>
<td>91.7%</td>
<td>77.7%</td>
</tr>
<tr>
<td>The person responsible for my food intake is: *</td>
<td>80.1%</td>
<td>83.3%</td>
<td>77.8%</td>
</tr>
<tr>
<td>(me)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Behavior</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I eat certain foods before training or competing.</td>
<td>61.9%</td>
<td>83.4%</td>
<td>33.3%</td>
</tr>
<tr>
<td>I eat certain foods to recover from training or competing.</td>
<td>33.3%</td>
<td>25%</td>
<td>44.4%</td>
</tr>
<tr>
<td>My diet is different on rest days than on training or competition</td>
<td>52.4%</td>
<td>58.4%</td>
<td>44.4%</td>
</tr>
<tr>
<td>days.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I eat about 2 hours before training or competing.</td>
<td>57.1%</td>
<td>50%</td>
<td>66.7%</td>
</tr>
<tr>
<td>I drink even if I'm not thirsty.</td>
<td>71.4%</td>
<td>66.6%</td>
<td>77.8%</td>
</tr>
<tr>
<td>I eat at least 4 fruits and vegetables a day.</td>
<td>42.9%</td>
<td>58.4%</td>
<td>22.2%</td>
</tr>
<tr>
<td>I base my food choices on:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taste</td>
<td>76.2%</td>
<td>83.3%</td>
<td>66.7%</td>
</tr>
<tr>
<td>Finances</td>
<td>23.8%</td>
<td>41.7%</td>
<td>0%</td>
</tr>
<tr>
<td>Nutrient density</td>
<td>33.3%</td>
<td>33.3%</td>
<td>33.3%</td>
</tr>
<tr>
<td>Food guide pyramid</td>
<td>19%</td>
<td>16.7%</td>
<td>22.2%</td>
</tr>
<tr>
<td>Location that most closely describes where you get each meal:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>School</td>
<td>47.7%</td>
<td>66.6%</td>
<td>22.2%</td>
</tr>
<tr>
<td>Fast Food</td>
<td>14.3%</td>
<td>16.7%</td>
<td>11.1%</td>
</tr>
<tr>
<td>Vending Machine</td>
<td>4.8%</td>
<td>0%</td>
<td>11.1%</td>
</tr>
</tbody>
</table>

*Possible responses were "me," "parent/guardian," "other"; percentages reflect those who answered "me"

Table 2: Pre-Season Survey Results for Knowledge Items
Percentages of participants who chose the correct answer for the knowledge-based items on the pre-survey, given in overall percentages and broken down by gender.

<table>
<thead>
<tr>
<th>Item</th>
<th>Total</th>
<th>Males (n=12)</th>
<th>Females (n=9)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knowledge</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What is the best source of energy for an athlete? (carbohydrates)</td>
<td>81%</td>
<td>100%</td>
<td>55.6%</td>
</tr>
<tr>
<td>Some fats are good for you and are necessary in the diet. (true)</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

*correct answer given in parenthesis

Post-Season Survey

The results of the post-survey are shown in Table 3 and Table 4. Table 3 includes the attitude and behavior items with the percentages showing the sum of those who answered "strongly agree" or "agree." Table 4 shows what percentages correctly answered the knowledge based multiple choice questions (see also Appendix A).
Table 3: Post-Season Survey Results for Attitude and Behavior Items
Percentages of participants who answered "strongly agree" or "agree" to the attitude and behavior items on the post-survey, given in overall percentages, and broken down by gender.

<table>
<thead>
<tr>
<th>Item</th>
<th>Total %</th>
<th>Males (n=12)</th>
<th>Females (n=9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I enjoyed learning about sports nutrition this season.</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Nutrition plays an important role in my athletic performance.</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>In which of the following aspects did you notice a difference?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Level</td>
<td>81%</td>
<td>66.7%</td>
<td>100%</td>
</tr>
<tr>
<td>Endurance</td>
<td>66.7%</td>
<td>75%</td>
<td>55.6%</td>
</tr>
<tr>
<td>Speed</td>
<td>42.9%</td>
<td>41.7%</td>
<td>44.4%</td>
</tr>
<tr>
<td>Overall feeling of health</td>
<td>61.9%</td>
<td>66.7%</td>
<td>55.6%</td>
</tr>
<tr>
<td>Recovery time</td>
<td>33.3%</td>
<td>16.7%</td>
<td>55.6%</td>
</tr>
<tr>
<td>State of hydration</td>
<td>66.7%</td>
<td>50%</td>
<td>88.9%</td>
</tr>
<tr>
<td>Behavior</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I changed my eating habits over the season.</td>
<td>85.7%</td>
<td>83.3%</td>
<td>88.9%</td>
</tr>
<tr>
<td>I drink when I'm not thirsty.</td>
<td>71.4%</td>
<td>75%</td>
<td>66.7%</td>
</tr>
<tr>
<td>I eat at least 4 fruits and vegetables a day.</td>
<td>66.7%</td>
<td>66.7%</td>
<td>66.7%</td>
</tr>
<tr>
<td>I eat carbohydrates for fuel before I train or compete.</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>I time my meals for 2 hours before I train or compete.</td>
<td>57.1%</td>
<td>66.7%</td>
<td>44.4%</td>
</tr>
<tr>
<td>I eat certain foods to recover from training or competing.</td>
<td>71.4%</td>
<td>66.7%</td>
<td>77.8%</td>
</tr>
</tbody>
</table>

Table 4: Post-Season Survey Results for Knowledge Items
Percentages of participants who chose the correct answer for the knowledge-based items on the post-survey, given in overall percentages and broken down by gender.

<table>
<thead>
<tr>
<th>Item</th>
<th>Total %</th>
<th>Males (n=12)</th>
<th>Females (n=9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Which of the following is the best recovery meal? (whole wheat bread with honey and peanut butter)</td>
<td>76.2%</td>
<td>75%</td>
<td>77.8%</td>
</tr>
<tr>
<td>What is the best source of energy for an athlete? (carbohydrates)</td>
<td>81%</td>
<td>91.7%</td>
<td>66.7%</td>
</tr>
<tr>
<td>Which of the following is a healthy fat? (monounsaturated)</td>
<td>52.4%</td>
<td>41.7%</td>
<td>66.7%</td>
</tr>
</tbody>
</table>

*correct answer given in parenthesis

DISCUSSION
In general, the results of the surveys surpassed the expectations of the researcher in the areas of attitude and behavior, but expectations were not met in the area of knowledge. There were also some gender differences for some items that will be further discussed. Five of the items on the pre- and post-season surveys were identical in order to determine the change that occurred in specific areas. These items and their percentages are displayed in
Table 5. The results of these five items were analyzed using chi square, although none of them were statistically significant.

Table 5: Comparison of Identical Questions on Pre- and Post-Surveys
Percentages of participants who chose "strongly agree" or "agree", or answered the multiple-choice question correctly, for both the pre- and post-survey given in overall percentages.

<table>
<thead>
<tr>
<th>Item</th>
<th>Pre-Survey</th>
<th>Post-Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrition plays an important role in my athletic performance.</td>
<td>90%</td>
<td>100%</td>
</tr>
<tr>
<td>I drink when I'm not thirsty.</td>
<td>71.4%</td>
<td>71.4%</td>
</tr>
<tr>
<td>I eat at least 4 fruits and vegetables a day.</td>
<td>42.9%</td>
<td>66.7%</td>
</tr>
<tr>
<td>I eat certain foods to recover from training or competing.</td>
<td>33.3%</td>
<td>71.4%</td>
</tr>
<tr>
<td>What is the best source of energy for an athlete? * (carbohydrates)</td>
<td>81%</td>
<td>81%</td>
</tr>
</tbody>
</table>

*Correct answer given in parenthesis

Only 80% of all participants took personal responsibility for their food intake, which was lower than expected. The 20% who responded that their parent/guardian was responsible may have been focusing on the fact that the parent/guardian is usually the provider of food in the home. Fast food provided at least one meal per day for only three students (14.3%), and vending machines for only one student (4.8%), both of which were less than expected. This may be a sign that as athletes, most of these students are already health conscious and are trying to eat food from their homes or from the school that is more nutritious. Although both males and females put fast food and vending machines as a meal source, those who put finances as a basis for food choice (23.8%) were all males.

On the post-survey all of the participants reportedly enjoyed learning about sports nutrition, and they all agreed that nutrition is important for performance. This change was not statistically significant, but that was expected since so many participants reported that on the pre-survey. Most of the participants (85.7%) reported changing their eating habits over the season. The amount who said they drink when they're not thirsty was 71.4% for both surveys. This was expected to show an overall increase on the post-survey, especially since two-thirds (66.7%) reported a change in their hydration state. However, although the total percentage remained the same, there was an increase in the number of males who reported drinking when not thirsty, while the amount of females decreased.
Those who reported eating four fruits and vegetables a day increased from nine (42.9%) on the pre-survey to fourteen (66.7%) on the post-survey. This change was not statistically significant, but still shows an improvement for almost one-fourth of the participants. The increase in females from pre- to post-survey was four, almost half of the female participants. All of the students stated they eat carbohydrates for fuel before training or competing, which was an expected increase. However, the number of students who correctly answered carbohydrates as the best source of energy for an athlete remained the same (81%) from pre-survey to post-survey. This was expected to increase also, especially since all males answered it correctly on the pre-survey. On the post-survey, though, only 91.7% of the males were correct, while the females increased slightly from five (55.6%) on the pre-survey to six (66.7%) on the post-survey, an increase that did not match the expectation.

The number of students who reported eating certain foods to recover more than doubled from seven (33.3%) on the pre-survey to fifteen (71.4%) on the post-survey, but only one-third (33.3%) reported a noticeable difference in their recovery time. The discrepancy may lie in what types of foods they eat afterwards, but about three-fourths (76.2%) answered correctly that whole wheat bread with peanut butter and honey would be the best recovery meal of the possible responses, which also included graham crackers, a chocolate chip granola bar, and potato chips.

