

LABORATORY REPORT

Activity: Twitch Contractions and Summation

Name: Student

Instructor: Instructor

Date: 01.08.2017

Predictions

Effect of Muscle Fiber Length on Contraction

1. As muscle fiber length increases

contraction force increases, becoming maximum at an optimal length, then decreasing at longer lengths

Effect of Stimulation Frequency on Contraction

2. As the frequency of stimulation increases, the force of contraction:

increases

Materials and Methods

Measurement of Threshold Stimulus

1. Dependent Variable

contraction force

2. Independent Variable

stimulation voltage

3. Controlled Variables

temperature, frequency of stimulation, muscle fiber length

Effect of Muscle Length on Contraction

1. Dependent Variable

contraction force

2. Independent Variable

muscle fiber length

3. Controlled Variables

temperature, stimulation voltage, frequency of stimulation

Effect of Stimulation Frequency on Contraction

1. Dependent Variable

contraction force

2. Independent Variable

frequency of stimulation

3. Controlled Variables

temperature, stimulation voltage

4. What structure was stimulated to cause a muscle contraction?

Motor neuron axons in sciatic nerve were stimulated.

5. Explain why the temperature of the water bath was 35 C (95 F).

This is the mouse's body temperature.

6. At a stimulation frequency of 15 Hz how many stimuli were there per second?

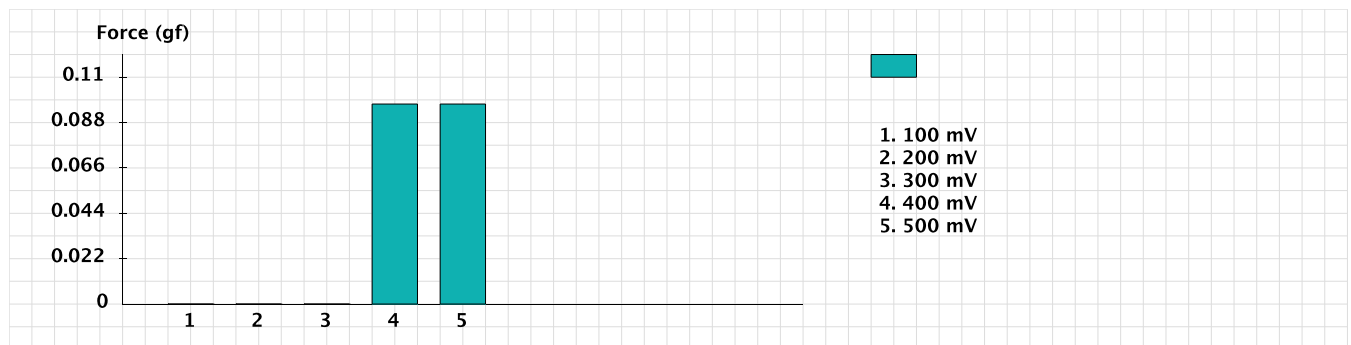
At a stimulation of 15 Hz there are 15 stimuli per second.

Results

Table 4: Measurement of Threshold Stimulus

	Voltage (mV)				
	100 mV	200 mV	300 mV	400 mV	500 mV
Maximum Force (gf) (Motor unit 1)	0	0	0	0.097	0.097

