Brisa Herrera

Laboratory 9 – Muscle Physiology

October 9, 2023

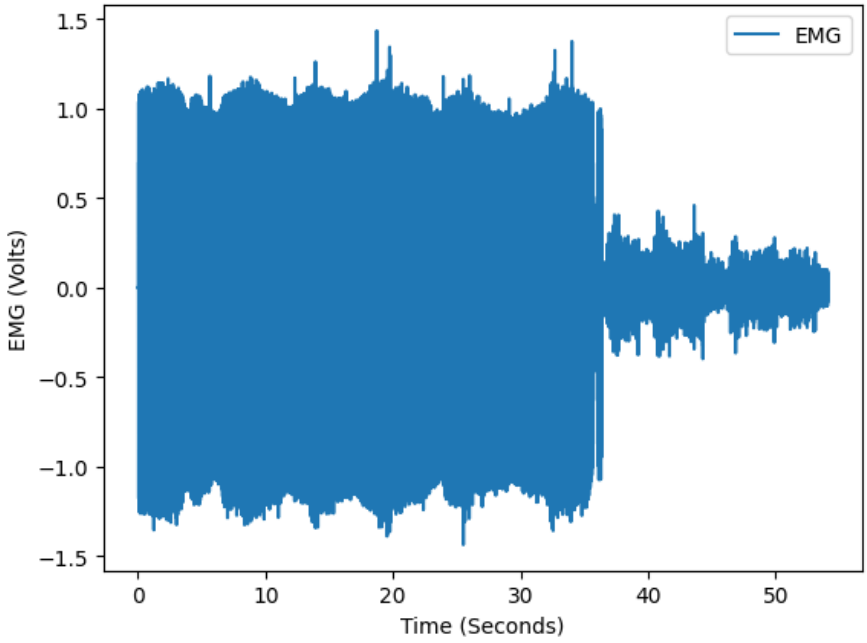
Purpose – Myology, the study of muscle, investigates the performance of skeletal, cardiac, and smooth muscle. Although all muscle cells are similar in their abilities to depolarize and contract, they differ in their degree of innervation, rate and duration of contraction, fatigue rate, and response to neurotransmitters. Each skeletal muscle fiber contacts a nerve fiber at a neuromuscular junction known as a motor end plate. This unit chemically transmits the action potential of the neuron to the muscle cell membrane (sarcolemma). Skeletal muscle cells exert rapid contractions of short duration and are subject to early fatigue. Smooth muscle consists of tightly packed small cells that conduct depolarization waves over their membranes. Once stimulated, by either nervous impulse or stretching, smooth muscle cells exert slow, sustained contractions that are very slow to fatigue. The purpose of laboratory 9, muscle physiology is several experimental procedures that will be used to investigate the different contraction characteristics of skeletal, cardiac, and smooth muscle. The effects of the neurotransmitters, acetylcholine, and norepinephrine, on the rates of contraction of cardiac and smooth muscle will be examined. A procedure for recording an electromyogram (EMG) and the effect of oxygen availability to skeletal muscles will also be demonstrated.

