BIOL 110: Energy for Life

Heart Rate Activity

Determine your resting heart rate

- Find your pulse by pressing gently on your carotid artery (on one side of your neck, under your chin). Alternately, you could find the pulse on the underside of your wrist.
- Keeping time with a stop watch, count the number of pulses for 15 seconds.
- Record this number in the chart on your worksheet.
- Multiply that number by 4 to determine the number of times your heart beat in one minute.

Trial #	# of Beats in 15 seconds		Beats per minute
1: "Resting" heartrate		**x 4**	
2: After 2 minutes of physical activity		**x 4**	
3: After 15 minutes of inactivity		**x 4**	

1. How is breathing related to cellular respiration?

2. Hypothesize: How will exercise affect the rate of cellular respiration?

Determine your heart rate after activity

Follow your lab instructors directions and record the date in the table above.

Determining your Target Zone

Use the resting heartrate you measured earlier today, and complete the following calculation:

- Subtract your age from 220 to get your maximum heart rate.
- Calculate your heart rate reserve (HRR) by subtracting your resting heart rate from your maximum heart rate.
- Multiply your HRR by 0.7 (70 percent). Add your resting heart rate to this number.
- Multiply your HRR by 0.85 (85 percent). Add your resting heart rate to this number.
- These two numbers are your training zone heart rate for vigorous intensity exercise. Your heart rate during exercise should be between these two numbers.

1. Calculate your 70 – 85% target zone:

2. How does this compare to the active heart rate you measured after exercising?

Heart Rate Recovery

- When prompted by your lab instructor (after a rest period of 15 minutes), once again record the number of pulses you feel for 15 seconds.
- Using the data from all three measurement periods, create a graph that shows the change in your heart rate over time.

1. How does your final heart rate measurement compare to the measurement you took right after exercising?

2. How does your final measurement compare to the first measurement you took? If they are different, speculate about why that might be.

Photosynthesis Activity

1. Formulate a hypothesis about which color in the visible spectrum will cause the most plant growth. Explain your reasoning.

2. How will you test this hypothesis?

3. What is the independent variable in your experiment?

4. What is the dependent variable?

5. Why is it important to grow more than one plant under each of the various conditions?

Now, conduct the experiment, using the online virtual lab activity found here:
https://nt7-mhe-complex-assets.mheducation.com/nt7-mhe-complex-assets/Upload-20190715/InspireScience6-8CA/LS12/index.html

Do not use the "journal" or "data" table on the website. Instead, enter your data into the data tables below:

Experiment #1: Spinach										
Height (cm)	**Red 1**	**Red 2**	**Violet 1**	**Violet 2**	**Blue 1**	**Blue 2**	**Green 1**	**Green 2**	**Orange 1**	**Orange 2**
Plant 1										
Plant 2										
Plant 3										
Average										

Experiment #1: Radish										
Height (cm)	**Red 1**	**Red 2**	**Violet 1**	**Violet 2**	**Blue 1**	**Blue 2**	**Green 1**	**Green 2**	**Orange 1**	**Orange 2**
Plant 1										
Plant 2										
Plant 3										
Average										

Experiment #1: Lettuce										
Height (cm)	**Red 1**	**Red 2**	**Violet 1**	**Violet 2**	**Blue 1**	**Blue 2**	**Green 1**	**Green 2**	**Orange 1**	**Orange 2**
Plant 1										
Plant 2										
Plant 3										
Average										

Averages					
	Red	**Violet**	**Blue**	**Green**	**Orange**
Spinach					
Radish					
Lettuce					

After completing the data table, use these averages to create a graph of your results – your lab instructor will assist you with this. Make sure to label the axes properly.

6. Analyze the results of your experiment. Did your data support your hypothesis? Explain.

7. Did you find the same result across all three experiments? Describe any similarities or differences you discovered between the different species of plants.