Effect of Stimulation Value on Twitch Contraction Force



1. What is the threshold stimulus?

400 mV

2. What is the maximum force generated at the threshold stimulus?

0.097 gf

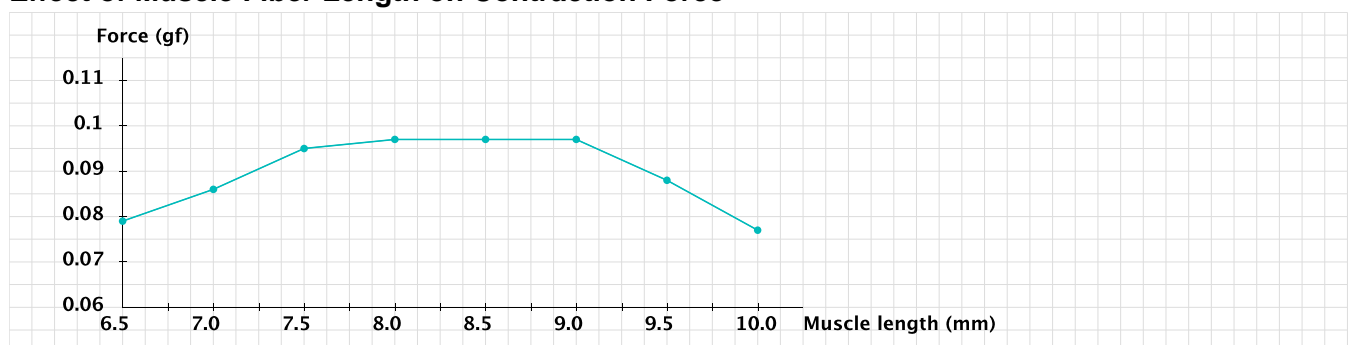
3. How does increasing voltage above threshold stimulus affect force development?

Increasing stimulation voltage above threshold does not increase (or decrease) the amount of force developed.

Table 5: Muscle Length and Contraction Force

Maximum Force (gf) (Motor unit 1)	Muscle length (mm)								
	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10	10.5
Trial 1	0.079	0.086	0.095	0.097	0.097	0.097	0.088	0.077	0.071
Trial 2	0.080	0.086	0.095	0.097	0.097	0.097	0.088	0.078	0.071
Trial 3	0.079	0.086	0.095	0.097	0.097	0.097	0.088	0.077	0.071
Averages	0.079	0.086	0.095	0.097	0.097	0.097	0.088	0.077	0.071

Effect of Muscle Fiber Length on Contraction Force



4. What was the average force of contraction at a muscle length of 7.0 mm?

0.086 gf

5. What was the optimal muscle length (muscle length that generated the maximum force)?

8.0 to 9.0 mm

6. What was the maximum force generated at optimal length?

0.097 gf

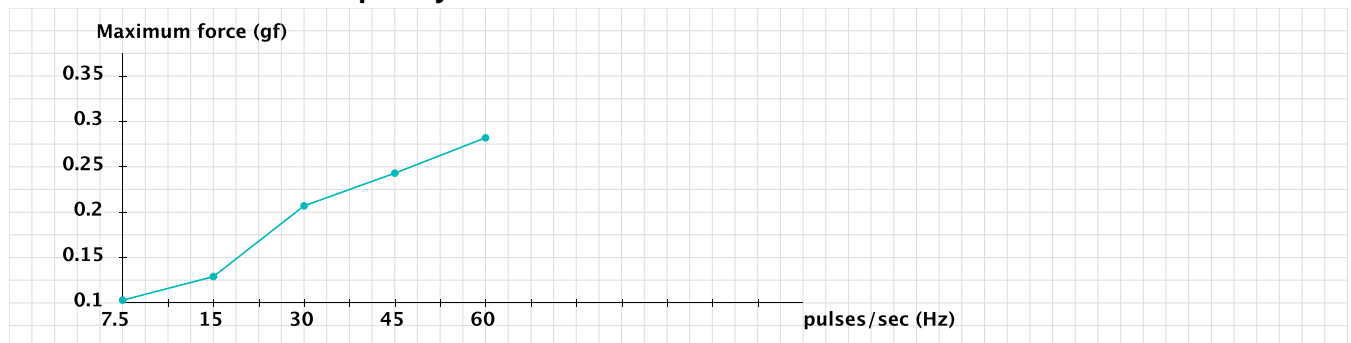
7. How does increasing muscle fiber length affect force of muscle contraction?

Force increases until muscle length reaches 8.0 mm. Maximum contractile force occurs when muscle length is between 8.0 and 9.0 mm. Force of contraction decreases for muscle lengths above 9.0 mm.

