Purpose
In this laboratory, several experimental procedures 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

Procedure
1. Observe the laser disc presentation. Understand the terminology subliminal, liminal and

maximal stimulus.

2. Sketch the changes in the waveforms that result from increased amplitude and frequency of stimulus.

3. Sketch the staircase phenomenon and complete tetanus followed by muscle fatigue. 4. Observe the effects of overloading a muscle.
5. Explain these observations in terms of the phases of a skeletal muscle twitch.

9-B: Cardiac muscle contraction

The thoracic cavity of a Bullfrog is opened and pericardium cut away. A thin thread is tied to the ventricle and attached to the myograph transducer. Ringer's solution is periodically applied to the heart.

Procedure
1. Observe the laser disc presentation.

2. Understand the experimental setup

3. Observe the changes in heart rate after the application of the following substances: a. Acetylcholine
b. Epinephrine
c. Nicotine in Ringer's solution

d. Caffeine
4. Explain the results.

9-C: Smooth muscle contraction (Optional)

A distal segment of ileum is detached from pithed Bullfrog, Rana catesbeiana. After trimming, it is attached to thin threads that are then attached to the myograph transducer. Locke's solution is periodically applied to the ileum.

Procedure

1. Obtain a baseline trace of the smooth muscle at rest.

2. Observe and note the effects on the chart recording of injection of these neurotransmitters:
a. Acetylcholine
b. Norepinephrine

3. Diagram the typical smooth muscle contraction.

4. Summarize the effects of acetylcholine and norepinephrine on smooth muscle contraction.

9-D: Demonstration of the electromyograph (EMG)

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.

NOTE: You will need to arrange yourselves in groups to be able to obtain a copy of EMG recordings from the laptop computer running the Iworx program.

Procedure

1. To get things started:
    - Before you turn anything on, be 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 the C-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).
2. Open the Labscribe3 program by clicking on the Labscribe3 icon on the desktop. As soon as the program opens, you should see a window pop-up that says "Hardware found IWX214:2008-1-24," click "OK."
3. 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 "AntagonisticMuscle," click on that tab and the close the pdf file that appears, you don't need it.

4. Instruct the subject to remove all jewelry from his/her arm and wrist. Use an alcohol swab to clean the regions of skin on the forearm you are going to use (Fig. 9-1.). Let the area dry. Remove a disposable electrode from its plastic shield, and apply the electrode to the six locations
5. 5. Place the electrodes from proximal to distal on the forearm in the following order: +2, -2 on the posterior and +1, -1 and ground on the anterior. (Fig. 9-1.) Snap the lead wires onto the electrodes as follows:
   the red "+1" lead is attached to the proximal electrode on the anterior surface.
   the black "-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.
   6. 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 (A, B, C, D – see below) 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. The recording for exercise "A" should look like Fig. 9-3. If you do not see anything, try clicking on the AutoScale tab and/or checking the electrode contacts. Repeat these procedures for each of the remaining activities.

A. Gently flex 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.

B. 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.

C. Attempt to flex the wrist against resistance applied by another student for 10 seconds.

D. 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.

7. Evaluate the amplitude and frequency of the EMG recordings. Identify the agonists, antagonists and synergists, if applicable, for each activity. For example, what muscles were the agonists during wrist flexion - anterior or posterior forearm muscles? How did the EMG change for the antagonists when the wrist was more forcefully moved? During which exercise(s) did synergistic muscle activity become apparent?

8. Print a sample of each activity. Before you print, find your highest amplitude waves (probably in activity C or D) and AutoScale. Click on the AutoScale tab at the upper margin of each of the EMG channels. Look for the row that says on the left “A1:EMG Anterior (or Posterior) 3-10KHz,” the AutoScale tab is the second icon after “Hz,” it looks like a magnifying glass with a symbol on it. After you click this for the biggest waves, this is the scale you will print all four activities. To print a section of the recording, click on “File,” select “Print View.” Select “Landscape” for the page set-up. Be sure to select M- 106 as the printer destination.