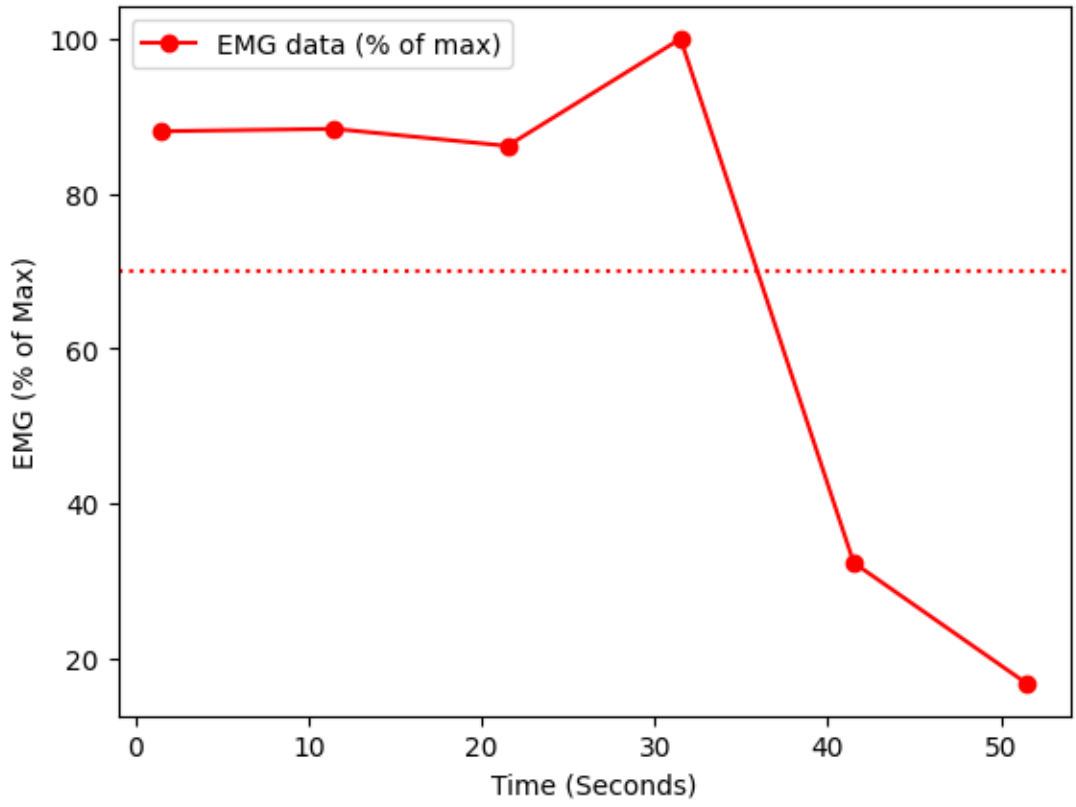
Procedures – For laboratory 9, Muscle Physiology we were able to identify the phases of a typical skeletal muscle twitch, the waveforms of the skeletal muscle exercises, explain the effects of neurotransmitters and other substances on cardiac muscle, and the effects of acetylcholine and norepinephrine on smooth muscle, distinguish the EMG of a partially contracted muscle from a fully contracted muscle, Understand the differences in EMG's of isotonic versus isometric contractions, Understand the role of oxygen supply in muscle contraction. This exercise will demonstrate the concepts of agonist, antagonist, and synergist muscles. An agonist, or prime mover, is the muscle primarily responsible for a given movement. An antagonist muscle will work in opposition to the agonist. A synergist will aid the agonist and help refine a given movement for experiment 9-D- Demonstration of the electromyography (EMG), we started off by making sure the IWX/214 unit is plugged in, and that the IWX/214 unit is connected to the laptop by USB cable. Be sure that theC-AAMI-504 EEG cable is inserted into the isolated inputs of Channels 1 and 2 of the IWX/214. Be sure that the color-coded lead wires are correctly inserted in the lead pedestal of the C-AAMI-504 EEG cable. Insert the connectors on the electrode lead wires into the color-coded matching sockets on the lead pedestal of the ECG cable. Once everything is connected, FIRST turn on the laptop and allow it to fully boot up before you turn on the IWX/214 unit. Once the Iworx unit is on, the red indicator light on the Iworx unit should light up and you may hear the USB chime from the laptop if the laptop does not default to mute (many are set to default to mute). Open theLabscribe3program by clicking on theLabscribe3iconon the desktop. As soon as the program opens, you should see a window pop-up that says "Hardware foundIWX214:2008-1-24," click "OK. Then, In the second from the top row (the row that says "File Edit View Tools Settings Advanced External Devices Help"), click on the "Settings" tab. About halfway down the drop-down window should be a tab called

"Human Muscle." Click on that tab and that should lead you to another drop-down list with the second tab from the top called "Antagonistic Muscle," click on that tab and close the pdf file that appears, you don't need it. Instruct the subject to remove all jewelry from his/her arm and wrist. Use an alcohol swab to clean the regions of skin on forearm you are going to use (Fig. 9-1.). Let the reader. Remove a disposable electrode from its plastic shield and apply the electrode to the six locations. Place the electrodes from proximal to distal on the forearm in the following order: +2,-2on the posterior and +1,-1 and ground on the anterior.(Fig.9-1.)Snap the lead wires to the electrodes as follows, thered"+1" lead is attached to the proximal electrode on the anterior surface, theblack"-1" lead is attached to the distal electrode on the anterior forearm, the green "C" lead (the ground) is attached to the remaining electrode on the anterior surface, the white "+2"lead is attached to the proximal electrode on the posterior forearm, the brown "-2"lead is attached to the distal electrode on the posterior surface. Record an EMG of the muscles of the forearm illustrating agonistic and antagonistic muscle activity for each of the exercises described below. Type the student's name and the appropriate letter for the activity in the mark box to the right of the mark button. Click the red "Rec" button to begin the recording; then, press the Enter key on the keyboard to mark the beginning of each the activity. If you do not see anything, try clicking on the Auto Scale tab and/or checking the electrode contacts. Repeat these procedures for each of the remaining activities. Once everything is connected and in place you start by gently flexing the wrist with the palm open and hold for four seconds. Return the wrist to a neutral position. Extend the wrist, again with the palm open, and hold for four seconds. Repeat several times. Then, forcefully flex the wrist with the hand closed into a fist, hold for four seconds. Return to a neutral position. Extend the wrist maintaining the fist and hold for four seconds. Repeat several times. Attempt to flex the wrist against resistance applied by another student for 10seconds. Place the hand in mid-supination and make a fist. Attempt to move the hand upwards against resistance applied by another student. Hold for 10 seconds. Then once you have all your data evaluate the amplitude and frequency of the EMG recordings. Identify the agonists, antagonists, and synergists, if applicable, for each activity. For experiment 9-E, the effect of oxygen supply on skeletal muscle activity, we did the same thing just different movements. Firmly squeeze a tennis ball as rapidly as possible with your non-dominant hand until you feel fatigued and can no longer squeeze it. Record the duration of this effort. Repeat the squeezing exercise with your dominant arm. Record the time duration of this effort. (NOTE: it is important to stop at the same sensation of fatigue, or "burn," as the non-dominant arm.) Evaluate the differences between the two duration measurements obtained in terms of energy demands of skeletal muscle and fatigue. After we have all our data, we make our graphs.

