***Chapter 5***

*Nutrition and Energy Requirements*

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egardless of the goals or tools used to monitor effort, both walkers and joggers must fuel their body to do the work needed to perform the desired exercises. As you might imagine, exercising on an “empty tank” would be very uncomfortable if not impossible. This chapter will cover the basics on nutrition, how much energy is required for walking and jogging, energy sources, and ways to apply these concepts.

**Nutritional Basics**

While eating for energy is essential to our survival and good health, it’s not the only reason we eat. Eating also gives us access to other essential nutrients that help to promote cellular activity, repair damaged tissue, produce chemicals such as hormones and neurotransmitters, and countless other functions. Experts have identified 45 essential nutrients that we must get from food because we don’t produce them fast enough for use or we don’t produce them at all.

These 45 nutrients can be broken down into two major classifications: **macronutrients** and **micronutrients**. Within each of the two classifications, 3 subcategories can be formed.

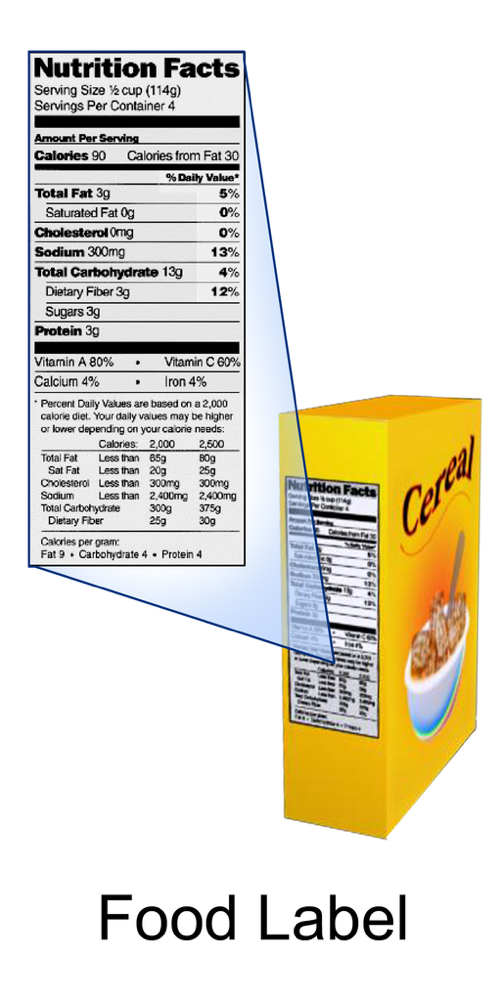
* Macronutrients-nutrients we need in large amounts and that contain energy (calories).
  + Carbohydrate
  + Protein
  + Fats
* Micronutrients-nutrients we need in small amounts and do not contain energy (calories).
  + Vitamins
  + Minerals
  + Water

**Macronutrients**

Macronutrients are needed in relatively large quantities for good health. Generally, these nutrients are measured in grams. Reading food labels on food packaging will help to understand the makeup of the food. As you can see in the food label below (figure 5.1), macronutrients are organized in grams and account for the caloric make up of each serving.

**Proteins** are the building blocks and major structural components of nearly all cells and function to aid in bone repair, muscle, skin and blood cells. A protein is made up of a series of building blocks called **amino acids**. There are 20 amino acids necessary for optimal functioning, but the body only manufactures 11 of those. The remaining 9 amino acids are termed essential amino acids and must be obtained from our foods. The foods that contain all of the essential amino acids come from complete protein sources, primarily animal sources such as red meat, poultry, fish, eggs, and milk products. Incomplete sources come from plant sources such as nuts, beans, seeds and leafy green vegetables.

Figure 5.1



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<https://commons.wikimedia.org/wiki/File%3AFood_Label.png>

**Fats**, or lipids, are also important for our diet. Fats are important for flavor in foods, energy, thermoregulation, cushioning of organs, and cellular function. There are 3 different types of fats, all are named based on their molecular structure (specifically, the number of carbon bonds taken by hydrogen).

Saturated fats have all bonds filled by hydrogen and can be found in animal products such as red meats and dairy products. Saturated fats should be consumed in limited amounts.