Table 6: Stimulation Frequency and Contraction Force

	Stimuli per second				
	7.5	15	30	45	60
Maximum Force (gf) (Motor unit 1)	0.103	0.129	0.207	0.243	0.282

Effect of Stimulation Frequency on Contraction Force



8. What was the force of contraction at a stimulation frequency of 22.5?

Approximately 0.18 gf

9. At what frequency of stimulation was the maximum force generated?

60 Hz

10. What was the maximum force generated in this experiment?

0.282 gf

11. How does increasing stimulation frequency affect force production?

Increasing frequency of stimulation increases force produced. Force begins to plateau at 45 Hz.

Discussion

1. Explain why muscle contraction does not occur below threshold stimulus.

Threshold stimulus depolarizes membrane potential to threshold and results in generation of an action potential along the sarcolemma. Below threshold stimulus, the membrane potential is not depolarized to threshold, no AP is generated and the muscle does not develop force.

2. When stimulation voltage was increased above threshold, did the force of contraction increase, decrease, or stay the same? Explain why this occurred.

When stimulation voltage was increased above threshold the force of contraction stayed the same. The AP is all or none therefore increasing stimulus voltage above threshold does not affect the amplitude of the AP and amount of force developed does not change.

3. Explain why force of contraction changes with muscle fiber length.

At optimum length there is optimum overlap of thin and thick filaments allowing more cross-bridges to form. The amount of force developed is determined by the number of crossbridges formed so the more cross-bridges formed, the more force developed. When muscle fibers are stretched beyond optimal length there is less overlap of thin and thick filaments and less crossbridges are formed. At less than optimal length, thick filaments crumble against Z disc and less cross-bridges are formed.

4. Compare the maximum force generated when stimulation frequency was increased with the maximum force generated at threshold stimulus. In your opinion, which experiment resulted in the highest level of intracellular calcium?

Maximum forces increases with increasing stimulation frequency until a plateau is reached. The amount of calcium would be greatest in the experiment "The Effect of Stimulation Frequency on Contraction"

5. Explain why differences in intracellular calcium levels result in differences in force production.

Increasing frequency of stimulation increases amount of intracellular calcium in muscle fibers. Because intracellular calcium removes blockade of myosin binding sites on actin, increasing intracellular calcium exposes more myosin binding sites on actin which enables more cross-bridges to form. Force development is dependent on number of crossbridges formed.

6. In the experiment Effect of Stimulation Frequency on Contractile Force, why was muscle fiber length set to optimal length?

In order to compare the effect of stimulation frequency on maximal force development, the muscle must be at optimal length for force development.

7. Restate your predictions that were correct and give data from your experiment that support them. Restate your predictions that were not correct and correct them with supporting data from your experiment.

The answer to this question is dependent on the students initial predictions. The following are correct predictions: 1. As muscle fiber length increases, contraction force increases becoming maximum at an optimal length, then decreasing at longer lengths. 2. As the frequency of stimulation increases, the force of contraction increases.

Application

1. Botulinum toxin is taken up by axon terminals and inhibits the ability of a motor neuron to stimulate a skeletal muscle motor unit to contract by preventing the release of acetylcholine from the axon terminal. Explain how this prevents skeletal muscle contraction.

If acetylcholine is not released, an action potential will not be generated along the sarcolemma. The action potential traveling down the t-tubules results in release of calcium from sarcoplasmic reticulum. Calcium couples excitation to contraction.

2. Explain why injecting Botox (derived from botulinum toxin) into a superficial facial muscle reduces the appearance of deep facial wrinkles called muscle lines. Hint: Superficial facial muscles are attached at one end to skin.

Contraction of the superficial facial muscles pulls on skin. As we age, sun damage (which decreases skin elasticity) and contraction of the superficial muscles results in wrinkles. By blocking contraction of superficial muscles, these muscles do not pull on the skin and the wrinkles relax.