Welcome to the physiology of weight control presentation. The purpose of this presentation is to provide the health and fitness professional with a brief overview on the physiological mechanisms associated with weight control. After completing this section, the health and fitness professional will be able to understand the physiological components to losing and gaining weight, understand how certain laws of science have direct correlation with weight control, and confidently communicate the rationale for weight gain, weight loss, and weight maintenance to their clients.

The body is a remarkable machine that can manage many extremes of dieting. For example, in absence of carbohydrates, the body can produce this macronutrient from fragments of other nutrients. In conditions of either a surplus or deficit of energy, the body will not be able to maintain a steady weight. Either an increase or a decrease of body fat will result from an imbalance in the energy budget. The concept of energy balance, the basics of metabolism, and the genetic and environmental influences on body weight will be covered in this presentation.

At its most basic level, weight control is a demonstration of energy balance, a simple equation representing the relationship between energy or calorie, intake and output. A person will be in a positive energy balance when they have eaten, over time, more calories than they expended. Likewise, a state of negative energy balance will prevail when a person has expended more calories over time than they have eaten. This concept is illustrated in the first law of thermodynamics.

The first law of thermodynamics is an expression of the more universal physical law of the conservation of energy. This law states that energy cannot be created or destroyed, and can only be changed from one form to another or transferred from one body to another. With this being said, the human body will maintain its weight if energy input, or what we eat and drink, is equal to the energy output, or what we expend. Conversely, if energy input is greater than or lesser than energy output, weight gain or weight loss will occur.

Our bodies require calories to stay alive. However, in modern society, many people find themselves in a caloric surplus, as physical demands have decreased due to the advancements of technology, while at the same time, the availability and convenience of food has increased. This increase in caloric ingestion and a decrease in caloric expenditure leads to America's expanding waistlines.

Now that we've reviewed how we obtain energy, food, and drink and how it can affect one's weight, let's look at the contributing elements to energy expenditure. These elements include basal metabolic rate, the thermic effect of feeding, and physical activity.

Basal metabolic rate, or BMR, is used to describe the rate at which the body expends energy to maintain basic physiological survival, and makes up the majority of daily energy expenditure, roughly 75% of daily energy expenditure. The term Resting Metabolic Rate, or RMR, is also used to express basal metabolic rate, but with slightly different measurement conditions. Basal metabolic rate is measured while the person is awake but lying still after a restful sleep and an overnight fast. Resting metabolic rate is slightly higher than basal metabolic rate because the criteria for food intake and activity are not as strict.

The term "Resting Energy Expenditure," or REE, is also commonly interchanged with resting metabolic rate. The most common methods for estimating resting energy expenditure include the Harris Benedict equation, the Mifflin St. Jeor equation, and the Owen equation. Let's go through an example using the easiest equation of the three, the Owen equation.

When using the Owen equation for a male client, you would multiply 10.2 by their weight in kilograms and add 879 to that number. When using it for a female, you would multiply 7.18 by their weight, again in kilograms, and add 795 to that number. So if you have a 140-pound female client, you would first convert her weight from pounds to kilograms by dividing 140 by 2.2, which equals 64 kilograms. You would then multiply 64 by 7.18, which is 460. Then add 795 to 460, which calculates to an estimated resting metabolic rate of 1,255 calories expended per day.

The Thermic Effect of Feeding, or TEF, refers to an estimation of the energy required to digest, absorb, transport, metabolize, and store nutrients, and makes up roughly 10% of daily energy expenditure.

Physical activity refers to an estimation of energy required to support physical work outside of basal metabolic rate, and makes up between 10% and 30% of total daily energy expenditure. In a sedentary person, physical activity may account for less than half as much energy as basal metabolic rate. In an athlete, energy expenditure from physical activity may be equal to their basal metabolic rate.

This table shows roughly the number of calories expended per minute during some common physical activity sessions. For example, if your client is 150 pounds and he is going to bicycle at 19 miles per hour for 30 minutes, you would take his weight, 150 pounds, and multiply it by 0.076, which equals 11.4. Then multiply 11.4 by 30 minutes, which equals 342. So this individual would expend roughly 342 calories in that cycling session.