RECOMMENDATIONS

Teen-aged athletes need to be sure to obtain adequate amounts of energy in their diets. Most of this energy, 60-70%, should be provided by carbohydrates such as whole grains and fruits and vegetables. Protein needs can be met by consuming at least 0.8 grams of protein per kilogram of body weight. Protein foods should be low in fat, and should include both animal and plant sources. Fat should make up the remaining energy needs, about 20-30% of total energy. Food choices should be low in saturated fat, such as butter and animal fat, with an increase in the consumption of healthy vegetable fats, such as olive oil. Athletes will also benefit from eating a variety of fruits and vegetables of different colors in order to meet their vitamin and mineral requirements.
Pre-Season Survey
Please circle the answer that best describes your current diet behaviors and beliefs.

Age: Gender: Grade: Year in CC:

1. Nutrition plays an important role in my athletic performance.
   Strongly Agree Don't Know Disagree Strongly Disagree
   Agree

2. I eat certain foods before training or competing.
   Strongly Agree Don't Know Disagree Strongly Disagree
   Agree
   If Strongly Agree or Agree, what foods?

3. I eat certain foods to recover from training or competing.
   Strongly Agree Don't Know Disagree Strongly Disagree
   Agree
   If Strongly Agree or Agree, what foods?

4. My diet is different on rest days than on training/competition days.
   Strongly Agree Don't Know Disagree Strongly Disagree
   Agree

5. I eat about 2 hours before training or competing.
   Strongly Agree Don't Know Disagree Strongly Disagree
   Agree

6. I drink even if I'm not thirsty.
   Strongly Agree Don't Know Disagree Strongly Disagree
   Agree

7. I eat at least 4 fruits and vegetables a day.
   Strongly Agree Don't Know Disagree Strongly Disagree
   Agree

8. I base my food choices on: (circle all that apply)
   taste finances nutrient density food guide pyramid other (please specify)

9. The person responsible for my food intake is
   me parent/guardian other

10. Fill out the table by marking the box that most closely describes where you get each meal. Mark only one location for each meal.

<table>
<thead>
<tr>
<th></th>
<th>Home</th>
<th>School</th>
<th>Fast food</th>
<th>Vending Machine</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lunch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dinner</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11. What is the best source of energy for an athlete?
   carbohydrates protein fat water

12. Some fats are good for you and are necessary in the diet.
   True false
Post-Season Survey

Age: Gender: Grade: Year in CC:

1. I enjoyed learning about sports’ nutrition this season.
   Strongly Agree
don’t Know Disagree Strongly
   Agree

2. I changed my eating habits over the season.
   Strongly Agree
don’t Know Disagree Strongly
   Agree

3. Nutrition plays an important role in my athletic performance.
   Strongly Agree
don’t Know Disagree Strongly
   Agree

4. I drink when I’m not thirsty.
   Strongly Agree
don’t Know Disagree Strongly
   Agree

5. I eat at least 4 fruits and vegetables a day.
   Strongly Agree
don’t Know Disagree Strongly
   Agree

6. I eat carbohydrates for fuel before I train or compete.
   Strongly Agree
don’t Know Disagree Strongly
   Agree

7. I time my meals for 2 hours before I train or compete.
   Strongly Agree
don’t Know Disagree Strongly
   Agree

8. I eat certain foods to recover from training or competing.
   Strongly Agree
don’t Know Disagree Strongly
   Agree
   If Strongly Agree or Agree, what foods?

9. Which of the following is the best recovery meal?
   Whole Wheat bread w/ honey & peanut butter
   Graham crackers
   Chocolate chip Granola Bar
   Potato chips

10. If you applied the nutritional information to your diet, in which of the following aspects did you notice a difference? (circle all that apply)
   energy level overall feeling of health other (please specify)
   endurance recovery time
   speed state of hydration

11. What is the best source of energy for an athlete?
   carbohydrates protein fat water
12. Which of the following is a healthy fat?  
   partially hydrogenated  saturated  monounsaturated

13. What information was the most useful to you?

14. What information was the least useful to you?

15. How effective was the presenter of the information?  
   very effective  effective  don't know  ineffective  very ineffective

16. How could the presenter have been more effective?
Pre-Season Survey Results
Each item is presented with a results table below it. The right hand column shows the possible answer choices for each question; the middle column the percent of the total participants who chose that answer; the left hand column the number of participants who chose that answer. For open ended questions, or the choice of “other,” participant responses are included.

Age:
14: 4.8% 1
15: 38.1% 8
16: 28.6% 6
17: 23.8% 5
18: 4.8% 1

Grade:
10: 47.6% 10
11: 23.8% 5
12: 28.6% 6

Gender:
M: 57.1% 12
F: 42.8% 9

Year:
1: 57.9% 11
2: 21.1% 4
3: 21.1% 4

1. Nutrition plays an important role in my athletic performance.

<table>
<thead>
<tr>
<th></th>
<th>50%</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRONGLY AGREE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGREE</td>
<td>40%</td>
<td>8</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>5%</td>
<td>1</td>
</tr>
<tr>
<td>DISAGREE</td>
<td>5%</td>
<td>1</td>
</tr>
<tr>
<td>STRONGLY DISAGREE</td>
<td>0%</td>
<td>0</td>
</tr>
</tbody>
</table>

2. I eat certain foods before training or competing.

<table>
<thead>
<tr>
<th></th>
<th>14.3%</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRONGLY AGREE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGREE</td>
<td>47.6%</td>
<td>10</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>23.8%</td>
<td>5</td>
</tr>
<tr>
<td>DISAGREE</td>
<td>14.3%</td>
<td>3</td>
</tr>
<tr>
<td>STRONGLY DISAGREE</td>
<td>0%</td>
<td>0</td>
</tr>
</tbody>
</table>

   If Strongly Agree or Agree, what foods?
   - fruits, breads, peanut butter; pasta, complex and simply carbohydrates; carbohydrates; carbohydrates and protein; licorice; carbohydrates and water; power bar; carbohydrates; fruits; carbohydrates; carbohydrates

3. I eat certain foods to recover from training or competing.

<table>
<thead>
<tr>
<th></th>
<th>9.5%</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRONGLY AGREE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGREE</td>
<td>23.8%</td>
<td>5</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>47.6%</td>
<td>10</td>
</tr>
<tr>
<td>DISAGREE</td>
<td>19%</td>
<td>4</td>
</tr>
<tr>
<td>STRONGLY DISAGREE</td>
<td>0%</td>
<td>0</td>
</tr>
</tbody>
</table>

   If Strongly Agree or Agree, what foods?
   - carbohydrates, protein, peanut butter and jelly; bananas and water; carbohydrates and protein; fruits and veggies; licorice

4. My diet is different on rest days than on training/competition days.

<table>
<thead>
<tr>
<th></th>
<th>14.3%</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRONGLY AGREE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGREE</td>
<td>38.1%</td>
<td>8</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>14.3%</td>
<td>3</td>
</tr>
<tr>
<td>DISAGREE</td>
<td>28.6%</td>
<td>6</td>
</tr>
<tr>
<td>STRONGLY DISAGREE</td>
<td>4.8%</td>
<td>1</td>
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</tbody>
</table>
5. I eat about 2 hours before training or competing.
   STRONGLY AGREE 9.5% 2
   AGREE 47.6% 10
   DON'T KNOW 38.1% 8
   DISAGREE 4.8% 1
   STRONGLY DISAGREE 0% 0

6. I drink even if I'm not thirsty.
   STRONGLY AGREE 14.3% 3
   AGREE 57.1% 12
   DON'T KNOW 14.3% 3
   DISAGREE 14.3% 3
   STRONGLY DISAGREE 0% 0

7. I eat at least 4 fruits and vegetables a day.
   STRONGLY AGREE 14.3% 3
   AGREE 28.6% 6
   DON'T KNOW 28.6% 6
   DISAGREE 19% 4
   STRONGLY DISAGREE 9.5% 2

8. I base my food choices on: (circle all that apply)
   TASTE 76.2% 16
   FINANCES 23.8% 5
   NUTRIENT DENSITY 33.3% 7
   FOOD GUIDE PYRAMID 19% 4
   OTHER 0% 0

9. The person responsible for my food intake is
   ME 80.1% 17
   PARENT/GUARDIAN 23.8% 5

10. Fill out the table by marking the box that most closely describes where you get each meal. Mark only one location for each meal.

<table>
<thead>
<tr>
<th></th>
<th>HOME</th>
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<td>0%</td>
<td>4.8%</td>
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</tr>
</tbody>
</table>

11. What is the best source of energy for an athlete?
   CARBOYDRATES 80.9% 17
   PROTEIN 9.5% 2
   WATER 33.3% 7

12. Some fats are good for you and are necessary in the diet.
   TRUE 100% 21
### Post-Season Survey Results

Each question is presented with a results table below it. The right hand column shows the possible answer choices for each question; the middle column the percent of the total participants who chose that answer; the left hand column the number of participants who chose that answer. For open ended questions, or the choice of other, participant responses are included.