Unsaturated fats have bonds available and may be monounsaturated (single bond available) or polyunsaturated (multiple bonds available). These fats usually consist of oils such as olive or vegetable oil and can be found in fish oils (omega 3 and omega 6). Unsaturated fats are the healthiest of the fats.

Food manufacturers often alter the properties of unsaturated fats to create a hybrid fat known as trans fats. These fats may be solid at room temperature but liquid when used to cook. Shortenings, margarines, and other hybrid fats should be avoided because of the negative impact they can have on health.

In order to deliver fats to the body’s cells, fats are packaged together with cholesterol in units called lipoproteins. These lipoproteins are collectively called cholesterol (Low-density lipoproteins (LDL) and high-density lipoproteins (HDL)). Cholesterol is important for cellular health but when LDL’s are in excess, they can invade damaged cells and cause arteries to harden and become blocked. HDL’s, on the other hand, help remove excess cholesterol. While aerobic exercise will help manage cholesterol levels by increasing HDL’s, bad food choices can negatively impact cardiovascular functioning by increasing LDL’s. Over consumption of saturated fats and trans fats leads to excess LDL production so these foods should be consumed in limited quantities.

**Carbohydrate** are chains of sugar molecules and their primary function is energy. There are two types of carbohydrate, simple and complex. Like proteins, they’re labeled based on their molecular structure. Simple carbohydrates have 1-2 sugar chains and can be found in fruits, sugar cane, and some vegetables. Complex carbohydrates have 3 or more sugar chains and can be found in grains, rice, potatoes and vegetables.

While carbohydrate consumption often gets a bad name, carbohydrates are important for energy and should not be overlooked. Complex carbohydrates should be the staple of carbohydrate consumption as they not only contain energy, but also carry multiple other nutrients important for energy production. They also contain fiber, a non-digestible carbohydrate that benefits the digestive tract as well as several other health-related outcomes.

**Micronutrients**

Micronutrients are needed in relatively small quantities. However, don’t mistake their importance because of the small amount needed for good health. As you see in the food label above, they are measured in milligrams (for example, sodium, 300 mg).

**Vitamins**

Vitamins can be broken down into two primary types, each having similar functions which promote all the chemical reactions needed for cellular health. These two types are: water-soluble and fat-soluble vitamins.

Water-soluble vitamins are easily absorbed with water and consist of vitamins C and the B-vitamins. These vitamins assist in immune system health and the breakdown of fats and carbohydrates so they can be processed by the cells for energy production.

Fat-soluble vitamins require fat to be available to be absorbed and consist of vitamins A, D, E and K. These vitamins assist in healthy blood cells, bone and eye health, digestive health and growth and repair of tissues.

**Minerals**

Minerals have very similar functions as vitamins in that they assist in regulating chemical reactions in the cells and body. They can be broken down into two categories: major and trace minerals.

Major minerals consist of minerals such as calcium, sodium, potassium, and chloride. Each of these minerals plays specific roles in nervous system function, bone health, muscular contraction, cardiovascular functioning and fluid balance.

Trace minerals consist of several minerals such as selenium, iron, chromium, magnesium, zinc, iodine, phosphorous, copper and fluoride. Those of special interest include iron which is important for blood and fluoride which is important for teeth.

**Water**

Unlike the other micronutrients, water is needed in large amounts. However, water doesn’t have any calories associated with it making it a perfect fit for the micronutrient category. About 60% of the body is made up of water making it an absolutely critical nutrient. While you could live for weeks on energy storage you could only live for days without adequate water. Water is the solution where all the chemical reactions must occur. Changes in fluid volumes can result in an inability to properly transport substances from one area of the body to another, improper pH balance, and improper balance of salt solutions within the cells.

Traditional recommendations suggest the average adult needs approximately 48-64 ounces of water every day to maintain this delicate balance. More recent guidelines recommend larger quantities with 0.5 ounces of water for every pound of body weight. In addition to getting water from the tap or bottled sources, water can be obtained from foods we eat, especially water rich foods like fruits and vegetables.