According to the US dietary guidelines, overweight and obese persons should aim for a slow, steady weight loss by decreasing calorie intake while maintaining adequate nutrient intake while increasing physical activity. Most experts agree that a safe and maintainable rate of weight loss is from a half a pound to two pounds per week generated by a 250- to 500-calorie deficit per day below maintenance level.

It is well-documented that although most people participating in weight loss programs can successfully lose weight in the short term, the majority cannot sustain the reduced body weight. Most evidence suggests that the vast majority of people who lose weight regain it during the subsequent months or years.

A plausible hypothesis that can account for the body's tendency to return to its prior weight can be explained through the set point theory. The set point theory states that body weight is maintained at a set level, and deviations from the preferred set point are resisted and minimized by a feedback control system.

Clients often use the set point theory to explain reaching a plateau in weight loss that seems insurmountable. If a weight loss plateau occurs, it is a result of one's caloric expenditure being the same as their caloric ingestion, leading to no change in weight. If this occurs, caloric imbalance must be created either through a decrease in caloric ingestion or an increase in caloric expenditure for weight loss to reoccur. Strategies on how to accomplish this will be covered in greater detail in the Avoiding and Breaking a Plateau section of this course.

If energy imbalance cannot be completely explained by the various mechanisms of the set point theory, why then do people accumulate excess body fat? The law of thermodynamics has given us the simple answer that most obese clients take in more than they expend, but why does this occur? Is it genetic, environmental, cultural, behavioral? The answer is probably yes to all.

While the law of thermodynamics explains the consequence of energy imbalance, it does not account for the regulation of food intake. An understanding of why people over- or under-eat is more involved than a straightforward mathematical equation. These causes tend to fall in either the genetic or environmental arena, or a combination of the two.

The human body response to changes in caloric intake is dictated, at least in part, by genetics. It is believed that genes encode proteins that play a role in the appetite system. Appetite refers to the sensations of hunger, satiation, and satiety that prompt a person to eat or not eat. Hunger describes the sensations that promote food consumption, and it's a multi-dimensional attribute with metabolic, sensory, and cognitive facets.

Satiation follows the initiation and progression of a meal and causes hunger to subside. Satiation is determined by both meal size and duration. Eventually, feelings of satiation will contribute to the cessation of eating, and a period of abstinence from eating will begin.

Some hormones play a role in controlling appetite, while others have been identified as contributing to the energy regulation. While a complete review of the endocrinology of appetite is beyond the scope of this course, it is important to recognize that not only do hormones contribute to this system, but that a properly working hormonal system is, in part, genetic. In other words, if the hormonally regulated telecommunication system between the brain, gut, and circulating nutrients is not working properly, the regulation of energy intake may not be matched with physiological need, and that broken system can be inherited.

The environment also plays a role in America's expanding waistline and includes all of the circumstances that we encounter daily that may push us toward energy surplus or deficit. Some include fast food, which is the availability of a high-energy, low-nutrient-dense food; super-sizing and value meals, which are the larger sizes of food that people buy because they perceive them to be a good economic value; decreased physical activity by the utilization of escalators, elevators, automobile, remote control, and automated tools and recreation; media exposure to food and food promotion; and the prevalence of fad diets, weight loss magic products, and gimmicks. Not only do these items almost always fall short on delivering their promises, but with exaggerated and false information, they undermine the scientifically validated, though often less appealing, recommendation of healthy diet and more exercise.

To summarize, the global epidemic of obesity is driven by an environment that encourages overeating and discourages physical activity, creating a consistent bias toward positive energy balance. Public health professionals note that we have had no biological reason to develop a physiological control system to vigorously oppose a small degree of sustained positive energy balance.

Additionally, genetic and environmental factors are not mutually exclusive, and there can exist a complicated interaction between the two. For example, children of obese parents have a higher likelihood of becoming obese, but this is probably a result of both environmental and genetic circumstances. In other words, there is a powerful role of the environment exerting effects on already vulnerable genetic susceptibility for overweight and obesity. Maintaining a healthy body weight requires balancing both sides of the energy budget, the intake and the output.