<table>
<thead>
<tr>
<th>Age:</th>
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<tbody>
<tr>
<td>14: 4.8% 1</td>
<td>10 47.6% 10</td>
</tr>
<tr>
<td>15: 38.1% 8</td>
<td>11 23.8% 5</td>
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<tr>
<td>16: 28.6% 6</td>
<td>12 28.6% 6</td>
</tr>
<tr>
<td>17: 23.8% 5</td>
<td>Year in CC:</td>
</tr>
<tr>
<td>18: 4.8% 1</td>
<td>1st 57.9% 11</td>
</tr>
<tr>
<td>Gender:</td>
<td>2nd 21.1% 4</td>
</tr>
<tr>
<td>M: 57.1% 12</td>
<td>3rd 21.1% 4</td>
</tr>
<tr>
<td>F: 42.8% 9</td>
<td></td>
</tr>
</tbody>
</table>

1. I enjoyed learning about sports nutrition this season:
   - STRONGLY AGREE 76.2% 16
   - AGREE 23.8% 5
   - DON'T KNOW 0% 0
   - DISAGREE 0% 0
   - STRONGLY DISAGREE 0% 0

2. I changed my eating habits over the season:
   - STRONGLY AGREE 0% 0
   - AGREE 85.7% 18
   - DON'T KNOW 14.3% 3
   - DISAGREE 0% 0
   - STRONGLY DISAGREE 0% 0

3. Nutrition plays an important role in my athletic performance:
   - STRONGLY AGREE 81% 17
   - AGREE 19% 4
   - DON'T KNOW 0% 0
   - DISAGREE 0% 0
   - STRONGLY DISAGREE 0% 0

4. I drink when I'm not thirsty:
   - STRONGLY AGREE 33.3% 7
   - AGREE 38.1% 8
   - DON'T KNOW 19% 4
   - Disagree 9.5% 2
   - STRONGLY DISAGREE 0% 0

5. I eat at least 4 fruits and vegetables a day:
   - STRONGLY AGREE 23.8% 5
   - AGREE 42.9% 9
   - DON'T KNOW 23.8% 5
   - DISAGREE 9.5% 2
   - STRONGLY DISAGREE 0% 0
6. I eat carbohydrates for fuel before I train or compete:
   STRONGLY AGREE  57.1%  12
   AGREE           42.9%   9
   DON'T KNOW      0%      0
   DISAGREE        0%      0
   STRONGLY DISAGREE 0%    0

7. I time my meals for 2 hours before I train or compete:
   STRONGLY AGREE  19%    4
   AGREE           38.1%  8
   DON'T KNOW      28.6%  6
   DISAGREE        14.3%  3
   STRONGLY DISAGREE 0%    0

8. I eat certain foods to recover from training or competing:
   STRONGLY AGREE  14.3%  3
   AGREE           57.1% 12
   DON'T KNOW      19%    4
   DISAGREE        9.5%   2
   STRONGLY DISAGREE 0%    0
   If Strongly Agree or Agree, what foods?
   wheat bread; apple or banana and Gatorade; carbohydrates; vegetables and fruit;
   crackers, fruit; protein; Gatorade, carbs; peanut butter and jelly, oatmeal; sandwich,
   Gatorade; peanut butter, bananas; fruits, carbs; fruits; banana, apple; bananas, pasta,
   bread; carbs, fruit; protein; carbs and protein

9. Which of the following is the best recovery meal?
   WWBREAD W/ HONEY AND PB  76.2% 16
   GRAHAM CRACKERS          9.5%  2
   CHOCOLATE CHIP GRANOLA BAR 9.5%  2
   POTATO CHIPS             4.8%   1

10. If you applied the nutritional information to your diet, in which of the following aspects did you notice a difference? (circle all that apply)
    ENERGY LEVEL   81%    17
    ENDURANCE      66.7%  14
    SPEED          42.9%   9
    OVERALL FEELING OF HEALTH 61.9% 13
    RECOVERY TIME  33.3%   7
    STATE OF HYDRATION   66.7% 14
    OTHER (PLEASE SPECIFY) 4.8%   1
    Responses to "other": nonslothismness during running

11. What is the best source of energy for an athlete?
    CARBOHYDRATES  81%   17
    PROTEIN        9.5%   2
    WATER          14.3%  3

12. Which of the following is a healthy fat?
    PARTIALLY HYDROGENATED 19%   4
    SATURATED             23.8%  5
    MONOUNSATURATED       52.4% 11
13. What information was the most useful to you?

- drink more water
- carbohydrates
- what to eat and when
- water
- everything
- what to eat before and after
- carbohydrates
- what to eat before race
- what I should eat
- drink even if you’re not thirsty
- drinking water
- two different kinds of carbs
- carbs
- staying hydrated
- all
- pre-meal eating
- water
- all
- food before and after meets and stuff
- what to eat before/after running
- the food groups
- what to eat after running
- post-race
- protein after run
- info about carbs and fruits and veggies
- what to eat before and after you run
- fats

14. What information was the least useful to you?

- fats
- the kinds of fat
- percentages of stuff
- saturated fats
- fat
- what sugars and fats do
- sugar
- what foods have what fat
- each fat
- what the carbohydrates look like
- water I need

15. How effective was the presenter of the information?

<table>
<thead>
<tr>
<th>Choice</th>
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<th>Count</th>
</tr>
</thead>
<tbody>
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<tr>
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<td>8</td>
</tr>
<tr>
<td>DON’T KNOW</td>
<td>0%</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>VERY INEFFECTIVE</td>
<td>0%</td>
<td>0</td>
</tr>
</tbody>
</table>

16. How could the presenter have been more effective?

- give more examples, less chemistry
- give food
- use more objects, or pertain to individuals
- food
- if you can help it, don’t use such big nutritional words, or explain in more detail
- more on what you should eat before the race
- give more assignments
- if I listened
# APPENDIX B: LESSON PLAN OUTLINES AND HANDOUTS

<table>
<thead>
<tr>
<th>Lecture</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>Hydration</td>
<td>35</td>
</tr>
<tr>
<td>3</td>
<td>Energy</td>
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<td>9</td>
<td>Fruits &amp; Veggies</td>
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</tr>
<tr>
<td>10</td>
<td>Vitamins &amp; Minerals</td>
<td>63</td>
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</table>
Lecture 1: Introduction

- We eat in order to obtain nutrients
  - There are 6 nutrients: carbohydrates, protein, fat, vitamins, minerals, water
- These nutrients provide the energy, building blocks for growth and repair, and chemicals needed for body processes
- Sports nutrition is "the application of eating strategies to promote good health and adaptation to training, to recover quickly after each exercise training session, and to perform optimally during competition" (Williams, 2005)
- We get the fuel our body needs from the food we eat
- We'll be covering each of the 6 nutrients – what they are, what they do, where you get them, and why you need them
- We'll go over how the body converts food into energy – through metabolism and the various energy systems
- We'll cover what you should eat and when, and what will work to your advantage
  - The key is to eat nutrient dense foods that provide the calories (energy) needed, but also the nutrients the body needs
- We'll learn how and why nutritional needs of athletes are slightly different than those for the general public
- Overall, the key to good nutrition is eating a variety of whole foods

Warning

- Whatever I say, do what you know will work for you, what you can definitely handle
- If you're going to try something for the first time, do it on a practice day, maybe 2 practice days, before doing it on a race day
Lecture 2: Hydration

- Proper hydration is one of the strongest influences on sports performance, and water is the most essential nutrient
- Input: food, drink, metabolism
- Output: sweat, respiration, urine, feces
- Water is needed for other nutrients to function properly; for water-soluble vitamins; to maintain blood volume; to regulate body temperature
- You know you're properly hydrated when you're urine is clear, pale yellow, and you're going every hour or two
- When you're dehydrated, you're blood volume decreases, and heart rate subsequently increases, forcing the cardiovascular system to work under stressful conditions; (Figure 2.1 - Dehydration flowchart)
- After 2% of body water has been lost (2 lbs or ~1 L, for a 100 lb person; 3 lbs or ~1.5 L for 150 lb person), thirst mechanism begins, but aerobic performance has already been reduced
- The key to remain hydrated is to drink when you're not thirsty; you can also keep track of you're "juiced up weight" and refill as needed after exercising (1 lb = 2 cups water)
  - Example: if your "juiced up weight" is 130 lbs, and after exercising, you weigh 129 lbs, you need to drink 2 cups water
- What should you drink? Fluids are absorbed by body faster when they're cold, dilute, and in small amounts, so drink cold, dilute stuff a little at a time
- When should you drink? Before, during and after exercising:
  - Before: make sure you're adequately hydrated the day before and morning of exercising; if it's a really hot day, drink 10-17 oz (1-2 cups) 15-30 minutes before exercising
  - During: if you're exercising 1-4 hours, drink small amounts cold fluid every 15-20 minutes
  - After: since you're trying to restore fluids lost by sweating, you need to consume more fluids than what was lost; also need to replace lost electrolytes
- What fluids should be avoided? Caffeine: it's a diuretic and can increase water loss; also inhibits glycogen synthesis (this will be covered later);
  - Carbonation: you've probably always heard that it's so, so bad for athletes; actually, carbonation itself doesn't seem to be the problem, but what carbonation usually comes with: caffeine, little nutrients, less water intake

Sweat & Temperature Regulation

- Sweat is 99% water
- You can lose up to 1 L fluid per hour when you're sweating really hard
- The body sweats to cool off; the heat generated by muscles goes to body's core and raises body temperature; body cools off when sweat evaporates from the skin
- You must consider both temperature and humidity; both will contribute to body's ability to cool itself
  - Temperature: when it's hotter, you sweat more
  - Humidity: if it's too high sweat can't evaporate; sweat that drips or is rubbed off skin doesn't contribute to cooling process
- If the body gets too hot, it can cause thermal injury; symptoms include weakness, chills, cramps, headache, nausea; can lead to death (Figure 2.2 - Body's Response to Heat)
- In addition to water, sweat also contains electrolytes: sodium (Na\textsuperscript{+}), chlorine (Cl\textsuperscript{-}), potassium (K\textsuperscript{+})
  - Na\textsuperscript{+}: this is needed to maintain fluid balance, for nerve impulse transmission, for muscle contractions; it's low in natural foods, but high in processed foods
  - Cl\textsuperscript{-}: you get this mostly from table salt; works with Na\textsuperscript{+}
- **K+**: you get this from bananas, citrus fruits, veggies, meat, milk; it's needed by cells for electrical impulses, and to get glucose into muscle cell and to store glycogen (discussed later)
  - After exercise, lost electrolytes need to be replaced along with water
  - Water alone may dilute blood and lower electrolyte concentration even more, so a sports drink might be a good idea for after exercising; however, it may not be as critical since most exercise for team lasts only around 30 minutes

**Key Points**
- Drink when you're not thirsty
- Replace both water and electrolytes
Figure 2.1 – Dehydration Flowchart: When you’re dehydrated, blood volume decreases, and heart rate increases, putting stress on the cardiovascular system (Thompson, 2003).

