

Activity 3.2.5: Metabolism – A Balancing Act

Introduction

In any cell, two basic processes, *catabolism* and *anabolism*, work together to balance what is being built with what is being broken down. In catabolism, energy rich fuel molecules are broken down to release their energy to supply the cell’s needs. Anabolism, on the other hand, takes simple building blocks and uses them to build up more complex molecules a cell may need for growth and repair. Together, anabolism and catabolism make up *metabolism*, the sum of all of the chemical reactions that occur within body cells. These important reactions help convert the fuel in the food we eat to power for everything we do.

In PBS, you learned that the calorie is a measure of energy. Calories are stored in the molecules that make up the food that we eat. We burn these molecules through the process of cellular respiration and release energy that can be used by the body. To remain fit, you must balance the amount of calories you ingest with the amount you spend completing daily activities. If what is being consumed is not balanced by what is being burned, you’ll notice the difference on the bathroom scale.

So how much energy do you use in a day? Remember that even when you are sleeping or watching TV, your body is using energy. Energy cannot be seen or touched, but it keeps your heart beating, your neurons firing and your muscles pumping. Basic metabolic functions and chemical reactions that break down and build new materials are always occurring. Your total energy expenditure includes energy used at rest and during physical activity.

In this activity, you will play the role of a registered dietician or a nutrition counselor and meet with a client hoping to adopt a more healthy lifestyle. You will analyze the diet of your client and balance the energy he or she consumes with the energy expended in daily activities. Examining standard measures of weight and fitness, as well as the theory behind gaining and losing weight, will help you see how too many or too few calories will impact the health of many body systems. Report your findings to your client and suggest ways he or she can better utilize energy for optimum performance and health.

Equipment

* Computer with Internet access
* Career journal
* Activity 3.2.5 Student Resource Sheet –Laboratory journal
* Calculator

Procedure

James Clifton is a 24-year-old man who has always been in good health. James is a busy law student, James finds he has less and less time to exercise. He used to cook most of his meals at home, but now he grabs whatever he can when he is on the way to the library or to class. His doctor just called him to let him know that his routine physical results revealed a mildly elevated LDL and a low HDL level. Both his mom and his dad have shown early signs of heart disease.

Jeanette King is a19-year-old sophomore majoring in Biology. Jeanette gets up to go running every morning before class and sometimes adds a second workout in after dinner. She is a strict vegetarian and she has recently cut all carbohydrates (except for an occasional slice of wheat toast) out of her diet. Jeanette is convinced she needs to lose at least 10 more pounds. She drinks plenty of water and consumes a sugar-free energy drink when she needs to stay up and study, but she still feels tired and run down.

Jeffrey Wilson is a 21-year-old senior who has not worried much about his weight in the past four years. He does not want to lose his scholarship so most of his focus is on his GPA and his internship at the local hospital. Jeffrey knows he has gained weight over the past four years, but he did not realize how bad it was until his doctor referred to him as obese at his last appointment. Jeffrey wants to lose weight, but his doctor fears that he will not lose the weight in a safe manner unless he consults with an expert.

All three individuals begin to worry about their health and decide to see the campus nutritionist (that’s you).

1. Note that you will be assigned one of the three clients by your teacher.
2. Use the Internet to research a career as a dietician or a nutritionist.
3. In your career journal, describe the education required for the position and the standard salary range for individuals in this field. List at least five duties of this biomedical professional. Under your list, write a short paragraph describing how a dietician or nutritionist might help the patient you have been assigned.

In the first session with either James, Janette or Jeffrey, you collect basic information from the client and record height and weight. The patient has been asked to keep a detailed food log, chronicling all of his or her meals, drinks, and snacks, for the past week.

1. Obtain a Student Resource Sheet from your teacher and read the information presented in the health history section of the partially completed *Client Report*. Your task will be to analyze the patient’s diet and complete this report. Bulleted items describe the tasks you will need to complete to finish your assessment. You will receive more instructions as you complete each step. If possible, type your findings directly onto the report sheet.
2. Know that body Mass Index (BMI) is a measure of body fat based on both height and weight of an individual. BMI is a simple numeric measurement that can be used to determine whether an adult is overweight. View the Howard Hughes Medical Institution video clip on BMI at http://www.hhmi.org/biointeractive/body-mass-index-bmi. Record the standard values for BMI in your laboratory journal. What is considered a healthy BMI? What BMI values are associated with being overweight or obese?
3. Refer to information found on the Client Report and calculate your client’s BMI using the formula shown below. Make sure to use the correct units. Remember- there are 0.454 kilograms per pound and 2.54 centimeters in an inch.