9-E: The effect of oxygen supply on skeletal muscle activity

Procedure

1. Firmly squeeze a tennis ball as rapidly as possible with your non-dominant hand until

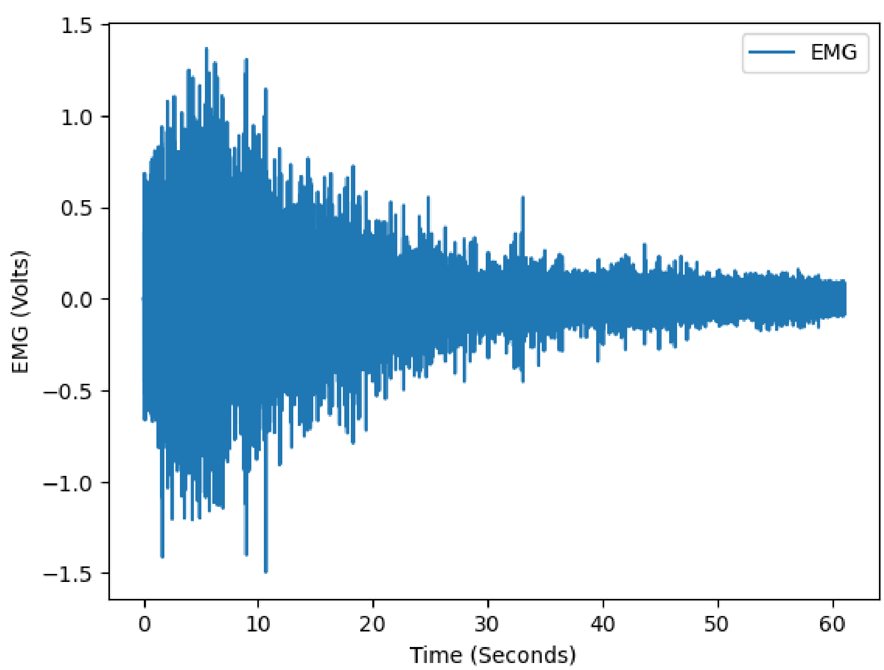
you feel fatigued can no longer squeeze it. Record the duration of this effort.

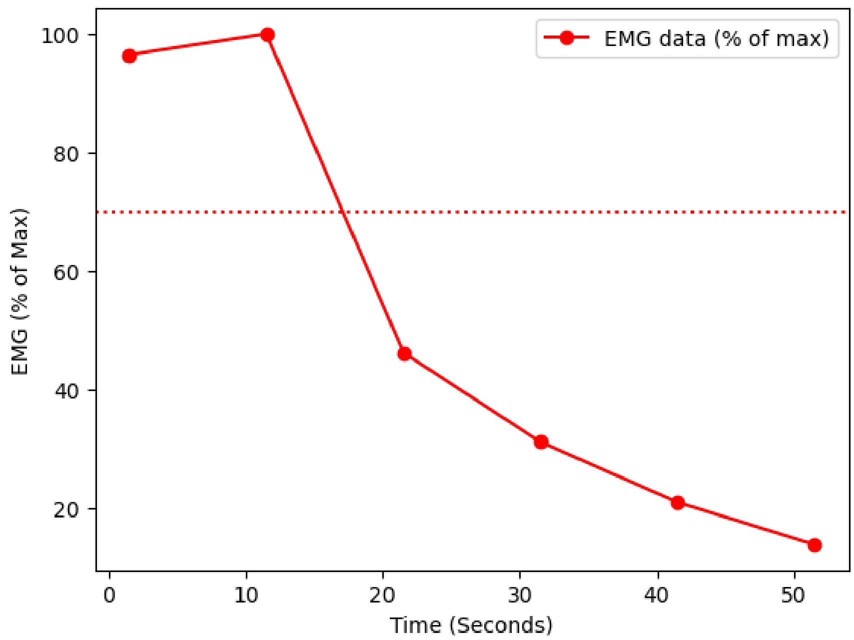
2. Have a partner attach a sphygmomanometer cuff to your dominant arm and inflate it to 150 mmHg, or 10 mmHg above your normal systolic pressure, if you know your blood pressure values.

3. 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.)

4. Evaluate the differences between the two duration measurements obtained in terms of energy demands of skeletal muscle and fatigue.

Results





Discussion

At zero seconds the maximum strength is at 96% after 51 seconds fatigue is recorded at 13%.

Conclusion

At the beginning of recording, strength is strong and after the period of tensing hold the ball- fatigue is apparent.