**Eating for Health and Fitness**

**Eating Energy Dense Foods**

As you may have noticed, much of the food important for health evolves around fruits, vegetables, and whole grains. One major reason for this comes from the fact that these foods can not only provide energy, but they can also deliver the nutrients needed. This concept is associated with term eating “**nutrient dense**” foods.

As an example, consider eating a snack such as a candy bar of 250 calories. While the candy bar would have plenty of caloric value, very few additional nutrients tag along for the ride. By contrast, eating a Greek yogurt and some strawberries would provide plenty of protein and be packed with vitamin B and vitamin C, all around the same 250 calorie range. Not only that, but you would likely be more filling than the candy bar meaning you would eat less total calories over the course of the day.

**Energy Balance, Eating the Right Amounts**

Just as important as knowing your target heart rate is knowing how many calories you need on a daily basis. This will provide the foundation of planning your fuel consumption for the day. **Calories**, give us a way to measure how much fuel we are putting into our bodies. As previously noted, the basic unit of energy the body must produce, and use is ATP. In order to produce ATP, we must eat! The primary substances in our foods that are converted to ATP are fats and carbohydrates. Four calories can be found in 1 gram of carbohydrate. One gram of carbohydrate can then be broken down into individual glucose molecules and broken down and processed in the body’s cells to produce ATP. Similarly, fats are broken down by to body and processed by cells to generate ATP. However, 9 calories can be found in one gram of fat. While protein does contain 4 calories per gram, protein is used sparingly if at all for energy during physical activity.

The balance of food, or energy balance equation, suggests that in order to maintain weight the same amount of energy consumed must be burned. In other words, if you eat 2500 calories you must burn 2500 calories to maintain your current weight. In simpler terms, energy in must equal energy out. By consuming more calories than needed, weight gain would result. By consuming fewer calories than needed, weight loss would be the result. Regardless of the goal, the foundation of this equation is understanding how many calories are needed on a daily basis.

To find your total daily energy expenditure, you need to calculate the components of your energy expenditure. The 3 ways you burn calories are: Basal metabolic rate (BMR), food digestion, and physical activity.

BMR accounts for the greatest amount of energy out so it’s a great place to begin the calculations. The most widely used equation is known as the Mifflin-St. Jeor equation, named for its founders. Here is the equation:

* **For men:** BMR = 10 x weight (kg) + 6.25 x height (cm) – 5 x age (years) + 5
* **For women:** BMR = 10 x weight (kg) + 6.25 x height (cm) – 5 x age (years) – 161

Once the BMR is calculated, the addition of the food digestion and physical activity can be added in. To do this, simply multiply the BMR by 1.2-1.9 based on your estimated daily activity levels. For mostly sedentary behavior, use 1.2 and for very active behavior use 1.9.

Generally, these numbers are an estimate of what you do on a daily basis and may exclude specific exercise sessions. Of course, this means the additional exercise sessions would need to be included in the final calculations. For example, the BMR and activities may account for daily functions such as work, housework, childcare, etc. but will not account for a 30-minute evening jog. So, the evening jog would be totaled and added to the BMR and activities.

**Macronutrient Distribution**

Another way of examining and analyzing eating patterns is to determine what’s best in regard to adequate macronutrient distribution. Remember, macronutrients consist of proteins, fats and carbs. The recommendations for how much to consume of each category are wide open giving freedom to adapt to your personal circumstance and needs.

The distribution ranges are expressed as percentages of the total diet. The recommended amount of protein, fat and carbohydrate for an adult range from

10-30%, 20-35%, and 45-65%, respectively. For example, food labels are based on the daily values assuming 2000 calories to be the magic number for everyone (not always the case). That same food label may indicate the amount of protein consumed, for that particular food, accounts for 10% of the total recommended amount out of 2000 calories. In other words, the protein content of that food product equals 200 calories which is being suggested as 10 percent of what is recommended.

However, the recommendations were created as ranges, not set amounts. An elite endurance athlete may need close to 65% of his/her total daily calories to come from carbohydrate to support the energy requirements of the daily training and frequent competitions. While someone needing to lose weight may elect to stick closer to the 45% range of carbohydrate and 30% range of protein. Unfortunately, no magic number exists for everyone so finding the right distribution range can be a process.

