

Contraction of Motor Units

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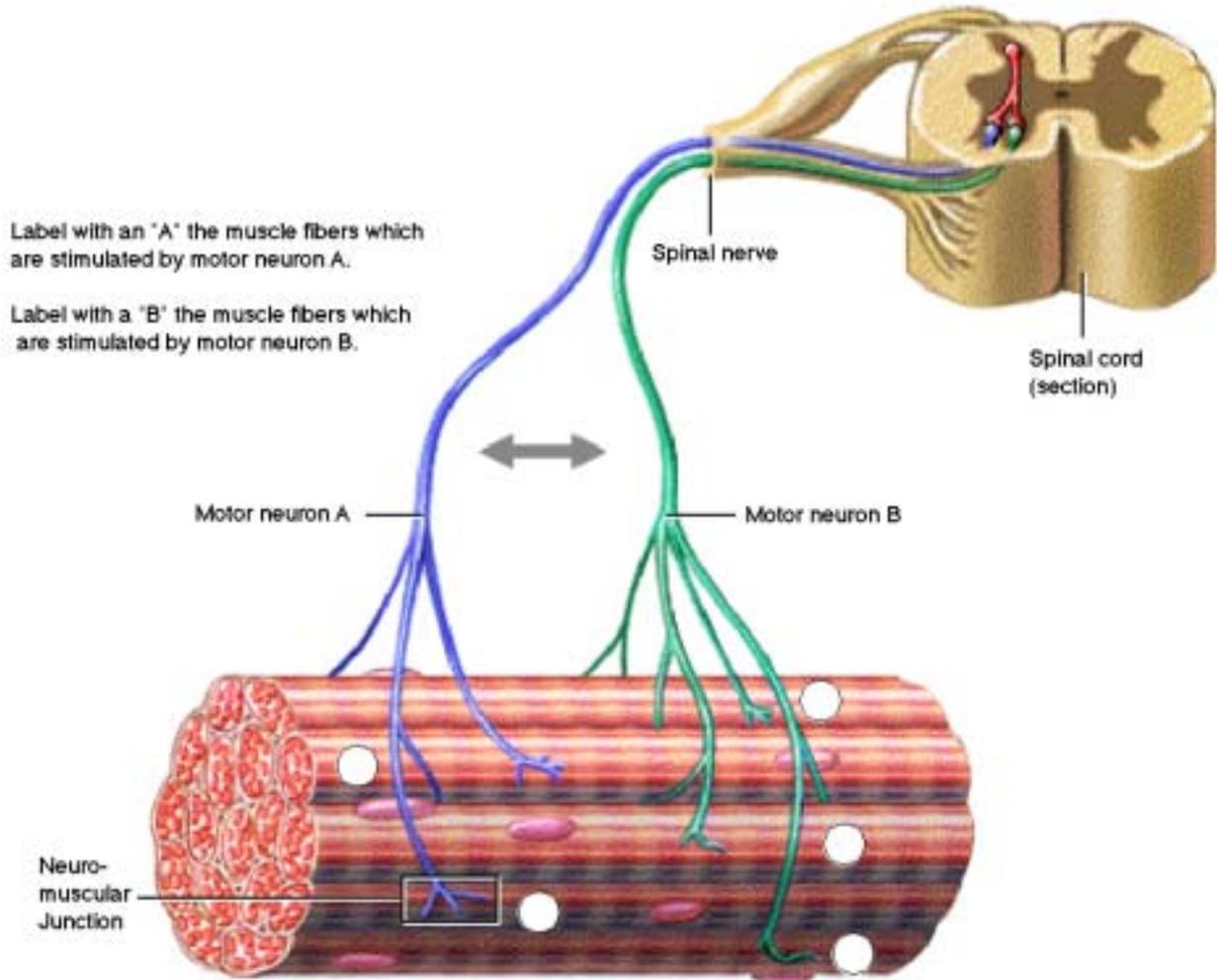
Page 1. Introduction

- A motor unit is a motor neuron and all of the muscle cells (muscle fibers) it stimulates. The strength of a muscle contraction is determined by the size and number of motor units being stimulated.

Page 2. Goals

- To examine the components of a motor unit.
- To understand the relationship between motor unit size and precision of muscle movement.
- To explore the relationship of motor units to muscle tone.

Page 3. The Motor Unit



- A motor unit is a motor neuron and all of the muscle cells (muscle fibers) it stimulates. When one neuron fires, all of the muscle cells which are stimulated by that one neuron will contract.
- On this diagram each of the two motor neurons shown have only a few junctions with the muscle cells, however the actual number can vary from four to several hundred muscle cells per motor neuron. The average number of muscle cells in a motor unit is 150.