* **BMI** **= weight (kgs)**

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**[height (m)]2**

1. Record BMI on the Client Report and discuss the implications of this value.
2. Answer Conclusion question 1.
3. Read the information presented under *Activity Level* on the Client Report.
4. Note that Basal Metabolic Rate (BMR) is the baseline rate at which your body uses energy. This value takes gender, height, weight and age into consideration to calculate the number of calories needed to fuel the basic functions of life. Calculate your client’s BMR using the appropriate formula shown below.

* Men: BMR = 66.5 + (13.75 x W) + (5.003 x H) – (6.775 x A)
* Women: BMR = 655.1 + (9.5663 x W) + (1.85 x H) – (4.676 x A)
* W = actual weight in kilograms
* H = height in centimeters
* A = age in years

1. Record BMR on the Client Report. Show your calculations.
2. Notice that BMR only accounts for the body’s resting energy needs. To get an accurate value for the amount of energy a person spends per day, you need to factor in your level of physical activity. The more you exercise, the more calories you burn and thus, the more calories you need to consume.
3. Once you know your client’s BMR, calculate his or her caloric needs based on level of activity using an approximation called the *Harris-Benedict equation*. Use information about this equation found at BMI-Calculator.net <http://www.bmi-calculator.net/bmr-calculator/harris-benedict-equation/> to determine *activity factor*.
4. Multiply the BMR you calculated in Step 10 by this activity factor to determine the number of calories your client should consume daily to maintain his or her current weight. This value is referred to as the *Total Daily Energy Expenditure* (TDEE). Show your work and the final TDEE on the Client Report.
5. Answer Conclusion question 2.
6. Read the information presented in the *Food Intake* portion of the Student Resource Sheet.
7. Answer Conclusion questions 3 and 4.
8. Compare how much energy your client uses during a typical day (the TDEE) to how much energy he or she consumes (average calorie consumption per day). Calculate a difference. According to these values, is your client consuming too many or too few calories? Record the calorie deficit or surplus on the Client Report.
9. Predict your client’s expected weight loss or gain if he continues these activity and eating patterns for **one month**. Use the information below to help you estimate this value and record your findings on the Client Report.

* To lose weight, you need to create a calorie deficit. To gain weight you need to increase your calories about your TDEE.
* There are approximately 3500 calories in a pound of stored body fat.
* If you create a calorie deficit of 500 calories per day, you will be down 3500 calories in a week, and thus lose 1 pound. If you consume an extra 500 calories a day, you will be up 3500 calories in a week, and thus gain 1 pound. NOTE: This assumes a constant activity level (as controlled for by your activity factor).

1. Analyze your client’s food choices. Explore the components of a healthy day’s eating at the USDA ChooseMyPlate site <http://www.choosemyplate.gov/>.
2. Click on each section of the plate piece to view recommendations on the components of a healthy diet. Review healthy food choices in each section.
3. Complete the remaining sections of the Client Report sheet. Report your findings in a clear succinct conclusion and make recommendations to your client about improving lifestyle. Take all aspects of health history into account.
4. Note the following websites (along with the MyPlate site) may be helpful in the completion of your report:

* Food and Drug Administration: How to Understand and Use the Nutrition Facts Label (Note: contains an example label showing recommended daily values) <http://www.fda.gov/Food/IngredientsPackagingLabeling/LabelingNutrition/ucm274593.htm>
* NutriStrategy: Nutrients, Vitamins, Minerals and Dietary Information <http://www.nutristrategy.com/nutritioninfo2.htm>

1. Answer the remaining Conclusion questions.

Conclusion

1. What are the limitations of using BMI as a measure of weight and overall health? How might muscle tone affect BMI?
2. What are factors that can increase or decrease BMR? Explain each.
3. What are the health risks associated with high levels of saturated fat and cholesterol in the diet? Think back to what you learned in PBS.
4. Each gram of fat you consume provides over twice as many calories as a gram of protein or carbohydrates. What does this tell you about your body’s ability to burn off these three fuels? Which would require the most energy to burn?
5. Discuss at least two health risks faced by people with a BMI above 25.
6. Discuss at least two health risks faced by people with a BMI below 20.
7. Describe how being overweight affects at least three other body systems.
8. Describe how being underweight affects at least three other body systems.
9. Explain how a nutritionist or dietician might help an athlete train for a major competition, race, or game.