**Culminating Task – SBI4U Metabolic Processes Unit**

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Respiration and Fitness: Can you keep up with Renaldo?

To produce sufficient energy for survival all organisms must respire. During aerobic respiration, oxygen is utilized in order to extract a maximum amount of ATP (36 ATP) from glucose molecules. In the absence of oxygen, organisms may undergo anaerobic respiration, a less efficient process in which only 2 ATP are produced from the breakdown of glucose. Without a source of energy, life cannot be possible.

Christiano Renaldo is playing in the biggest game of his life. You are being considered as a candidate to play striker on the same line as Renaldo. To prepare for the game, you will need to get yourself into soccer shape. Better start working out now and eat your Wheaties if you want to keep up with Renaldo!

1. Procedure:

**Note**: Make sure to have a good lunch or snack before beginning this activity.

1. Choose a partner:
   1. Partner 1 will be the runner or speedwalker\* (Alternative Activity: Clothespins and Muscle Fatigue – For students who are not able to run-see Appendix 4)
   2. Partner 2 will be the coach. The coach will be responsible for:
2. Measuring the breathing rate (breaths/minute) and pulse of the runner BEFORE he/she begins running
3. Measuring the breathing rate (breaths/minute) and pulse of the runner DURING and AFTER running (at halftime and at the end of the activity). For the measurement of breathing rate, have partner 1 count the number of breaths over a period of 1 minute.
4. Recording all results in table 1
5. Encouraging the walker/runner throughout the activity.
6. Create a data table in order to record breathing rate and pulse throughout the activity. Refer to Appendix 1 for an example of a table format.
7. Partner 1 will sit down in a chair by the starting line.
8. Partner 2 will measure the breathing rate and pulse of Partner 1 **BEFORE** running has begun. Record values in table 1.
9. Partner 1 will run around the defined course for 7 minutes. As soon as Partner 1 begins to feel muscle cramps specifically in the legs (due to lactic acid buildup), Partner 1 will immediately raise their hand and partner 2 will record the time at which this is felt.
10. After 7 minutes has elapsed, Partner 2 will quickly measure the breathing rate and pulse of Partner 1 (for 60 seconds). Make sure that Partner 1 is sitting in the same position as when measurements were originally taken.
11. Partner 1 will continue running for an additional 7 minutes.
12. Repeat measurements taken in line E.
13. The entire procedure will then be repeated, having Partner 1 as the coach and Partner 2 as the runner (repeat steps A-G)
14. Plot two line graphs on one set of axes (a double line graph) using MS Excel. Follow the guidelines for graphing included. See Appendix 2.
    1. Graph 1: Breathing Rate versus Elapsed Time
    2. Graph 2: Pulse Rate versus Elapsed Time
15. Mark on both of your plots the time at which muscle fatigue was first felt.
16. Determine the range in breathing rate and pulse over the entire time period (minimum and maximum values)
17. Calculate the change in breathing rate and pulse over the entire time period (maximum – minimum value)
18. Transfer your data into the communal Excel spreadsheet (created by your teacher). This data will be used for analysis questions. Teacher will have a specific table where male and female data will be entered into different columns.
19. Using a graph for all of the data from the class (provided by the teacher), discuss the range and differences in breathing rate and pulse.

Analysis Questions:

In answering these questions, use the concepts that have been taught through the duration of the Metabolic Processes unit where applicable.

1. A) What is the significance, in terms of cellular respiration, of the onset of muscle cramping that was felt by the runner?   
   B) What is the reason for the cramping sensation?  
   C) Marathon runners have discovered that taking walk breaks during a race may get them to a finish line faster than running all the way. Explain in terms of cell respiration.
2. A) How does your range in breathing rate and pulse compare to that of the entire class?
3. What is the significance of this difference, if any, in breathing rate and pulse in terms of respiration?
4. A) Based upon what has been discussed in class, why will a fit person feel less tired than a person with lower fitness after completing the same amount of physical activity?   
   B) How does breathing rate and pulse differ between males and females across the entire class?
5. Using the data produced during this lab, prepare a 1-minute dramatic proposal as to why you would be the best candidate to play soccer alongside Renaldo. Your options for the proposal may include but are not restricted to (upon approval by the teacher):
6. A 1-minute skit
7. A 1-minute recorded video
8. A 1-page written proposal
9. A 1-page drawing