Results –

9-D: Demonstration of the electromyograph (EMG)



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Time at ~70 % of max: 41.4995 seconds
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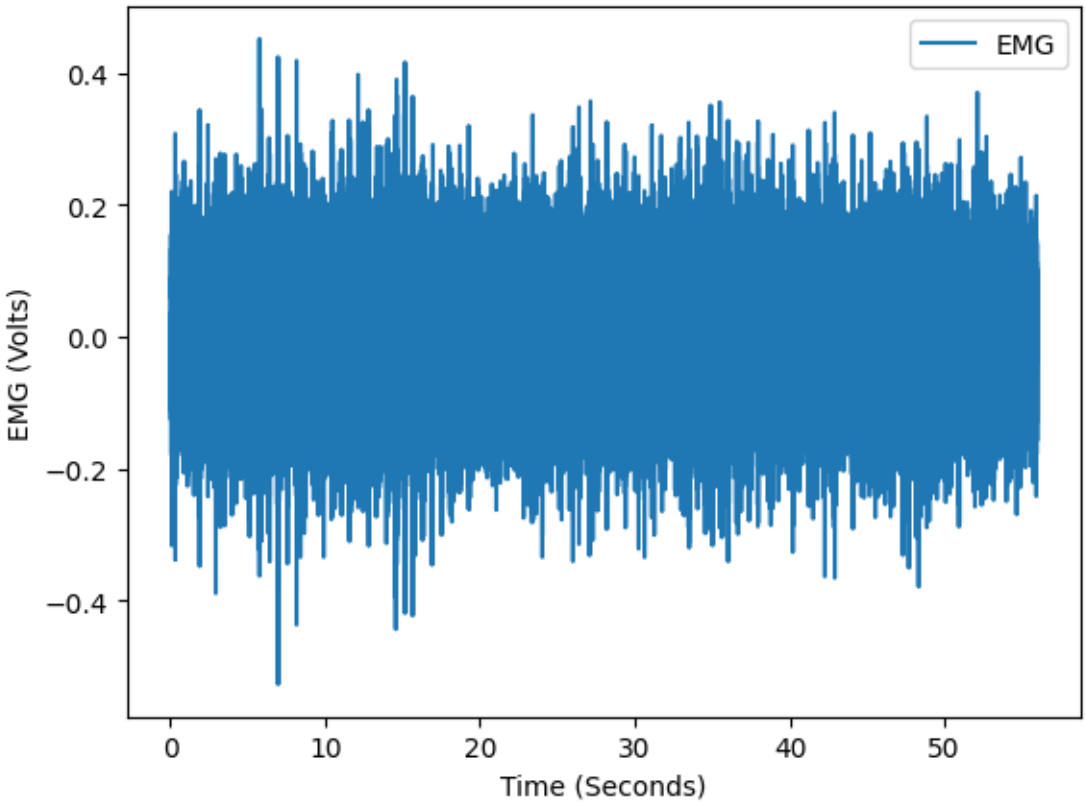
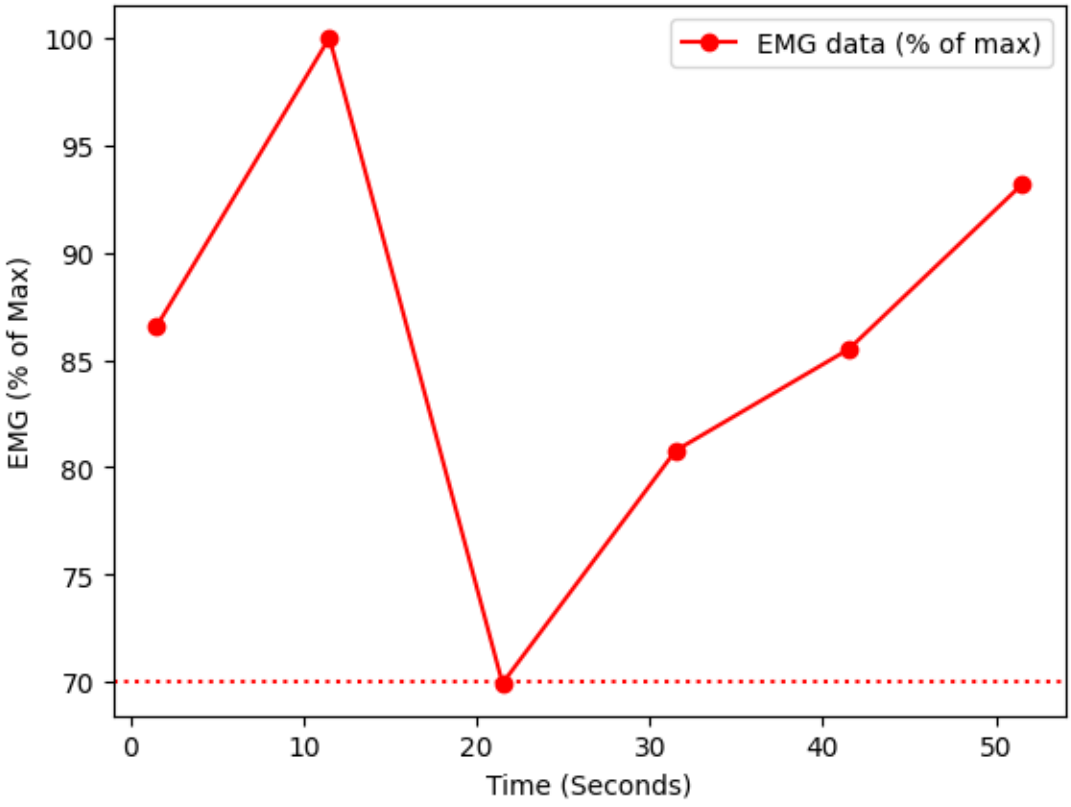
9-E: The effect of oxygen supply on skeletal muscle activity (squeezing ball)