8. What conclusions can you draw about how the way different colors in the visible spectrum affect plant growth?

9. Given that white light contains all colors of the spectrum, what growth results would you expect under white light?

The Mystery of the Seven Deaths Activity

Imagine that you work at the medical examiner's office for a major metropolitan city such as Chicago. As Chief Medical Officer, you investigate suspicious deaths and provide toxicology services for the county. Unfortunately, it's been a busy week. In the past five days, seven people have died, all with similar symptoms. It is your job to examine the data and determine the cause of death for these victims.

The first was a 12-year-old girl. Her parents said that she was awake in the middle of the night complaining of a stuffy nose and sore throat. They gave her an extra strength Tylenol and sent her back to bed. At 7 am the next morning, the parents discovered that the girl had collapsed on the bathroom floor. An ambulance rushed the girl to a nearby hospital, where she was pronounced dead.

That same day, paramedics found the second victim unconscious on his kitchen floor after what they thought was an apparent heart attack. Sadly, the victim's brother and fiancée also collapsed later that night while the family gathered to mourn his passing. Both had taken Tylenol to help them cope with their loss shortly before collapsing; neither survived.

In the next four days, four other similar deaths were reported, all in the same neighborhood and all with similar symptoms. Most deaths were very rapid, occurring within a few hours of symptoms.

Are these seven deaths related? What is causing these people to die? It is your job to answer these questions before more deaths are reported.

Your instructor will introduce this activity, and give you additional information that you will need to solve this mystery in your breakout room.

Part I:

1. Are there any similarities or connections between these seven individuals? What questions would you want to ask the families to answer these questions?

2. In your opinion, are these seven deaths connected? Why or why not?

Part II:

Autopsy Results:

- In all cases, immediate cause of death was hypoxia
- Tissue sections from heart, lung, liver and kidney all show massive cells death.
- There was major mitochondrial damage present within the affected tissues.
- Blood oxygen levels were ~110 mm Hg
    - The normal range is 75 – 100 mm Hg
- The presence of cyanide was detected

1. Recalling your knowledge of the function of organelles, what function of the cells was interrupted in these patients? Could this loss of function lead to the death of these individuals? Why or why not?

2. Given the data in the autopsy, were there any reports that seemed inconsistent with the immediate cause of death?

Part III:

Metabolites are the intermediate products of metabolic reactions catalyzed by various enzymes that naturally occur within cells. This term is usually used to describe small molecules, although broader application is often practiced.

- **Glucose** is a monosaccharide and is the primary metabolite for energy production in the body. Complex carbohydrates are ultimately broken down in the digestive system into glucose and other monosaccharides prior to absorption in the small intestine. The main biochemical reaction employing glucose as its substrate is glycolysis, which, used by all tissues for the breakdown of glucose, provides energy in the form of adenosine triphosphate (ATP) and produces intermediates for other metabolic pathways. In cells with mitochondria and an adequate supply of oxygen, pyruvate emerges as the end product of glycolysis, and is subsequently converted through oxidative decarboxylation into acetyl coenzyme A (acetyl-CoA), the major fuel for the citric acid cycle.

- **Pyruvate** sits at an intersection of key pathways of energy metabolism. It is the end product of glycolysis and the starting point for gluconeogenesis. It plays a central role in balancing the energy needs of various tissues in the body. Under conditions in which oxygen supply is limiting, e.g., in exercising muscle, or in the absence of mitochondria, re-oxidation of NADH produced by glycolysis cannot be coupled to generation of ATP.

- NAD (Nicotinamide adenine dinucleotide) is a cofactor central to metabolism. NAD exists in two forms: an oxidized and reduced form, abbreviated as NAD+ and NADH respectively. In metabolism, NAD is involved in redox reactions, carrying electrons from one reaction to another. The cofactor is, therefore, found in two forms in cells:
    - **NAD+** is an oxidizing agent – it accepts electrons from other molecules and becomes reduced.
    - This reaction forms **NADH** (NAD plus Hydrogen), which can then be used as a reducing agent to donate electrons.

Metabolite	*Average Patient Levels*	*Normal Levels*
Glucose	99 µM	100 µM
Pyruvate	27 µM	25 µM
NAD+	10 µM	75 µM
NADH	400 µM	50 µM

1. For each metabolite listed in the table, describe its role in cellular respiration? Are they substrates or products? What is their main function?

Glucose	
Pyruvate	
NAD+	
NADH	

2. Are there any abnormalities in the levels of these metabolites in the victims? Develop a hypothesis about which pathway may be affected based on these abnormalities.

3. Explain your reasoning for your hypothesis.

Part IV:

The **electron transport chain** is a series of four protein complexes that couple redox reactions, creating an electrochemical gradient that leads to the creation of ATP in a complete system named oxidative phosphorylation. It occurs in mitochondria in both cellular respiration and photosynthesis. In the former, the electrons come from breaking down organic molecules, and energy is released. In the latter, the electrons enter the chain after being excited by light, and the energy released is used to build carbohydrates.

1. What affect would cyanide have on the electron transport chain and the production of ATP? Explain your answer.

2. Given what you now know about the action of cyanide on cellular respiration, explain why the patients died of lack of oxygen while their blood oxygen levels were normal?

3. Would artificial respiration or oxygenation have saved these people? Why or why not?

4. Looking back at the information you have about the people before they got sick, can you suggest a possible source of the cyanide poisoning? How should public health officials and police respond to this tragedy?

Assessing Nutritional Data

Now, we will analyze the nutrition data that you collected over the past week.

1) Using the chart you filled out as a part of last week's home assignment, compare the following categories:

	What is the nutritional target for this group?	**How much (by what percentage) were you over or under this daily target limit?**
Carbohydrates		
Lipids (Fats)		
Protein		

2) Let's consider fat intake now. Did you, or the sample meal plan you evaluated, consume more unsaturated fats, saturated fats, or trans-fats?

3) What about salt?

a) Was your meal plan under or over the target limit for sodium? By how much?

b) Look at the date or meal that contained the most salt. Which foods contained the highest amount of sodium? List them here.

4) Are there any vitamins and minerals for which your meal plan did not meet the daily targets? List them below.

5) Was your meal plan over the limit for any of the fat-soluble vitamins? List them below.

Calculating Basal Metabolic Rate

Now, we will learn how to calculate BMR. We can estimate BMR using the Harris Benedict formula, which determines daily caloric needs more accurately than an estimate based only on body weight.

To calculate for women: 655 + (9.6 x weight in kg) + (1.7 x height in cm) – (4.7 x age in years)
To calculate for men: 66 + (13.7 x weight in kg) + (5 x height in cm) – (6.8 x age in years)

6. In the space provided below, record the BMR for Jean (female) and Gene (male) that will be calculated by your lab instructor. Both weigh 130 lbs, are 5'4" tall, and 20 years old.

BMR for Jean:
BMR for Gene:

1 pound = 0.454 kg
1 inch = 2.54 cm

7. Now, use the correct formula above to calculate your own BMR, or the BMr for one of the celebrities below:

Henry Cavill	Taylor Swift
Age: 36 Height: 6'1" Weight: 198 lbs	Age: 31 Height: 5'10" Weight: 119 lbs

Now we will examine the diet of a student named Helen, a 150-pound, 20-year old female college student. A typical day's food for Helen consists of around 2,000 calories: 60 grams of protein, 70 grams of fat, and 282.2 grams of carbohydrate.

In order to calculate the calories provided by each type of nutrient, we need to know that:

- Protein and carbohydrates provide 4 calories/gram
- Fats provide 9 calories/gram

8. Calculate the percentage of calories provided by Helen's diet, and determine whether or not she is getting a recommended percentage of each macronutrient.

9. OPTIONAL QUESTION: Considering what you have learned about nutrition during this activity, are there any changes you think you might want to make in the future for your own eating habits?