**Assessment**

**In-lab Skills Checklist (to be distributed to the students prior to the lab)**

Students are required to complete the following components:

1. Student has read the lab prior to the activity O
2. Student ate a meal prior to the activity O
3. Student prepared a data table BEFORE the lab O
4. Student collected ALL materials required for the lab O
5. Student remained on task throughout the lab O
6. Student motivated runner throughout the lab O
7. Student returned equipment as instructed O

**Evaluation**

1. Breathing Rate-Time and Pulse-Time Graphs
2. Analysis Questions
3. Presentation (skit, video, proposal, drawing)

**Rating Scale for the Presentation**

Accuracy 0 1 2 3

Creativity 0 1 2 3

Relevance of Arguments 0 1 2 3

Engagement of the Class 0 1 2 3

Length of Presentation 0 (>30s off) 1 (<30s off) 2

**Appendix 1**

Table 1: Data for World Cup Champion of Tomorrow

|  |  |  |  |
| --- | --- | --- | --- |
| Time Period | Time (min:sec) | Breathing Rate (breaths/minute) | Pulse (beats/minute) |
| Before Running |  |  |  |
| Start of Rest Period |  |  |  |
| After Running |  |  |  |
| Time at which muscle fatigue was first felt |  |  |  |

**Appendix 2**

**There are certain specific requirements for a graph:**

**1) Meaningful underlined title within the space of the graph paper**

**2) Data points with a shape drawn around them**

**3) Legend if there is more than 1 set of data plotted**

**4) Axes with units in brackets**

**5) Spread out data over the entire graphing area**

**6) No calculations on the front of the graph**

**7) Include the data table on a separate sheet of paper**

**8) No arrowheads**

**Appendix 3**

**Answer Key for Analysis Questions**

In answering these questions, use the concepts that have been taught through the duration of the Metabolic Processes unit where applicable.

1. A) What is the significance, in terms of cellular respiration, of the onset of muscle cramping that was felt by the runner?

* **At that point respiration shifted from aerobic to anaerobic, leading to lactic acid buildup in the muscles.**

B) What is the reason for the cramping sensation?

* **Since lactic acid is a toxic substance, it leads to onset of muscle cramping.**

C) Marathon runners have discovered that taking walk breaks during a race may get them to a finish line faster than running all the way. Explain in terms of cell respiration.

**- By taking breaks, more oxygen can reach the muscles leading to the restarting of**

**Aerobic respiration and the removal of lactic acid from the muscles.**

1. A) How does your range in breathing rate and pulse compare to that of the entire class?

* **Answers will vary from student to student.**

1. What is the significance of this difference, if any, in breathing rate and pulse in terms of respiration?

* **Answers will vary from student to student.**

1. A) Based upon what has been discussed in class, why will a fit person feel less tired than a person with lower fitness after completing the same amount of physical activity?

* **The lung capacity of a fit person will be larger, allowing for greater inhalation and thus greater delivery of oxygen to the tissues.**

B) How does breathing rate and pulse differ between males and females across the entire class?

* **Answers will vary from student to student.**

1. Using the data produced during this lab, prepare a 1-minute dramatic proposal as to why you would be the best candidate to be playing soccer alongside Renaldo. Your options for the proposal may include but are not restricted to (upon approval by the teacher):
2. A 1-minute skit
3. A 1-minute recorded video
4. A 1-page written proposal
5. A 1-page drawing

* **Answers will vary from student to student.**

**Appendix 4**

**Alternative Activity: Clothespins and Muscle Fatigue**

Refer to the Try This Activity on page 81 of Nelson Biology 11 College Preparation ©2003

**Appendix 5**

**Communal Data Table**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Student | Sex (M/F) | Breathing Rate  (Breaths/Minute) | | | Pulse  (Beats per Minute) | | | Time of Muscle Fatigue |
| Before | During | After | Before | During | After |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |