Muscle Lab

Part 1: Muscle Fatigue

Background

Normally, muscles use oxygen through a process known as cellular/aerobic respiration to make energy (or ATP) from

sugar (glucose). This process is very efficient and produces 38 ATPs for each molecule of glucose. Carbon dioxide and water are the results of this reaction.

When muscles undergo rigorous exercise they require more oxygen to make ATP than the blood can supply. At this point the muscle is forced to produce ATP without oxygen. This is known as anaerobic respiration. Anaerobic respiration produces only 2 ATPs for each molecule of glucose. The result of this reaction is lactic acid.

The advantages of anaerobic respiration are that the muscle cell can make ATP without oxygen and it can make ATP very quickly. This a particular advantage when lifting heavy objects. The big disadvantage to anaerobic respiration is that it produces lactic acid which gives muscles a temporary burning sensation. Muscle fatigue (or tiredness) results when the demand for ATP is greater than the rate at which ATP can be produced in the muscle fibers. As a result, ATP levels are too low for muscle fibers to produce their maximum force contraction. Under condition of extreme fatigue, muscles

become incapable of contracting or relaxing. (They stop working)

Today you will experience the use of aerobic respiration and anaerobic respiration by the muscle fibers in your fingers. You will experience the production of lactic acid and the sensation it produces in your muscles. The lab will demonstrate how your body used the resources available to provide you with the energy you need to do work.

Procedure

1. Hold the clothespin straight out and in between the thumb and forefinger of your non-writing hand. The rest of your fingers should be closed like a fist.
2. We will be doing five 60-second trials with a 15 second break between trials.
3. Start squeezing the clothespin as many times as possible within the sixty second interval.
4. Keep a count of the number of times you have closed the clothespin and write the number down in the data table.
5. Repeat this for 5 trials (or until it starts to burn too much. DON’T HURT YOURSELF!)
6. Graph the data that was just collected. Label the x-axis with the trial number, and the y-axis with the number of squeezes.

|  |  |
| --- | --- |
| **Trial** | **# of Squeezes** |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 7 |  |
| 8 |  |
| 9 |  |
| 10 |  |

Conclusions

* Did the results turn out the way you would have expected given what you know about muscle fatigue?
* How does the data and graph help support the discussion about aerobic versus anaerobic respiration that

 we had at the beginning of the lab?

* What have you learned from this lab?
* What is something else concerning muscle fatigue that you would be interested in finding out the answer to?

# Part 2: Muscle Sounds

Some muscle, such as the masseter (cheek) and the biceps bronchii, emit detectable sounds on contraction. These sounds can be heard in a perfectly quiet area (step just outside the room) when a stethoscope is placed over the area of the muscle. The stethoscope can be placed over the side of the face at about the region of the third molar (last tooth). You may also use the biceps of the anterior portion of the upper arm. Place the stethoscope on your upper arm where the muscle forms a bulge as you flex your arm. Each student should attempt this observation, taking note of the frequency of the sounds and whether or not the quality of the sound changes as these muscles are intensely contracted.

* 15) Describe what it sounds like to you.
* 16) Did you notice any difference in the sounds made by the cheek muscle as compared to the biceps?
* 17) Explain why sounds are made when muscles contract.

# Part 3: Just Plain Cool!

Stand in the doorjamb and stand straight. Raise your arms (palms in) until the backs of your hands hit each side of the doorjamb. Push (isometrically) with both arms as firmly as you can for 1 minute. Immediately after the time has elapsed, step into the classroom and consciously relax your arms. THIS EXPERIMENT WILL NOT WORK IF YOU CONSCIOUSLY OVERRIDE THE EFFECTS OF THE ARM AT COMPLETE REST!

* 18) What happened when you stepped into the room and relaxed?
* 19) Explain why this type of reaction occurred? What caused it?

# Part 4: Effect of Temperature on Muscle Action

Count the number of times you can make a fist in 20 seconds. Start with your hand completely outstretched and make a tight fist each time. Do it as rapidly as you can. Make a data table below to record your results.

Now submerge your hand in a bucket of ice water and leave it there for one full minute.

Remove your hand and immediately count how many forceful fists you can make in 20 seconds.

* 20) What conclusions can you draw?

## Part 5: The Chair Trick

1. Stand with your toes touching a wall.
2. Placing one foot behind the other, take two steps back.
3. Have a partner place a chair between you and the wall.
4. Bend at the waist and place the top of your head against the wall.
5. Lift the chair.
6. Now stand up.
* So, could you do it?
* Did you find any trends in who could and couldn’t do it?
* If you did find any trends, please explain what you think is going on.