Figure 9.8 Some physiological effects of dehydration. The decreased blood volume and increased core temperature may contribute to premature fatigue and heat illness.
Figure 2.2 – Body’s Response to Heat: When the body gets too hot, it can lead to thermal injury (Thompson, 2003).
Lecture 3: Energy

- calorie: the amount of heat needed to raise the temperature of one gram of water one degree Celsius; a Calorie (Cal) from food actually is a kilocalorie, or 1000 calories
- We obtain energy in form of calories from carbohydrates, protein and fat: 1 g carbohydrate typically provides 4 Cal; 1 g protein typically provides 4 Cal, 1 g fat typically provides 9 Cal
- These nutrients are broken down and used to produce ATP, the form of energy available for immediate use in the body
- ATP (Figure 3.1 - ATP) – Adenosine Triphosphate; ATP is required for muscle contractions; when the bonds in ATP are broken energy is generated – ATP is broken down to Adenosine Diphosphate (ADP)
- ATP is stored in small amounts in tissues, otherwise it must be generated from CHO, Pro and Fat from the following energy stores:
  - CHO is stored as blood glucose and muscle and liver glycogen
  - Fat is stored as triglycerides in muscle and adipose tissue
  - Pro is stored in muscle tissue, but is not usually used for energy production
- 3 energy systems are used to produce ATP
- ATP-PCr System: (Figure 3.2 – ATP-PCr System) In this system, as ATP gets broken down to ADP, PCr (Creatine Phosphate) gets broken down to restore ATP; this system is anaerobic meaning it is done without oxygen; it’s a very limited energy source – it only lasts up to 10 seconds
- Lactic Acid System (LAS) (Figure 3.3 – Lactic Acid System): this system can produce ATP rapidly from muscle glycogen; the process glycolysis breaks down glucose; this system is also anaerobic, with lactic acid produced as a by product; it’s also short-lived, lasting only 10-120 seconds; 1 molecule of glucose will produce 2 molecules ATP
- Oxygen System (Figure 3.4 – Oxygen System): this system is aerobic, so oxygen must be available; this system also uses glycolysis, but no lactic acid is produced; the products of glycolysis are put through the TCA cycle and Electron Transfer System to produce a lot of ATP; the rate of ATP production is lower than in the LAS, but far more ATP can be produced; 1 molecule of glucose produces 36 molecules of ATP; this system is used for endurance and will be the one used primarily for runners
- Although ATP can be made from all 3 nutrients, some work better than others:
  - CHO is high performance fuel because it produces ATP the fastest.
  - Fat provides more calories per gram, and more ATP when used, but does so much slower than CHO
  - Pro is used to make ATP mainly during a stress response
- The intensity and duration of exercise determines which system will be used and the amount of ATP that will be generated (Figure 3.5 – Energy Systems)
  - Intensity: high – the body uses glucose and glycogen anaerobically in the LAS; moderate – the body uses glycogen, glucose and fatty acids aerobically in the OS; low – the proportion of fat used increases, but is still used aerobically in the OS
  - Duration: the longer you exercise, the more your body relies on fat, but CHO must still be available
- How much energy (Calories) do I need to consume daily? You can determine your Estimated Energy Requirement (EER) based on your gender, age, weight, and physical activity level:
  - Males: 662 – 9.93 x age + [PA x (15.91 x weight + 539.6 x height)]
  - Females: 354 – 6.91 x age + [PA x (9.361 x weight + 726 x height)]
  - Age in years; Physical Activity coefficient from table; weight in kg (lbs x 0.454); height in meters (inches x 0.0254)
- Where should my energy come from? The Acceptable Macronutrient Distribution Range tells how CHO, Pro and Fat should be distributed in the diet: 60-70% Calories from CHO, 10-15% from Pro, 20-30% from Fat
  - If you eat more CHO, more CHO will be used for energy; the same goes for Fat
You might think that a high fat diet would be better, but that's not true; although fat provides more Calories per gram, a high fat diet can cause performance to suffer because of a lack of glycogen which must be present for fat to be used to make ATP.

Key Points
- Energy comes from the food we eat and those nutrients are used to generate ATP.
- Runners will rely primarily on the oxygen system, most likely exercising at moderate to high intensity, so CHO will be the primary source of ATP.
- Follow the AMDR to make sure you get enough CHO.
Figure 3.1 – ATP: Adenosine Triphosphate is the form of energy used by the body (Thompson, 2003).

Figure 3.2 – ATP-PCr System: This system restores ATP from ADP to provide energy for a short time (Thompson, 2003).
Figure 3.3 – Lactic Acid System: This system is used to create ATP in the absence of oxygen. Lactic acid is formed as a byproduct and can lead to early fatigue (Thompson, 2003).
Figure 3.4 – Oxygen System: This system produces ATP in the presence of oxygen. It is the most efficient way to generate energy for working muscles (Thompson, 2003).
Figure 3.5 – Energy Systems: Depending on the intensity and duration of the exercise, different systems will be used to generate the ATP needed to fuel the activity (Thompson, 2003).

- **Aerobic System**
  - Beyond 1/2 mile run, aerobic system becomes progressively more important.

- **Anaerobic Power-endurance**
  - 200-400 m dash, 50-100 yard swim

- **Sustained power**
  - Sprint, fast breaks, football line play

- **Strength—power**
  - Power lift, high jump, shot put, golf swing, tennis serve

- **ATP-CP + Lactic Acid**

- **Immediate/Short-Term Non-Aerobic Systems**

Predominant Energy Pathways
Lecture 4: Carbohydrates

- Carbohydrates are organic compounds made up of carbon, oxygen and hydrogen, in the ratio of \((CH_2O)\)_n.
- You get them mostly from the bottom half of the (old) food guide pyramid: breads, cereals, grains, fruits, veggies; you can also get them from sugary junk food that would probably be included in the point of the old pyramid.
- Why do we need them? The main function of CHO is to supply energy – they are the most important energy food for exercise and are the main source of glucose and glycogen for energy systems that will generate ATP.
- Simple sugars: the monosaccharides are glucose (found in the blood), galactose (made up the sugar in milk), and fructose (found in fruit); the disaccharides are maltose (2 glucose put together; found in grains), lactose (1 glucose and 1 galactose; found in milk), and sucrose (1 glucose and 1 fructose; common table sugar).
- Complex carbohydrates: these are starches that have 3 or more glucose molecules; polysaccharides have at least 10 glucose and are the storage form of CHO; fiber is a nondigestible polysaccharide.
- Which ones do I need? This depends on what you’re doing; for exercise, you want better quality CHO: whole grains, fruits, and vegetables; these also contain other necessary nutrients; candy bars and Twinkies will provide CHO in the form of simple sugars, but they’ll also include fat and don’t provide other nutrients.
  - The key is to go for nutrient dense foods; these foods have a lot of a specific nutrient or nutrients compared to the number of calories it has: Twinkie vs. apple – the apple is nutrient dense.
- You need at least 130 g CHO every day; this value is based on the amount of glucose used by the brain; the AMDR is 45-65% calories, but it may be better for athletes to get 60-70% of calories from CHO.
- A high CHO diet is recommended for athletes, although the body can make energy from both Pro and Fat.
- Glucose is the CHO most important for physiology – it makes up blood sugar, and is what most CHO is converted or simplified to.
- Blood sugar and exercise: glucose is used by the brain for energy; it also gets converted to liver & muscle glycogen which is broken down to provide ATP during exercise; it can also be converted to and stored as fat.
- During moderate intensity exercise, 50% of the energy comes from CHO; as intensity of exercise increases, the percent of CHO used also increases; at maximal levels of exercise, CHO is used almost exclusively.
  - Remember, CHO produces ATP the fastest and most efficiently.
- The primary source of CHO during exercise is muscle glycogen, so you must consume enough CHO prior to exercise to maintain your stock of muscle glycogen, otherwise your endurance and performance will suffer.
- Aim for the optimal glycogen replenishing diet: 65-70% CHO (greater than AMDR), 0.8 g/kg Pro, with fat making up the rest of your calories; basically, good quality/nutrient dense CHO should make up the bulk of your diet.

Glycemic Index (GI)

- This is a measurement of how different substances affect blood glucose levels.
- A food low on the GI (<60) will cause blood glucose levels to rise slowly; foods high on the GI (>85) cause it to rise faster (Figure 4.1 – Glycemic Index of common foods).

- So what types of CHO should you eat and when should you eat them? The critical point is the day leading up to the event, so eat good sources then.
- Before exercising: eat low GI foods, or the insulin response to high blood glucose levels may be too high and remove glucose from the blood too quickly; low GI examples – white or brown rice, spaghetti, banana, grapes, orange.
• After: eat high GI foods for optimal glycogen restoration; high GI examples – whole wheat bread, cheerios, rice krispies, graham crackers
• Basically, eat CHO before and after exercising

Recommendations
• A 2000 calorie diet needs about 300 g CHO; a 2500 calorie diet needs about 375 g CHO (this provides 60% calories from CHO)
• Eat more whole grains instead of refined grains – whole grains are usually brown, refined are white (brown bread vs. white bread; brown rice vs. white rice) (ingredients lists will say "refined" or "enriched" flour instead of "whole wheat flour")
• Fruits and vegetables are a good, nutrient dense, low fat alternative to candy and junk food that also provide carbohydrates

Key Points
• CHO main role is to supply energy
• Athletes need CHO from good quality sources that make up 60-70% of the diet
• Eat low GI foods before exercise, high GI foods after
Figure 4.1 Glycemic Index (Thompson, 2003).