**Nutritional Tracking**

Keeping track of the number of calories, the quality of foods being eaten, and the distribution of calories can be an arduous task. Fortunately, technology has enabled this task to be done quite easily. Multiple food logs exist online and as applications on smart phones. Both Fitday.com and myfitnesspal fit into this category.

Regardless, the good ones have foods loaded into a database allowing users to look up specific foods eaten and select them as part of their food consumption for the day. Once the food is selected and serving size indicated, the total calories from the food are generated along with a macronutrient distribution and micronutrient profile. Additionally, by entering a user profile, BMR and activity rates can be calculated in terms of calories and then compared with total food consumption. As a result, an easy visual of energy in versus energy out can be done.

Some of these applications also offer suggestions for improving nutrition based on life stage, eating trends and activity habits. They also allow you to set goals and provide information and tracking on how many calories would be needed to be restricted in order to reach those goals.

**Application to Walking and Jogging**

To understand the energy requirements of walkers and joggers, it is important to understand two terms that are often used in correlation with how much energy is being used: economy and efficiency.

**Efficiency**, in the context of human movement, is the amount of energy being converted from the foods consumed (calories) to work stated as a ratio or percentage. An automobile may take 17 gallons of gasoline, but only a certain percentage of that gasoline can be utilized to produce forward motion while the remaining amount is given off as heat and waste product. Likewise, an athlete may consume 2500 calories throughout the day but only about 23-28% of that “fuel” can be converted into actual work. The remaining amount is given off as heat and waste product. In other words, human movement is not very efficient.

**Economy** is a term very similar to efficiency and often used interchangeably. However, they are very different terms. While efficiency describes the percentage of energy converted into work, economy describes how much energy is consumed over time or distance. For example, a sedan automobile may be able to go 35 miles in using only 1 gallon of gas, or a large truck may only be able to go 15 miles in using one gallon of gas. In walking or jogging, you may use 100 calories to travel one mile.

What do these terms have to do with walking and jogging? The amount of energy needed is directly affected by efficiency and economy. So, this can be tied back to the eating habits of the individual. A walker who walks with poor technique will be very inefficient and economy will be low, requiring more calories for the exercise session. From a performance perspective, this wouldn’t be a good thing. From a weight loss perspective, burning more calories, i.e. having a low economy, would be precisely what is needed. So, the question in this context would be: how do I burn more calories?

From *chart 4.1*, walking at 4 kph (about 2.5 mph) leads to burning about 3.3 calories per minute or 198 calories over the course of 4 kilometers (2.5 mi). However, as walking speeds increase, the economy changes. At 10 kph (about 6.2 mph), calories are being burned at over 11 calories per minute! Compare that to the 4 kph pace who burns 198 calories, and the faster walker would burn 271.

*Chart 4.1* helps explain how walking and running speeds correlate with energy expenditure.

*Chart 4.1*

This phenomenon is related to the mechanics of walking. Consider what was previously discussed in chapter 4 with walking technique. As the speed of walking increases, stride length will increase and so will the arm movements. This leads to inefficient walking in the context of energy expenditure, but progress in the context of speed and weight management.

An additional note from *chart 4.1* comes from the overlapping energy cost in running and walking. You have undoubtedly walked fast enough at some point that it’s no longer comfortable to walk so you begin a light jog. Based on energy cost, this is a natural response since jogging at 9 and 10 kph is more economical than walking at those same speeds.

While this might seem unimportant, it once again goes back to the basic idea of energy expenditure and consumption. If the goal of a walker is weight loss, understanding this concept of economy will assist in food selection and consumption amounts based on the activity’s energy cost. Or, for a jogger, this same understanding may present the right tools to fuel their body through a marathon race.

**Walking or Jogging?**

The question of whether to walk or to jog is a hotly debated topic. Joggers may criticize the effectiveness of walking for fitness and weight management while walkers may argue that walking poses less risk of injury and burns as many calories as jogging the same distance. For purposes of this chapter, that question can be examined through the eyes of energy expenditure.

*Chart 4.1* illustrates a general idea of the number of calories being burned for both walking and jogging. As you can see, jogging results in a greater absolute number of calories burned (with the exception of faster walking speeds). However, there is more to be considered.