** Note the following important points:

- When the nerve impulse gets down to the branches, it separates and goes down each branch.
- Only the muscle cells that have neuromuscular junctions with one of the branches of that particular neuron will contract.
- Motor neuron A stimulates fewer muscle cells than motor neuron B. When you clicked on motor unit A, the force of contraction was less than with motor unit B as evidenced by the height the red weight moved toward the bell.
- Notice that motor neuron A & B do not stimulate muscle cells in just one location within the muscle. The muscle cells stimulated are spread out. This causes an even muscle contraction.

** Now is a good time to go to quiz question 1:

- Click the **Quiz** button on the left side of the screen.

- After answering question 1, click the Back to Topic button on the left side of the screen.
- To get back to where you left off, click on the scrolling page list at the top of the screen and choose "4. Recruitment".

Page 4. Recruitment

- Recruitment occurs when a strong contraction is needed and additional motor units are stimulated.
- ** Note the following important points:
 - When you click on motor unit A, which is a small motor unit, the weight travels about one-third of the way to the bell. When you click on motor unit B, which is a larger motor unit, the weight travels about two-thirds of the way to the bell. By stimulating both motor units to contract at once (recruitment), enough energy is provided to have the weight hit the bell.

Page 5. Question on Motor Unit Size

- Motor units which contain only a few muscle cells allow for precise muscle movements.

Page 6. Small Motor Units

- Variables affecting the strength and degree of muscle movement:
 1. number of motor units firing
 2. the number of muscle cells per motor unit
- Precise movements are created by small motor units.

Page 7. Large Motor Units

- Gross movements are created by large motor units.

** Now is a good time to go to quiz questions 2-4:

- Click the Quiz button on the left side of the screen
- Click on the scrolling page list at the top of the screen and choose "2. Precise Movements".
- Work through questions 2,3, & 4.
- After answering question 4, click the Back to Topic button on the left side of the screen.
- To get back to where you left off, click on the scrolling page list at the top of the screen and choose "8. Muscle Tone".

Page 8. Muscle Tone

- Muscle tone is due to random, asynchronous motor unit contractions.
- ** The narration states that muscle tone is due to minute contractions which are maintained by activities of the spinal cord. Note that many muscles of the face and some muscles of the neck are controlled by cranial nerves, as opposed to spinal nerves. In this case, the impulses would come from the brain, not the spinal cord.

Page 9. Muscle Tone Demo

- Cutting a motor nerve results in the loss of muscle tone.

Page 10. Summary

- A motor unit is composed of a single motor neuron and all of the muscle cells it stimulates.
- The number of muscle cells within a motor unit determines the degree of movement when that motor unit is stimulated. Motor units vary in size. Small motor units are used for precise, small movements; large motor units are used for gross movements.
- Muscle tone is maintained by asynchronous stimulation of random motor units.

Notes on Quiz Questions:

Quiz Question #1: Components of a Motor Unit

- This question allows you to identify the parts of a motor unit.

Quiz Question #2: Precise Movements

- This question gives you to practical experience in distinguishing between the actions of small and large motor units.

Quiz Question #3: Gross Movements

- This question gives you to practical experience in distinguishing between the actions of small and large motor units.

Quiz Question #4: Motor Units in Basketball

- In order for this basketball player to make the basket, he must jump up to avoid interference from the opponent. This involves using the leg muscles. The number of motor units required for such a jump would be large since quite a bit of muscular activity must be expended to overcome the force of gravity.
- The basketball player's arms are responsible for throwing the ball. If too few motor units are used, the player will fall short of the basket. If too many motor units are recruited, the basket will go too far to make the basket.

Study Questions on: Contraction of Motor Units

1. (Page 1.) What are the groups of muscle cells called, within a muscle, that are innervated by one motor neuron and contracted together and stimulated by that motor neuron?
2. (Page 1.) What important factors determine the strength of contraction of a muscle?
3. (Page 3.) What is a motor unit composed of?
4. (Page 3.) What is the junction between the branch of an neuron and a muscle cell called?
5. (Page 3.) When a motor neuron fires, how many muscle cells are stimulated?
6. (Page 4.) What is the relationship between the strength of the muscle contraction and the number of motor units which are stimulated?
7. (Page 4.) What is recruitment?
8. (Page 5.) What is the general function of motor units that contain only a few muscle cells?
9. (Page 6.) What two factors effect the strength and degree of muscle movement?
10. (Page 7.) Describe the motor units in large muscles which exhibit gross movements.
11. (Page 7.) Tell if the following muscles would have small or large motor units:
 - a. muscles of the fingers
 - b. biceps brachii muscle
 - c. gastrocnemius muscle
 - d. muscles of the throat involved in speech
12. (Page 7.) Muscle A contains 12,000 muscle cells and 30 motor neurons which innervate these cells. Muscle B contains 2,000 muscle cells and 400 motor neurons which innervate these cells.
 - a. On average, how many muscle cells are there in each motor unit for both of these muscles.
 - b. Which of these muscles would you expect to contract with precise control?
13. (Page 8.) What is muscle tone?
14. (Page 8.) What causes muscle tone?
15. (Page 9.) What happens to a muscle if all the motor neurons to that muscle are cut?