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<tr>
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<td>Grapes</td>
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<td>Orange</td>
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<td>Pear</td>
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<td>Apple</td>
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<table>
<thead>
<tr>
<th>Starchy Vegetables</th>
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<tr>
<td>Potatoes, baked</td>
<td>83</td>
</tr>
<tr>
<td>Potatoes, instant</td>
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<tr>
<td>Potatoes, mashed</td>
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<td>Carrots</td>
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<td>Chick peas</td>
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<td>Butter beans</td>
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<td>Lentils</td>
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<td>Kidney beans</td>
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<tr>
<td>Yogurt, sweetened</td>
<td>33</td>
</tr>
<tr>
<td>Milk, skim</td>
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<tr>
<td>Milk, full fat</td>
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<table>
<thead>
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<tbody>
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<tr>
<td>Jelly beans</td>
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<tr>
<td>Graham crackers</td>
<td>74</td>
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<tr>
<td>Corn chips</td>
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</tr>
<tr>
<td>Life savers</td>
<td>70</td>
</tr>
<tr>
<td>Angel food cake</td>
<td>67</td>
</tr>
<tr>
<td>Wheat crackers</td>
<td>67</td>
</tr>
<tr>
<td>Popcorn</td>
<td>55</td>
</tr>
<tr>
<td>Oatmeal cookies</td>
<td>55</td>
</tr>
<tr>
<td>Potato chips</td>
<td>54</td>
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<tr>
<td>Chocolate</td>
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<tr>
<td>Banana cake</td>
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<td>Peanuts</td>
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<table>
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<tr>
<td>Honey</td>
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<tr>
<td>Sucrose</td>
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<td>Lactose</td>
<td>49</td>
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<td>Fructose</td>
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<table>
<thead>
<tr>
<th>Beverages</th>
<th>GI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft drinks</td>
<td>68</td>
</tr>
<tr>
<td>Orange juice</td>
<td>57</td>
</tr>
<tr>
<td>Apple juice</td>
<td>41</td>
</tr>
</tbody>
</table>

Foods listed from highest to lowest glycemic index within category
Glycemic index was calculated using glucose as the reference with GI of 100.
Modified from Foster-Powell and Brand Miller (1995).
Lecture 5: Protein

- Proteins are organic compounds with a backbone of Carbon (C), Hydrogen (H), Oxygen (O), and Nitrogen (N) – very similar to CHO, although with a very different structure
- There are 20 different amino acids (AA) that combine to form the proteins needed by the body
- Proteins are polypeptides, meaning the amino acids are connected to each other with bonds that involve the N; a polypeptide can have up to 300 amino acids
- Proteins are used for the structure of tissues, making up the bulk of muscle tissue; they are used in the formation of enzymes used in a number of biological processes; they also help form hormones, and are involved in water balance and immunity; they can be used for energy if they are deaminated – meaning the N is removed – allowing the remaining CHO to go into one of the energy systems
- Of the 20 AA, 11 are made by the body in sufficient amounts; the remaining 9 must be acquired from the diet – these are called the essential AA
- We obtain AA from animal and plant sources: meat, fish, eggs, poultry, cheese milk, wheat, rice, beans (legumes), nuts
  - A food source with all 9 essential AA is a "complete protein," and is usually an animal source; "incomplete proteins" have only some of the 9, are usually plants, and can be combined to provide all 9 in the following ways: grains & legumes, grains & dairy, or legumes & seeds
- You need about 0.8 g/kg or 0.36 g/lb of Pro daily; the AMDR is 10-35% of calories; you’ll probably get enough protein from a regular diet that is sufficient in calories; some athletes may benefit from a slightly higher amount of protein: 1.2-1.4 g/kg
- Athletes need protein for synthesis of muscle tissue which occurs predominantly during recovery, after exercising
- Eating protein after exercising helps stimulate muscle synthesis; when combined with CHO, it can also help with glycogen replenishment; this is why the food eaten after exercising is so important
- Protein can be used as an energy source; it contributes about 5% of fuel during exercise, more when exercise is prolonged; it provides 4 calories/g, but must first be deaminated

Recommendations

- A 2000 calorie diet needs about 75 g protein; a 2500 calorie diet needs about 93 g protein (this is based on 15% calories from protein)
- Watch out for protein sources that are also going to be high in fat (i.e. red meat, other animal sources); instead, eat lean cuts of meat, low fat milk, and plant sources, such as nuts, legumes, and seeds

Key Points

- Protein should contribute about 10-35% calories; a diet sufficient in calories probably provides enough protein
- You can get protein from plants and animals
- Athletes need to eat protein after exercising to help restore muscle tissue
Lecture 6: Fat

- Why do we need fat? It provides 9 calories of energy per gram and is the main source of energy during rest and light activity; it also provides the essential fatty acids needed by body; it’s used for fat soluble vitamins, and insulion and protection of the body and internal organs.
- Triglycerides: these include most of the fats eaten and stored by the body.
- Triglycerides – these are made up of a glycerol backbone and 3 fatty acid chains (Figure 6.1 – Fat Structures)
- There are lots of classifications for fatty acid chains: short, medium, long, saturated, unsaturated, cis, trans
- Saturated – “saturated” means the structure has the maximum number of C-H bonds; these are unhealthy fats: they are usually solid at room temperature; sources include butter, coconut oil, palm oil, animal fat, peanut oil.
- Monounsaturated – “unsaturated” means a double bond is formed between 2 C; “mono” means there is 1 double bond; these are healthy fats; they are usually liquid at room temperature; sources include canola oil, olive oil.
- Polyunsaturated – “poly” means there is more than 1 double bond; they are also healthy fats; they are liquid at room temperature; sources include corn oil, safflower oil, soybean oil.
  - Omega-3/Omega-6 – these are polyunsaturated fats; the number refers to the location of the first double bond from the end of each chain; these are healthy fats: linolenic, an α-3, and linoleic, an α-6, are essential fatty acids; sources include fish and in unsaturated fat oils.
- Partially Hydrogenated – this occurs to fats during food processing; it makes unsaturated fats more saturated, and therefore more unhealthy, as the double bonds are broken and replaced with single bonds.
- Trans Fatty Acids – this refers to the arrangement of the double bond in a fatty acid; natural fats are “cis” with the H’s on the same side of the double bond, causing the fatty acid chain to form a “U” shape; hydrogenation can cause the fatty acid to become “trans” with the H’s on opposite sides of the double bond, forming a kink in the chain; trans fatty acids are usually atherogenic, contributing to heart disease.
  - Trans fatty acids are found in processed foods, deep fried foods, shortening, margarine, baked goods.
- The AMDR for fat is 20-30% calories from total fat, but only 7-10% calories from saturated fat.
  - In a diet with too much fat, the fat most likely replaces CHO; it’s associated with excess calories and increased body weight; it can also contribute to conditions like heart disease, etc.
  - A diet with less than 15% of calories coming from fat can hinder athletic performance.
  - Sidenote: anything from the other nutrients, CHO and protein that is unused is eventually converted to fat, so you must be moderate in your consumption of the other nutrients as well.

Recommendations

- A 2000 calorie diet needs about 66 g total fat; a 2500 calorie diet needs about 83 g total fat (this is based on 30% calories from fat)
  - Examples – Crisco Fat Demonstration
- Replace high fat choices with lower fat choices (grilled or baked instead of fried; fruits and veggies for snacks instead of candy; 1% or skim milk; less red meat, more fish).
- Moderation is the key – you need some fat and you can eat fast food and treats occasionally, just make sure those sorts of foods don’t make up the bulk of your diet; in the old food guide pyramid, they are in the top point and should be used sparingly.
Key Points

- Fats are needed by the body, but there are good and bad kinds of fat.
- Mono and Polyunsaturated fats are the good kinds.
- Fats should only make up about 1/3 of the calories in the diet.
- Moderation is the key.
Figure 6.1 – Fat Structures: There are many different types of fat. a) Triglycerides are the form of fat obtain from food. b) Saturated fatty acids are the least healthy. c) Monounsaturated fatty acids are a healthy form of fat, characterized by one double bond. d) Polyunsaturated fatty acids are another healthy fat, with more than one double bond. e) Trans-fatty acids have a "trans" double bond, created during food processing. These are not healthy. f) Omega-3 and Omega-6 fatty acids are essential fatty acids that must be obtained from the diet.

a) TRIGLYCERIDE

b) SATURATED FATTY ACID

[c] MONOUNSATURATED FATTY ACID

d) POLYUNSATURATED FATTY ACID

e) TRANS FATTY ACID

f) OMEGA-3 AND OMEGA-6 FATTY ACIDS


## Crisco Fat Demonstration

### High-Fat Diet

<table>
<thead>
<tr>
<th>Amount</th>
<th>Food Item</th>
<th>Grams of Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Egg, Bacon, Cheese Croissant Sandwich</td>
<td>34.00</td>
</tr>
<tr>
<td>1 cup</td>
<td>Orange juice – chilled</td>
<td>0.67</td>
</tr>
<tr>
<td>2 cups</td>
<td>Brewed Coffee</td>
<td>0.02</td>
</tr>
<tr>
<td>1 fl oz</td>
<td>Rich’s Light Non-Dairy Creamer</td>
<td>1.00</td>
</tr>
<tr>
<td>1</td>
<td>Yeast Doughnut – Glazed</td>
<td>13.68</td>
</tr>
<tr>
<td>1 cup</td>
<td>2% milk with vitamin A</td>
<td>4.70</td>
</tr>
<tr>
<td>1</td>
<td>Fish + Fries + 3pc butter</td>
<td>50.00</td>
</tr>
<tr>
<td>1</td>
<td>Cole Slaw</td>
<td>6.00</td>
</tr>
<tr>
<td>20 fl oz</td>
<td>Cola type soda pop – regular</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>Salad plain BK</td>
<td>3.00</td>
</tr>
<tr>
<td>1</td>
<td>Potato with broccoli and cheese</td>
<td>14.00</td>
</tr>
<tr>
<td>1</td>
<td>Dairy Queen sundae – regular</td>
<td>10.00</td>
</tr>
</tbody>
</table>

**Total Fat Grams:** 137.08

### Nutritional Information

- **Calories:** 3319.99
- **Protein:** 88.27 g (10.64% cal)
- **Carbohydrate:** 431.28 g (51.96% cal)
- **Fat – Total:** 137.08 g (37.16% cal)
  - **Saturated:** 41.85 g (11.34% cal)
  - **Monounsaturated:** 47.13 g (12.78% cal)
  - **Polyunsaturated:** 17.73 g (4.81% cal)
## Low-Fat Diet