During exercise, fats and carbohydrates from foods consumed are broken down and utilized to help produce ATP. The intensity of exercise governs the ratio of fats to carbohydrates used for that session. For example, participating in a 10k (6.2 miles) at a lower intensity walking will lead to more fat being used for energy than would high intensity running. In other words, walking at 20% of your maximal capacity would result in close to 60% of your energy coming from fat, 40% coming from carbohydrate. If intensity increased to 70% of maximal capacity, only about 30% of energy would come from fat.

In terms of absolute calories, let’s compare a walker to a jogger of the same size who participates in the same 10k. The walker that walks at 7 kph (about 4.5 mph), corresponding to 50% of the max capacity would be able to complete the 10k in 1 hour and 22 min. Based on chart 4.1, this would equate to 6.5 cal/min for 82 minutes, or 533 calories. Of those 533 calories, 40% of them would be derived from fat (so, 213 calories from fat, 320 from carbohydrate).

A jogger who jogs at 12 kmh (about 7.5 mph), corresponding to 70% of max capacity would be able to complete the 10k in about 50 minutes. Based on the chart 4.1, this would equate to 14.3 calories per min, or 715 calories. Of those 715 calories, 25% of them would be derived from fat (so, 179 calories from fat, 536 from carbohydrate).

In short, jogging would have the greater energy cost burning almost as many calories from fat as total calories by the walker and significantly more from carbohydrate.

**Other Ways to Burn More Calories**

It may appear contradicting at this point to say “be inefficient” if you want to burn more calories but that rings true in this context. As has been illustrated, walking at faster speeds results disproportionately in more arm movement, longer strides and will burn more calories as a result of this less efficient walking pattern.

One additional element that hasn’t been mentioned in the energy expenditure conversation is body weight. As you might imagine, a walker who weighs 115 lbs. will require fewer calories than a walker who weighs 180 lbs. This can easily be monitored by using a heart rate monitor. The 115 lb. walker may be working at 50% of his/her max while the 180 lb. walker may be working at 65% of his/hers on the same course and pace. There are two key take-away points to this concept that have been lightly touched on in chapter 4: exercise prescription in cases like this should be customized for each individual (by using effort-based methods), and weight significantly influences caloric expenditure. This last point can be used for anyone. For example, if the 115 lb walker wanted to burn more calories, weight could be added by using a weight vest, backpack, or other objects.

Another way to increase energy expenditure is to change the grade of terrain. Walking up hills requires more effort and consequently burns more calories than downhill or flat surfaces. So, if the goal is to burn more calories, hills are a great way to do that.

It should also be noted that inefficient is not the same as poor technique. Technique should always be monitored so that injury risk can be minimized. Adding weight and terrain changes can alter good form and result in injury so caution is suggested if considering these tools.

**Nutrient Timing**

In recent years, attention has not only looked at what is being consumed at meal time but also the timing of the meals. Weight lifters have long used protein before and after workouts to help produce more muscle and aid in recovery in between workouts. As a result, questions have come up about how soon meals should be eaten before a workout and when to eat after the workout. This question not only stems from a desire to improve performance but also to avoid gastrointestinal discomfort and speed up recovery.

Most experts suggest eating 2-3 hours before a workout allowing ample time for digestion so as to avoid stomach and/or gastrointestinal (GI) discomfort. Eating a meal with ample carbohydrate is suggested to provide adequate energy that can be used during the activity. If hungry before the workout, try and consume a small amount of carbohydrate to get through the workout. Something like a granola bar, a few pretzels and peanut butter, or some fruit could be used. Keep in mind, walking and jogging consists of up and down and some side-to-side movements making it easy for foods to be sloshed around in the stomach. Foods that are greasy and fatty, like potato chips and fried foods are not recommended as they take longer to digest, sit heavy in the stomach, and can cause GI distress.

