

MODULE 9: METABOLISM LAB

This lab will include some activities and require some research that will help you understand and appreciate the relationship between oxygen consumption and metabolism. There will be an online worksheet that you will enter your answers on. You will be allowed to "Save for Later" and "Submit" the worksheet as many times as you want. However, there are a couple of things to keep in mind.

1. You will not be allowed to Submit your worksheet after the deadline. If you do not submit before the deadline, you may be able to work out a way to submit it as a late assignment but there will be point deductions.
2. If you Submit the lab assignment, and then decide to retake it before the deadline, all of your answers will be gone and you will have to retype all answers before submitting again.

The lab worksheet has been reproduced for you on the following pages, so that you can work on things offline. If you have printed the lab manual, you might write notes in the textbox fields, or you might use a .pdf document annotator on your computing device. Whatever you decide to do is fine, but ultimately, only answers entered on the I-learn worksheet can be submitted for grading.



Follow the instructions below very carefully. Many of the items in this assignment require reading or videos or something else to do. Be sure to write your answers completely before submitting the assignment. There is an option in the bottom right to save your answers and come back later, but once you submit this assignment, it will be graded.

Basic Metabolic Rate

Body metabolism simply means all of the chemical reactions taking place in the cells of the body and the metabolic rate is normally expressed in terms of the rate of heat liberation during those chemical reactions. Metabolic rate is expressed as kilocalories (Cal) per hour. Since direct measurement of heat production from the whole body involves very cumbersome and expensive apparatus, this method has been reserved to check the validity of indirect methods. Indirect methods use measurement of oxygen consumption as an indicator of heat production. The amount of heat produced when one liter of oxygen is metabolized depends on what type of nutrient is being utilized. When one liter of oxygen is metabolized with glucose, 5.01 Cal or energy are released; when metabolized with starches, 5.06 Cal are released; when metabolized with fat, 4.7 Cal, and when metabolized with protein 4.6 Cal. It has been determined that for the average diet approximately 4.825 Cal are released per liter of oxygen consumed. Using this value we can compute a relatively accurate estimate of the metabolic rate.

Metabolic rate is affected by any factor that increases chemical activity in the cells. Listed below are some of the factors that are known to have an effect on metabolic rate.

1. **Exercise:** Exercise causes by far the most dramatic changes in metabolic rate. In this lab procedure we will determine the effects of exercise on metabolic rate.
2. **Age:** The metabolic rate of a newborn child in relation to his body surface area is almost twice that of an aged person. Metabolic rate drops rapidly for about the first 20 years of life and then continues to slowly decline for the rest of a person's life. The high metabolic rate in children results from both high rates of cellular reactions as well as from rapid synthesis of cellular materials and growth of the body.
3. **Thyroid Hormones:** These hormones control the rate of activity of almost all the chemical reactions in the body. Hypo and hyper secretion of thyroid hormones have major effects on metabolic rate.
4. **Sympathetic stimulation:** Stimulation of the sympathetic nervous system increases the metabolic rates of essentially all of the tissues of the body.
5. **Growth Hormone:** GH can increase metabolic rate as much as 15 to 20 percent as a result of direct stimulation of cellular metabolism.
6. **Fever:** Chemical reactions in the body increase when body temperature increases.
7. **Climate:** Studies of metabolic rates of persons living in different geographic regions have shown as much as 10 to 20 percent lower metabolic rates in tropical regions than in arctic regions. This is probably due to adaptation of the thyroid gland with increased secretion in cold climates and decreased secretion in hot climates.
8. **Male Sex Hormones:** Males generally have a metabolic rate that is about 10 percent greater than females due to the effect of the male sex hormones.

9. **Malnutrition:** Prolonged malnutrition can decrease metabolic rate by as much as 20-30 percent. This decrease is thought to be caused by the lack of necessary nutrients in the cells. However, recent studies indicate that metabolism tends to slow down even during strict diets suggesting that the body is attempting to preserve calories.

1. Do you think your Metabolism has increased, slowed down or stayed the same since you arrived in Rexburg to attend college? Explain.

2. Which of the following would be MOST likely to **Decrease** a person's metabolic rate?

- A Fever
- Hyperthyroidism
- Pituitary Dwarfism
- Puberty

3. Do you think your basal metabolic rate increased or decreased or stayed the same when you came to BYU-Idaho and started school? Explain.

VO2 Max

VO2 Max is the maximal amount of oxygen that a human body can use. VO2 max is often a favorite measurement to assess someone's fitness level. VO2 max is a good measurement of fitness for the following reasons.

1. Muscle cells have the ability to use more oxygen than any other body cell. So if a person has more muscle tissue then, they would have the possibility to use more oxygen than someone with less muscle tissue. The number and health of your muscle cells determines strength and endurance which is a characteristic of fitness.
2. An exercising muscle cell is capable of using nearly all of the oxygen delivered to it and could probably use even more if it was possible to deliver more. Our cardiovascular system is responsible for delivering oxygen. If we have a large and strong heart (like Lance Armstrong did) and if we have healthy blood and healthy blood vessels, then we should be able to deliver more oxygen which will be used by our muscle cells during exercise. Fitness is characterized by many things including a strong and healthy cardiovascular system.

In short, a person with lots of healthy muscle tissue and a strong cardiovascular system would be able to use more oxygen. If we measure the maximal amount of oxygen that a person can use, then we get an idea of their peak fitness level.