EMG
0.4
0.2
0.0
−0.2
−0.4
EMG (Volts)
0
10
20
30
40
50
Time (Seconds)


EMG data (% of max)
100
95
90
85
80
75
70
EMG (% of Max)
0
10
20
30
40
50
Time (Seconds)

Time at ~70 % of max: 21.4995 seconds

Discussion – Laboratory 9 was a very interesting but a difficult one. Getting everything together and having the Iworx work was hard. It was interesting to see how our muscles work and move, how much we are working our ligaments or how they move. Everyone got different graphs, but it was very interesting to see how everyone's strengths work. Performing this lab was and making the graphs for it was extremely confusing due to all the numbers we got. I personally think simpler graphs on excel would be easier to do. I do enjoy the new apps we are using but sometimes it just confuses me more. The results on these two labs were straight forward because it started off with a very steady motion and then once the movement was going on for a few minutes the graph started constricting. For the second graph it was super consistent, the tension didn't really move, and it was just a straight graph and that one was squeezing the tennis ball. These labs are very interesting, but I wish I was much simpler, and we didn't have to use computers or Iworx. Even though making the graphs and using Iworx is not easy it helps you develop computer skills, and you get to learn about new apps and how to transport files from one app to anpther.

Conclusion – All in all, the purpose of laboratory 9, muscle physiology is several experimental procedures that will be used to investigate the different contraction characteristics of skeletal, cardiac, and smooth muscle. The effects of the neurotransmitters, acetylcholine, and norepinephrine, on the rates of contraction of cardiac and smooth muscle will be examined. A procedure for recording an electromyogram (EMG) and the effect of oxygen availability to skeletal muscles will also be demonstrated. This laboratory that was done was very fun but also hard one. Myology, the study of muscle, investigates the performance of skeletal, cardiac, and smooth muscles. Although all muscle cells are similar in their abilities to depolarize and contract, they differ in their degree of innervation, rate and duration of contraction, fatigue rate, and response to neurotransmitters I really enjoyed doing it and recommend others to do it and see their electromyogram (EMG).