Each time you eat a meal, the carbohydrates you’ve consumed are broken down and, in part, stored in the muscles as glycogen. This glycogen is then readily available for use during the next activity. Once the workout is complete, muscles may be depleted of glucose/glycogen stores so consumption of carbohydrate within an hour after the workout is recommended. Because exercise can lead to muscle breakdown, protein post-workout can help speed up recovery by making needed amino acids available to muscle tissue in need of repair. A ratio of 4 grams of carbohydrate to 1 gram of protein will give optimal results. Foods like Greek yogurt, chocolate milk, and specially formulated protein shakes are excellent post-workout products.

The amount of post-workout calories should be determined by the length and intensity of the workout. Of course, the energy balance concept applies. Shorter workouts of less than 30 minutes and/or low intensity workouts will require little to no post-workout food while activities beyond 30 minutes are more and/or very intense workouts likely justify post-workout calories.

**Eating for Weight Loss**

Ultimately, weight loss can be achieved by eating fewer calories than calories burned. This negative energy balance must be accrued over long periods of time. In general, it is believed that 3500 calories equal 1 pound of fat. In the context of daily eating, a safe amount of calorie restriction would be 500 calories. By continuing that for 7 days, a negative energy balance of 3500 calories could be achieved and a pound of fat lost.

It is important to remember that energy out is not only achieved through calorie restriction. Energy out consists of BMR, food digestion, and physical activity. The healthiest way to lose weight comes from restricting calories and maintaining a consistent exercise program. For example, not drinking a soda, a daily habit for many, could mean 250 calories have been restricted each day. A daily, 2.5 mile, brisk, walk roughly burns 250 calories which goes on to the energy out, side of the scale. Together, subtracting the 250 calories from the soda and adding the 250 calories from the walk would generate a negative energy balance of 500 calories. This is a simple lifestyle change for most which could yield large results!

**Key Terms**

**Proteins-**major structural components of nearly all cells and function to aid in bone repair, muscle, skin and blood cells.

**Amino Acids**-the building blocks, or individual structural units of proteins.

**Fats** (or lipids)-any of a class of organic compounds that are fatty acids or their derivatives and are insoluble in water but soluble in organic solvents. They include many natural oils, waxes, and steroids.

**Carbohydrates**-any of a large group of organic compounds occurring in foods and living tissues and including sugars, starch, and cellulose.

**Vitamins**-any of a group of organic compounds which are essential for normal growth and nutrition and are required in small quantities in the diet because they cannot be synthesized by the body.

**Minerals**-an inorganic substance needed by the human body for good health.

**Nutrient dense**-foods that contain a high ratio of nutrients and energy.

**Calories**-the amount of heat required to raise 1 Liter of water 1 degree Celsius. It is often associated with foods to quantify the energy values.

**Efficiency**-the percentage of energy converted from food product to work.

**Economy**-the amount of energy consumed over distance or time.

**Testing Your Knowledge:**

1. Eating is essential to good health and survival because:
   1. Food gives us energy
   2. Food makes us feel full
   3. Food gives us essential nutrients
   4. Both a and c
2. Which of the following in **not** an energy providing macronutrients?
   1. Vitamins
   2. Carbs
   3. Fats
   4. Proteins
3. What is meant by recommendations saying we should eat “nutrient dense foods?”
   1. Eating foods with high caloric value is imperative
   2. Eating foods with a balance of high nutrition with energy is best
   3. Do not eat sweets for energy
   4. Drinking your calories, like drinking orange juice, is best
4. The energy balance equation states:
   1. burn the same number of calories you consume to maintain weight
   2. a squared plus b squared equals c squared
   3. 10% more energy is required for aerobic exercise like walking and jogging
   4. eat for energy in the morning and for nutrients in the evening to balance calories throughout the day
5. What 3 components of energy expenditure (calories burned), should be used to calculate total daily calorie needs?
   1. BMR, ATP, body composition
   2. ATP, body composition, digestion
   3. Digestion, RMR, activities
   4. Activities, ATP, digestion
6. Efficiency is best described as the percentage of energy being converted to actual work from the energy in foods that we consume.
   1. True
   2. False
7. Economy is best described as the amount of energy being converted to actual work from the energy in foods that we consume.
   1. True
   2. False

Answer Key:

1. d.
2. a.
3. b.
4. a.
5. c.
6. a.
7. b.

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