<table>
<thead>
<tr>
<th>Amount</th>
<th>Food Item</th>
<th>Grams of Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 cups</td>
<td>Cheerios</td>
<td>2.68</td>
</tr>
<tr>
<td>1.5 cups</td>
<td>Nonfat Skim Milk with Vitamin A</td>
<td>0.66</td>
</tr>
<tr>
<td>1.5 cups</td>
<td>Orange juice – chilled</td>
<td>1.01</td>
</tr>
<tr>
<td>2 cups</td>
<td>Brewed Coffee</td>
<td>0.02</td>
</tr>
<tr>
<td>2 pieces</td>
<td>Raisin Bread – toasted</td>
<td>2.30</td>
</tr>
<tr>
<td>2 tbs</td>
<td>Creamy Peanut Butter</td>
<td>16.32</td>
</tr>
<tr>
<td>6</td>
<td>Fig Newton Cookies</td>
<td>0</td>
</tr>
<tr>
<td>12 fl oz</td>
<td>Cranberry-Apple drink</td>
<td>0</td>
</tr>
<tr>
<td>2 cups</td>
<td>Spaghetti Noodles – cooked, with salt; enriched</td>
<td>1.88</td>
</tr>
<tr>
<td>0.75 cup</td>
<td>Chunky Garden Prego Spaghetti Sauce</td>
<td>1.50</td>
</tr>
<tr>
<td>2 pieces</td>
<td>French Bread (5 x 2.5 inch slice)</td>
<td>1.50</td>
</tr>
<tr>
<td>1 tbs</td>
<td>Soft margarine (made with safflower oil)</td>
<td>11.34</td>
</tr>
<tr>
<td>20 fl oz</td>
<td>Diet cola</td>
<td>0</td>
</tr>
<tr>
<td>6 oz wt</td>
<td>Chicken Cacciatore</td>
<td>17.89</td>
</tr>
<tr>
<td>1 cup</td>
<td>Spinach – boiled, drained, unsalted</td>
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</tr>
<tr>
<td>1 cup</td>
<td>White Rice – long grain, cooked</td>
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</tr>
<tr>
<td>1 cup</td>
<td>Frozen yogurt – low fat</td>
<td>8.06</td>
</tr>
<tr>
<td>1 piece</td>
<td>Angel food cake – enriched</td>
<td>0.23</td>
</tr>
<tr>
<td>0.5 cup</td>
<td>Fresh raspberries</td>
<td>0.34</td>
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**Total Fat Grams:** 66.67

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<tbody>
<tr>
<td>Calories</td>
<td>3120.28</td>
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<tr>
<td>Protein</td>
<td>106.33 g 13.63% cal</td>
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<tr>
<td>Carbohydrate</td>
<td>529.03 g 67.82% cal</td>
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<tr>
<td>Fat – Total</td>
<td>66.67 g 19.23% cal</td>
</tr>
<tr>
<td>Saturated</td>
<td>17.53 g 5.06% cal</td>
</tr>
<tr>
<td>Monounsaturated</td>
<td>23.43 g 6.76% cal</td>
</tr>
<tr>
<td>Polyunsaturated</td>
<td>18.86 g 5.44% cal</td>
</tr>
</tbody>
</table>
High Fat Calorie Breakdown

- Fat: 37%
- Carbohydrates: 52%
- Protein: 11%

Low Fat Calorie Breakdown

- Fat: 16%
- Carbohydrates: 67%
- Protein: 14%
Lecture 7: Meals
Recap

- RDA – Recommended Dietary Allowance; this tells you the minimum you need of the nutrient
- AMDR – Acceptable Macronutrient Distribution Range; tells how macronutrients (CHO, Pro, Fat) should be distributed in diet
- Carbohydrates: the AMDR is 60-70% calories for athletes; the RDA is 130 g/day; they provide 4 calories/g; you get from foods in the bottom half of the old pyramid: bread, cereal, grain, fruits, veggies; they’re needed for energy
- Protein: athlete AMDR is 10-35% calories; the RDA is 0.8g/kg or 0.36 g/lb; it provides 4 calories/g; you get it from the meat and dairy groups; it’s needed for tissue structure and can be used for energy
- Fat: the AMDR is 20-30% calories from total fat, 7-10% from saturated fat; it provides 9 calories/g; you get it from all kinds of foods, depending on how the food is made; fruits and vegetables are naturally low fat; it’s needed mostly for energy

Pre-event meals
- The food eaten in the days leading up to an event are the most important, although the foods eaten right before can also affect performance
- Food empties from stomach in the following order: liquids first, CHO second, then protein, fat last; since fats take so long to get out you shouldn’t eat high fat foods too close to an event
- As your event gets closer, the amount of calories you eat should decrease
- Pre-meals should consist mostly of CHO; low GI foods will help keep glucose available to muscles throughout the event
- If you’re eating 4 hours before your event, you should eat 4-5 g/kg; 2 hours before, eat 2 g/kg; other sources say you need about 300-400 calories 2-3 hours before, or about 700 calories 3-4 hours before
- Do whatever works for you personally, what you know you can handle
- Foods to pick from: fresh fruit, 100% juices, bread, pasta, cereal, low-fat yogurt

Post-event meals
- Your recovery from the event will require CHO to replenish glycogen and protein to restore muscle tissue
- There’s a 2 hour window after exercising when these processes occur most efficiently; that is the best time to eat
- CHO should be high GI foods to make glucose available to muscles quickly
- Again, go with what you know you can handle after a race
- Foods to pick from: graham crackers, a bagel, bread and honey

Daily Diet
- 60-70% CHO, 10-35% Pro, 20-30% fat
- Basically, you should eat lots of grains, fruits, and veggies; protein is most likely adequate without making any changes; cut down on fatty foods like candy and fast food
- Your best bet is to go with whole grains, lean meats, and low-fat alternatives; fruits and veggies are naturally low fat snacks; also, you need to make sure your water intake is adequate – you should be going at least every couple of hours, and it should be clear and pale yellow

Key Points
- CHO should make up the bulk of your diet
- Specific foods will be advantageous before and after exercising – particularly CHO and Pro
- Handout: Hydration and Fueling for Cross Country Athletes
HYDRATION

Learn to Drink When Not Thirsty

Thirst mechanisms are not stimulated in the body until the body is 2% dehydrated. Aerobic performance is significantly reduced at this point, meaning that you will move slower in the race.

BEFORE THE RACE

Drink 20 ounces of fluid one hour before race time. Drink non-caffeinated fluids. Weigh yourself before the race to get an idea of how much fluid you are losing in the race.

AFTER THE RACE

Drink 16 ounces of non-caffeinated fluid for every pound lost during the race. Continue to drink fluids so that you are voiding clear urine every hour or two.

OTHER POINTS

Avoid Caffeinated Beverages

Caffeine is a diuretic. This means that it promotes fluid loss from the body by increasing urine production. You cannot hydrate, or rehydrate optimally using caffeinated beverages. Caffeine also inhibits carbohydrate replenishment.

Don’t Fuel with Fat

Fat is a slow fuel for your body. It takes much longer for your body to digest fat, and your blood is thicker after consuming a fat meal, making your heart work harder. Limit your fat intake on tournament meals to no more than 20% of calories from fat.

Stay Cool

Stay out of the heat (above 73° F) and the sun before races. Heat and the sun stress the body. During stress, the body is breaking down, and you want your body to be building up!

Get Enough Sleep

Set your own best curfew. Allow yourself at least eight hours of sleep, and time to eat and hydrate two hours ahead of the race.

Joan S. Thompson, Ph.D., R.D., C.D.

Associate Professor of Nutrition
Weber State University
Jthompson6@weber.edu
Phone (801) 626-7115
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HYDRATION AND FUELING FOR CROSS COUNTRY ATHLETES

Youth athlete recommendations for the runner and parent.

Summer and fall conditions are among the most stressful in youth sports. High temperatures place runners at risk for thermal injury, and the time between school and a race is often too short to fuel properly. If you are going to perform at your best and minimize the risk of heat exhaustion, you must be aware of your body’s fuel and hydration needs, and act responsibly in fulfilling those needs.

Your brain will not automatically motivate you to fuel and hydrate your body optimally for sport. Your brain is programmed only to prevent death. Use the recommendations contained in this pamphlet to guide you to optimum athletic performance.
Within 2 Hours After Race

Fueling

Eat the Right Food

120 pound person - 1/2 cup of apples

80 pound person - 1/4 cup of apples

Within 2 Hours After Race

80 pound person - 7/2 cups of apples

1/2 cup of spinach, 2 slices of bread, or
1 1/2 cups of apple juice, or
1 Power Bar

1 Power Bar

99 grams of protein

120 pound person - 8 grams of carbs and

7/2 cups of apples

2 Power Bars, 1 cup of apple juice
2 1/2 cups of spinach, 2 slices of bread, or
2 banana, 2 slices of toast, 2 cups of apple juice, or
2 Power Bars, 1 cup of apple juice

99 grams of protein

120 pound person - 108 grams of carbs

1 Power Bar
Lecture 8: Food Guide Pyramid

- The new MyPyramid can be personalized by gender, age and activity level
- It tells you how many calories you need and how many servings from each food group you should get each day
- What makes MyPyramid different from the old Food Guide Pyramid?
- In addition to telling you how many servings from each food group you should get each day, the new MyPyramid also emphasizes the types of foods that should be eaten:
  - Grains – you should make half of your servings whole grains
  - Vegetables – you should eat dark green and orange veggies, dry beans and peas, and starchy veggies (like potatoes and corn)
  - Fruits – you need to eat a variety, but go easy on fruit juices, fresh fruits are better
  - Milk – choose low-fat sources, like 1% or skim
  - Meat & Beans – choose low-fat and lean cuts; you should also choose more fish, beans, peas, nuts and seeds, instead of always eating meat
- MyPyramid also emphasizes daily physical activity
- There is also encouragement to include healthy vegetable oils, like olive oil, while limiting extra solid fats and sugars in your diet

- Handouts: sample MyPyramids for different genders, ages, and activity levels
Based on the information you provided, this is your daily recommended amount from each food group.

<table>
<thead>
<tr>
<th>GRAINS</th>
<th>VEGETABLES</th>
<th>FRUITS</th>
<th>MILK</th>
<th>MEAT &amp; BEANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 ounces</td>
<td>3 1/2 cups</td>
<td>2 1/2 cups</td>
<td>3 cups</td>
<td>7 ounces</td>
</tr>
<tr>
<td>Make half your grains whole</td>
<td>Vary your veggies</td>
<td>Focus on fruits</td>
<td>Get your calcium-rich foods</td>
<td>Go lean with protein</td>
</tr>
<tr>
<td>Aim for at least 5 ounces of whole grains a day</td>
<td>Amp up these amounts each week: Dark green veggies 3 cups Orange veggies 2 1/2 cups Dry beans &amp; peas 3 1/2 cups Starchy veggies 7 cups Other veggies 10 1/2 cups</td>
<td>Eat a variety of fruit Go easy on fruit juices</td>
<td>Go low-fat or fat-free when you choose milk, yogurt, or cheese</td>
<td>Choose lean or lean meats and poultry Vary your protein routine—choose more fish, beans, peas, nuts, and seeds</td>
</tr>
</tbody>
</table>

Find your balance between food and physical activity

Be physically active for at least 60 minutes every day or most days

Know your limits on fats, sugars, and sodium

Your allowance for oils is 8 teaspoons a day

Limit extra solid fats and sugars to 425 calories a day

Your results are based on a 2800 calorie pattern.