VO2 max is usually measured as ml of oxygen per Kg of body weight per minute (ml/kg/min). Measuring it this way allows us to compare VO2 max across different individuals and compare "apples to apples". For example, a large obese man might use a lot more oxygen than a small petite woman (because he has a lot more body cells). But, if we compare what one kg of the obese man's body mass does compared to 1 kg of the woman's body mass, then we see true differences. One kg of the woman's body mass is simply going to burn more oxygen per minute than one kg of the man's body mass because she has a greater density of muscle in that kg and she has a greater ability to deliver oxygen to that kg of body mass.

Measuring VO2 max can be pretty involved. It involves collecting all the gas that a person breathes in and out. We find that a person breathes in a certain amount of oxygen in a single inspiration and they breath out a little less oxygen in a single exhalation. The difference is what their body used. If we measure the amount of oxygen that a person breathes in and out while they exercise as hard as they possibly can, then we can see their VO2 max.

Of course it is difficult to directly measure a VO2 max and takes a lot of specialized equipment. However, there are many ways to estimate it.

4. [CLICK HERE](#) to see a web page that has some ways to estimate VO2 max. Choose one of the ways and write your estimated VO2 max in the box below (*Keep in mind that generally, the more physically hard it is to do the test, the more accurate it is...this is why the 1.5 mile run is the most accurate test on the web page*).

[Click Here](#) if you would like to see a page that organizes your VO2 max in fitness categories.

5. Using your estimated VO2 max, calculate how long it would take to burn the calories in a snickers bar (say 300 calories). Use the box below and **show your work for full credit.**

Resting Metabolic Rate

The basal metabolic rate (BMR) is the rate of metabolism that is required to maintain basic body functions, that is it is the rate of metabolism necessary to keep you alive. It is expressed as Calories per square meter of body surface area per hour and can only be determined if strict criteria are observed. These criteria are: 1) The subject cannot have eaten in the last 12 hours, 2) The BMR is determined after a night of restful sleep, 3) No strenuous exercise can be performed for at least 1 hour before the test, 4) The subject must be calm and relaxed, 5) The temperature in the room must be between 68 and 80 degrees Fahrenheit, and 6) The subject is not permitted to do any physical activity during the test.

Although we have the ability to measure how much oxygen a student's body uses in lab today, it is not possible to adhere to all the criteria above. Therefore, what we will be measuring is called a "resting" metabolic rate (RMR) expressed in Cal/hour or Cal/min.

On Campus Lab Students	Online Students
If you are taking the lab on campus, then your teacher will provide you with instructions on how to measure your own Resting Metabolic Rate.	If you are taking the lab strictly online, then follow these steps. CLICK HERE to watch a video that goes through the steps of how to measure a Resting Metabolic Rate. CLICK HERE to download an assignment that will have you calculate using provided Resting Metabolic Rate data.

Answer the following questions:

Using either your own data from lab or the calculated data for the online sections, answer the following question.

We know a faculty member who is very clever with their discipline for kids in trouble in his family. Awhile back, his oldest son decided to sneak in and steal a younger brothers Halloween candy. Well, this resulted in a fight and a need for some discipline. It played out like this...the older son was required to do this online lab (even though he was just in Junior High). The older son figure out his own RMR. He was then required to sit in time out for the length of time that he calculated it would take is resting metabolism to burn all the calories that he consumed in from his theft. Feeling that this would be good for you to do as well...please calculate the following:

How long would you have to sit in time out to burn 3 fun size candy bars, 2 pixie sticks, 5 jolly ranchers, 4 tootsie rolls, 3 candy kisses, and a fun size package of dots. (Lets say all together this would be 700 calories). Use your own RMR if you have it or use your RMR data provided in the downloaded assignment.

6. Use the box below and you **must show your work** (how you did all the calculations) to get full credit.

The influence of Exercise on Metabolism

Exercise causes many more muscle fibers to contract. It also causes the cardiovascular system to deliver a lot more oxygen. Muscle fibers will require oxygen to fully metabolize all the organic molecules used by the cell for energy production. As the muscle cells use more oxygen they will expend more Calories. Certainly, an exercising person will have a temporary but greater metabolic rate than a resting person. This activity will show us how we can use the methods from the previous activity to measure caloric expenditure of a person who has exercised.

On Campus Lab Students	Online Students
If you are taking the lab on campus, then your teacher will provide you with instructions on how to measure your own Exercising Metabolic Rate.	If you are taking the lab strictly online, then follow these steps. CLICK HERE to watch a video that goes through the steps of how to measure an Exercising Metabolic Rate. CLICK HERE to download an assignment that will have you calculate using provided Exercising Metabolic Rate data.

Remember the previous problem. Well, being very kind, the faculty member who had his oldest son in time out, decided to show mercy. He allowed the oldest son

to figure out how many calories he burned per minute when he did jumping jacks with a heart rate at about 140 beats per minute. He then allowed the son to stand up from time out and do jumping jacks for 5 minutes at a time. This of course shortened the total time out length.

7. How many calories would you burn per minute if you used your exercise metabolism data. Use the provided data from the exercise metabolic rate download if you are doing this lab online. Use the box below and you **must show your work** (how you did all the calculations) to get full credit.

8. If you exercised the whole time, how long would it take you (or the sample data) to burn the 700 calories of stolen candy? You must **show your work** for full credit.

9. Many weight loss experts argue that diet is more effective than exercise for weight loss. That belief may be largely based on crunching the numbers, like you have just done, and realizing how long it takes to burn calories compared to how long it takes to eat them.

Never-the-less, exercise is still promoted as a powerful weight loss tool. Do some research and write an essay expressing your thoughts on the following: Is exercise a powerful weight loss tool? You must support your essay with research you find and not just biased opinion etc.

This essay is subjectively graded by your instructor, but the most points are given for well-developed thoughts that are nicely supported by the research you summarize.