This calorie level is only an estimate of your needs. Monitor your body weight to see if you need to adjust your calorie intake.

Name:
Based on the information you provided, this is your daily recommended amount from each food group.

**GRAINS**
10 ounces
- Make half your grains whole
- Aim for at least 5 ounces of whole grains a day

**VEGETABLES**
4 cups
- Vary your veggies
- All for those amounts each week
- Dark green veggies
- 2 cups
- Orange veggies
- 2 cups
- Dry beans & peas
- 1 cup
- Starchy veggies
- 1/2 cup
- Other veggies
- 1/2 cup

**FRUITS**
2 1/2 cups
- Focus on fruits
- Eat a variety of fruit
- Get easy on fruit juices

**MILK**
3 cups
- Get your calcium-rich foods
- Go low fat or fat free when you choose milk, yogurt, or cheese

**MEAT & BEANS**
7 ounces
- Go lean with protein
- Choose lean, low fat meats and poultry
- Vary your protein portions—choose more fish, beans, peas, nuts, or seeds

Find your balance between food and physical activity
- Be physically active for at least 60 minutes everyday, or most days.

Know your limits on fats, sugars, and sodium
- Your allowance for oils is 11 teaspoons a day.
- Limit extras, solid fats and sugars to 650 calories a day.

Your results are based on a 3200 calorie pattern.

This calorie level is only an estimate of your needs. Monitor your body weight to see if you need to adjust your calorie intake.

Name: __________________________
Based on the information you provided, this is your daily recommended amount from each food group.

<table>
<thead>
<tr>
<th>GRAINS</th>
<th>VEGGIES</th>
<th>FRUITS</th>
<th>MILK</th>
<th>MEAT &amp; BEANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 ounces</td>
<td>2 cups</td>
<td>2 cups</td>
<td>3 cups</td>
<td>5 1/2 ounces</td>
</tr>
</tbody>
</table>

- **Make half your grains whole**
- **Vary your veggies**
  - Aim for these amounts each week:
  - Dark green veggies: 3 cups
  - Orange veggies: 2 cups
  - Dry beans & peas: 2 cups
  - Starchy veggies: 3 cups
  - Other veggies: 6 1/2 cups
- **Focus on fruits**
- **Get your calcium-rich foods**
  - Choose low-fat dairy when you choose milk, yogurt, or cheese
- **Go lean with protein**
  - Choose lean meats and poultry
    - Vary your protein routine: choose more fish, beans, legumes, nuts, and seeds

**Find your balance between food and physical activity**

Be physically active for at least 60 minutes every day, or most days.

**Know your limits on fats, sugars, and sodium**

Your allowance for oils is 6 teaspoons a day.

Limit extra solid fats and sugars to 265 calories a day.

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**Your results are based on a 2000 calorie pattern.**

This calorie level is only an estimate of your needs. Monitor your body weight to see if you need to adjust your calorie intake.

**Name:**

---
Based on the information you provided, this is your daily recommended amount from each food group.

<table>
<thead>
<tr>
<th>GRAINS</th>
<th>VEGETABLES</th>
<th>FRUITS</th>
<th>MILK</th>
<th>MEAT &amp; BEANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 ounces</td>
<td>3 cups</td>
<td>2 cups</td>
<td>3 cups</td>
<td>6 1/2 ounces</td>
</tr>
<tr>
<td>Make half your grains whole</td>
<td>Vary your veggies</td>
<td>Focus on fruits</td>
<td>Get your calcium-rich foods</td>
<td>Go lean with protein</td>
</tr>
<tr>
<td>Aim for at least 4 ounces of whole grains a day</td>
<td>Aim for these amounts each week: Dark green veggies 1 cup Orange veggies 2 cups Dry beans &amp; peas 2 cups Starchy veggies 6 cups Other veggies 7 cups</td>
<td>Eat a variety of fruit</td>
<td>Eat low-fat or fat-free when you choose milk, yogurt, or cheese</td>
<td>Choose lean meats and poultry</td>
</tr>
<tr>
<td>Find your balance between food and physical activity</td>
<td>Know your limits on fats, sugars, and sodium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Be physically active for at least 60 minutes every day, or most days</td>
<td>Your allowance for oils is 7 teaspoons a day</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Your results are based on a 2400 calorie pattern.

This calorie level is only an estimate of your needs. Monitor your body weight to see if you need to adjust your calorie intake.

Name: ____________________________
Lecture 9: Fruits & Veggies

- They're low-fat snacks and good sources of carbohydrates, vitamins, minerals
- They also have lots of antioxidants that fight free-radicals, and phytochemicals that promote health
- What are:
  - Free-radicals – atoms or molecules with unpaired electrons that can attack cells; you get them from aerobic respiration, lipid degradation, UV radiation, metal ions; you get rid of them with antioxidants
  - Antioxidants – vitamins, minerals, and phytochemicals that block activated molecules (free radicals) from damaging cells
  - Phytochemicals – health promoting substances found in plants; they give the plant its color, flavor, and aroma; they have antioxidant and anti-cancer properties; over 2000 different phytochemicals have been identified
- So how do you get all the phytochemicals you need? Variety and color
- Plant color is associated with the phytochemicals in that plant – different colored plants have different phytochemicals; eating a variety of different fruits and vegetables of all different colors will provide the phytochemicals you need
- There are 9 classes of phytochemicals
  - Carotenoids – in yellow, orange, red, purple foods
  - Glucosinolates & Isothiocyanates – in cruciferous plants (broccoli, cauliflower)
  - Inositol Phosphates – in cereals, oilseeds
  - Simple Phenols – in nuts, berries, legumes, grains
  - Phytoestrogens – in soy, berries, nuts, whole grains
  - Phytosterols – in corn, beans, plant oils
  - Polyphenols – in veggies, cereals, legumes, fruits, nuts
  - Saponins – in legumes
  - Sulfides & Thiols – in onion family

Key Points

- Eat a lot of fruits and vegetables
- Eat a variety of fruits and vegetables
- Eat lots of different colors of fruits and vegetables – go for a rainbow a day
Lecture 10: Vitamins & Minerals

Vitamins

- Substances needed in small amounts that must be obtained from the food we eat because they’re needed for various biological and biochemical functions.
- Why do we need them? They’re essential in order for various physiological processes to function properly.
- They’re used to make up coenzymes, which are part of enzymes, which regulate reactions and serve as catalysts.
- As an athlete, these processes must occur faster when you’re exercising, so you must have an adequate supply of vitamins to keep going.
- Fat-soluble: these vitamins can be stored in the fat in the body, so they don’t need to be replaced as often as water-soluble vitamins; sources for these vitamins usually have fat; it’s possible to overload on fat-soluble vitamin, since they can be stored; you have to be careful because getting too much can be toxic.
  - Vit. A – needed for vision, growth, bone development; a deficiency may impair gluconeogenesis in the liver which will affect available energy; you get this from yellow and dark green leafy veggies, orange fruits, milk and milk products, egg yolk.
  - Vit. D – needed for bones, affects metabolism of Calcium and Phosphorus which are also necessary for bones; it’s unique in that it can be obtained from sunlight; UV from sun converts a substance in the skin to colecalciferol, which is converted by the liver and kidneys to calcitriol, the active form of Vit. D; you can also get it from milk and fortified foods.
  - Vit. E – acts as an antioxidant to protect body against free radicals; it’s found in vegetable oils, leafy greens, milk, nuts, fortified foods.
  - Vit. K – needed for coagulation of blood and for the bones; it’s found in leafy greens and vegetable oils.
- Water-soluble: these vitamins can’t be stored, so must be replaced daily.
  - Thiamin, B1 – required for glucose metabolism to create energy, and for the nervous system; when you’re eating more CHO and exercising more, you need more of this; it’s found in whole grains, beans, pork, organ meats, legumes.
  - Riboflavin, B2 – used to form enzymes for energy production from CHO and fat; it’s also needed for protein metabolism; it’s found in dairy, eggs, liver, dark leafy greens, enriched breads/cereals; whole grains.
  - Niacin, B3 – this is needed for part of the coenzymes used in glycolysis and fat metabolism; it’s found in foods high in protein: lean meat, organ meats, fish, poultry whole grains, enriched foods.
  - Pyridoxine, B6 – needed for metabolism of CHO, protein, fat; it’s also used for gluconeogenesis and the breakdown of muscle glycogen; it’s found in protein foods: meat, poultry, fish, whole grains, brown rice, eggs.
  - Cobalamin, B12 – needed for synthesis of DNA red blood cells, and the myelin sheath; it’s found only in animal sources: meat, fish, poultry, dairy, eggs; vegetarians may need to supplement, but ask your doctor first.
  - Folate – coenzyme for protein metabolism, it’s also found in DNA and needed for red blood cell synthesis; it’s found in leafy greens, organ meats, legumes, and whole grains; in the US, all cereal and grain products are fortified.
  - Vit. C, Ascorbic Acid – needed for collagen synthesis for connective tissue, and the formation of hormones and neurotransmitters; it increases the absorption of iron; it also acts as an antioxidant; it’s found in citrus fruits, leafy greens, tomato, melon, peppers, and potato.
- As far as performance goes, getting more than the daily requirement of any of these vitamins hasn’t been found to improve performance.
Definitions
- Enriched/fortified: vitamins have been added back into foods after processing removed them
- Organ meats: liver, kidney
- Legumes: beans, lentils, peas, soybeans, kidney beans
- Whole grains: wheat, barley, rye
- Leafy greens: broccoli, spinach, kale

Minerals
- These are inorganic elements that are essential for life processes
- They’re found in the soil, eventually making their way into plants and animals
- They must be replaced daily
- Why do we need them? They act as building blocks for body tissue, components of enzymes, and regulators of metabolism
- For athletes they’re needed for muscle contractions, heart rhythm, oxygen transport, bone health and water balance
  - Calcium – this is the most abundant mineral in body; 98% of it is in the bones, and 1% is in the teeth; it’s used for muscle contraction, and the synthesis and breakdown of liver and muscle glycogen; exercising puts stress on the bone which leads to calcium being deposited to develop the bone, so you need to get enough of it; you get it from milk & dairy, fish with small bones, leafy greens, legumes, nuts, fortified foods
  - Phosphorus – this is the 2nd most abundant mineral in the body; it’s in the bones and teeth, phospholipids in cells, and is needed for metabolism; it also helps make up ATP and PCR for energy systems; it’s found in seafood, meat, eggs, milk, cheese, nuts, legumes, grains
  - Magnesium – this prevents bone fragility, helps with cardiovascular functions, regulates protein synthesis, and is involved in gluconeogenesis and lipid metabolism; it’s found in nuts, seafood, leafy greens, whole grains, black beans
  - Potassium, Sodium, Chlorine – these are the electrolytes which were discussed with hydration
  - Iron – this is a major component of hemoglobin and myoglobin which transport oxygen to muscles, so it’s important for athletes to get enough; girls especially need to get enough to balance menstrual losses; there are 2 types of iron: heme from animal sources, and non-heme from plant sources; non-heme is not as efficiently absorbed, but is better absorbed if it’s taken with Vit. C; it’s found in liver, heart, lean meats, oysters, clams, dark poultry meat, dried fruit, broccoli, peas, legumes, whole grains
  - Copper – this is needed for hemoglobin formation, and bone formation; it’s found in seafood nutrients, beans, meats, whole grains
  - Zinc – this is needed for protein synthesis, and bone formation; it’s found in all types of body tissues and in 300 enzymes; it’s found in animal sources: meat, milk, seafood
- How do I get them all? Eat a balanced diet rich in natural foods (i.e., not so many processed/packaged/pre-prepared foods); if you choose foods rich in calcium and iron, you will most likely obtain adequate amounts of the other minerals as well; calcium and iron sources include dairy products, meat, legumes, and leafy greens
- Supplements of any of these minerals are probably unnecessary since they can all be obtained from the diet; there has been no sign of improvement for physical performance with supplements; also, they can be harmful if you get too much

Key Points
- A balanced diet with a variety of whole foods will provide the vitamins and minerals you need
APPENDIX C: DOCUMENTATION

Wednesday August 24, 2005
Coach Rawlins introduced me to the team and I explained that I would be teaching
them about nutrition this season; what they need, why they need it, when to eat it, and
where to get it. Informed consent forms were passed out to be taken home and signed by
both the student and a parent.

Thursday August 25, 2005
I collected informed consent forms and some students filled out the pre-season
survey.

Friday August 26, 2005
I collected more informed consent forms and went over a little about the importance
of staying properly hydrated, especially when practice is in the afternoon. I told them to drink
before and after exercising, but gave no other specifications.

Monday August 29, 2005
I handed out and collected more surveys. I went over hydration: why water is needed
by the body and the roles it plays, how much water should be drunk and when to drink,
looking at urine color to determine state of hydration. I encouraged everyone to bring a
water bottle to drink from during school, plus another one to use at practice.

Tuesday August 30, 2005
I went over sweat and electrolytes. I explained how the body uses sweat as a cooling
system and how the result is a loss of water and electrolytes, which must both be replaced. I
told them the roles the electrolytes sodium, chlorine, and potassium play in the body and
what foods they can be found in. I suggested the use of a sports drink that contains
electrolytes in addition to water for after practice.

Thursday September 1, 2005
The team did intervals at the West Bountiful Park: double oasis then ladders of a 400,
600, 800, 600, 400 meters. Skies were clear, there was a slight breeze, the grass was dry, and
temperatures were in the mid to upper 80’s. Guys and girls went separate. I tried to keep
track of who were the first couple to finish each round for both groups. It was usually the
same couple of people; but there were some who fell further behind with each ladder.
I went over energy systems before the team started the intervals. I explained what ATP
is and how the body makes it using the nutrients carbohydrate, protein and fat. I explained
that there are 3 systems used to make ATP and that runners usually rely on the oxygen system,
which produces ATP in larger quantities and works the best with carbohydrates. Afterwards, I
spoke specifically to the girls about the importance of bringing their own water to intervals.
Coach had told them to, and most of the guys did, but after each ladder, most of the girls
were begging water from anyone.

Friday September 1, 2001
Today I went over the second part of energy. I did a quick recap of ATP and runners’
reliance on the oxygen system. I explained that although fat provides 9 cal/g and generates
more ATP overall, carbohydrates generate ATP much faster and is therefore the chief energy
source for their sport. I told them about the EER equations, and a couple of students figured out
their EER after practice. I also introduced the AMDR values of 60-70% carbohydrates, 10-15%
protein, and 20-30% fat.

Thursday September 8, 2001
Today the team did hill reps in Centerville. There were 4 levels they did in a ladder
workout, for a total of 7 reps. The route is all on asphalt with little or no shade, and the
temperature was in the lower 90's, with a slight breeze. Despite my reminders, only 13 students brought water bottles to the site.

I introduced carbohydrates. I went over what foods carbohydrates come from and the fact that almost all of them are converted to glucose that is used by the body. I explained that although carbohydrates can be found in many types of foods, the higher quality ones are what athletes should eat: whole grains, fruits and vegetables. I advised them to try to eat nutrient dense foods, explaining that those have a higher ratio of nutrients to calories. I also went over the AMDR values that athletes should aim for: 60-70% carbohydrates, 15-30% protein, and the rest from fat.

Friday September 9, 2005
Today I handed out the "Hydration and Fueling For Cross Country Athletes" pamphlet, as well as some tables with examples of pre-event meals that could be consumed at different times leading up to a competition. I didn't give a lecture, but I advised each student to bring water and food for before and after the race they have tomorrow morning, telling them to look through the handouts for suggested foods.

Monday September 12, 2005
Today I introduced the Glycemic Index and how it can be used to choose which foods to eat before and after exercising. I explained what it is and how foods are given different numbers based on how they affect blood glucose levels. I passed around a couple of tables listing the glycemic index of some foods for them to look at.

Tuesday September 13, 2005
Today I brought a bunch of different foods that could be eaten before or after running. I felt like yesterday's lecture was a little over their heads, and that some actual foods and visuals would help them understand. So I set up the food in groups of what were low glycemic foods to eat before, and what were high glycemic foods that could be eaten after.
I also gave some suggestions of how to combine some protein into the after meal, since the body needs to replace that as well. I felt like this went over well with the team, since they had something to look at and some actual examples.

Thursday September 15, 2005
Today I covered protein. I answered the questions Who, What, Where, Why, When and How regarding protein. Everything was on a poster so the team could read everything as I went over it as well. I've discovered that having something out as they are coming out from the school helps to interest them and get them asking questions, which is what I like better than just presenting information. I went over the importance of getting protein after exercising to help rebuild muscle.

Friday September 16, 2005
Today, instead of presenting anything, I went with the team to the Murray Invitational 5K. I mostly came to cheer and observe. I noticed some Power bars or other similar foods being eaten both before and after the race. Everyone drank water after the race, although I would have liked to see more personal water bottles and some drinking before the race. I got one question from a runner about whether or not it was too close to his race to eat a banana, so I guess some of them have tried to take what I've taught and use it to their best advantage.

Monday September 19, 2005
Today I introduced fat to the team. I went over the different kinds of fatty acids (saturated, monounsaturated, polyunsaturated, Omega 3 and 6, and trans), where we get each kind and which ones are good, bad, essential, etc. I had a poster showing the chemical structure of each kind of fat, then had the team tell me which name went with each structure. I wanted to clarify what all the kinds of fat they may have heard of were.
Tuesday September 20, 2005
Today I did the Crisco diet to show how quickly fat can add up in the diet. Based on two days of food intake, one high fat and one low fat, I had Crisco that represented the grams of saturated, monounsaturated, and polyunsaturated fats that were in each diet. I pointed out that the low fat diet had more food, less calories and less fat, and listed some of the low-fat choices that were included in that diet. I also went over the high fat diet, pointing out some of the fatty foods that had been chosen for that day.

Thursday September 22, 2005
Today I put together some meals that would exemplify how carbohydrates, protein and fat can be combined together in a healthy way, with examples of what could be eaten for dinner, breakfast, lunch and snacks before and after a race. I went through each meal, gave an example of when it might be eaten and had the team tell me whether it was a good or bad choice, what made it so, and what could be done to make it a better meal if it was a bad one.

Monday September 27, 2005
Today I told the team about the new food guide pyramid. I had handouts for them that laid out the number of calories and servings of each of the groups. I had food examples divided up into the food groups, showing what an actual serving size would be and pointed out how small most of them were compared to what the average person eats. I also pointed out the attention given to whole grains, colorful vegetables, low fat dairy, and protein sources other than meat or poultry.

Tuesday September 28, 2005
Today I went over fruits and vegetables and the concept of 5-a-day. I had a poster with pictures of all different colors of fruits and vegetables arranged to look like a rainbow to enforce the point of eating a variety of colors each day because different colors represent different nutrients that help guard against different infirmities. I challenged the team to look at their diets over the week and weekend to see about how many fruits and vegetables they usually eat, and what kinds, and then to see if they could either increase the number or increase the variety of fruits and vegetables in their diets.

Monday October 3, 2005
Today I had a poster showing some of the most important vitamins and minerals. I had ones that they would recognize and that are used by the body for various mechanisms required by athletes. I had pictures showing what each vitamin/mineral was used for and sources that could provide it. I focused on legumes, organ meats, whole grains, dark leafy greens and dairy products, since those seemed to be sources for almost every vitamin and mineral.

Tuesday October 4, 2005
Today I had the team fill out the post-season survey. I gave them some last-minute tips of what to eat in preparation for Region on Friday: hydrate and eat lots of carbohydrates until then.
REFERENCES


