



# Human Body Systems

## Virtual Learning

# 9-12th PLTW<sup>®</sup> HBS

PLTW<sup>®</sup> 4.4.2 Mind Over Muscle

April 28, 2020



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9-12th PLTW<sup>®</sup> HBS

Lesson: April 28, 2020

## Objective/Learning Target:

Students will be able to describe how to use a hand dynamometer and EKG to measure the maximum grip strength and relate this value to the electrical activity of a muscle to observe what happens when muscles begin to fatigue. (*Reference: PLTW<sup>®</sup> 4.4.2 Mind Over Muscle*)



# Let's Get Started/Warm Up Activities:

Before we start our lesson today, watch the following videos:

- [Bill Nye: Why Does Exercise Make You Tired?](#)
- [SciShow: Does Lactic Acid Really Cause Muscle Pain?](#)



# Lesson/Activity:

Watch this video:

[Muscle Fatigue: Why do Muscles get Tired & Weak After Exercise?](#)

## Activity #1:

Watch the entire video above before answering the questions below on a piece of a paper or in your notebook. Feel free to use other website resources for help as well.

1. What causes muscle fatigue, muscle tiredness and muscle weakness after a work out?
2. Why do our muscles get fatigued, tired, weak, sore, burn and hurt after exercise?
3. What causes our muscles to fatigue to the point where there is a physiological inability to contract, and why does it take time to recover from muscle fatigue?



# Lesson/Activity continued:

Watch this video:

[Hand Dynamometer: Tech Tips with Vernier](#)

**Activity #2:**

On your piece of paper or notebook, answer the following:

1. What is a dynamometer and what does it measure?
2. How do you use a hand dynamometer?



# Lesson/Activity continued:

Watch this video:

[Vernier Tech Tips: EMG and Muscle Activity](#)

**Activity #3:**

On your piece of paper or notebook, answer the following. Feel free to use other internet resources for help.

1. What does an EMG measure?
2. How does an EKG measure?
3. We can use use an EKG as an EMG in experiments. How is this possible?
4. Describe how to use a Vernier EKG as an EMG.

# Lesson/Activity Answers:

## Activity #1 Answers:

1. What causes muscle fatigue, muscle tiredness and muscle weakness after a work out?
  - a. There are several causes of muscle fatigue and weakness. One reason is the conversion of glucose to lactic acid which is called anaerobic glycolysis, or anaerobic glucose breakdown. During this process, lactate (not lactic acid) and hydrogen ions build up in muscle tissue causing the pH to lower or become more acidic. Note: Lactate is NOT an acid. The pH is being lowered in your body from the process of glycolysis and not lactate. Click [HERE](#) to see more information.
2. Why do our muscles get fatigued, tired, weak, sore, burn and hurt after exercise?
  - a. When your body is working at its greatest capacity, your muscles are not able to get enough oxygen to convert food to energy. Anaerobic glycolysis occurs causing your overall pH to lower and become acidic.
3. What causes our muscles to fatigue to the point where there is a physiological inability to contract, and why does it take time to recover from muscle fatigue?
  - a. Three hypotheses: 1) Muscles begin to use up ATP, especially during intense workouts; 2) Build up of waste products like phosphates and lactate which limits the amount of calcium that is needed for muscle contraction; 3) Disturbance of excitation contraction coupling: disturbance of the nerve at the junction of where the nerve and muscle meet which stops the muscle from contracting from a K<sup>+</sup> and Na<sup>+</sup> ion imbalance. It take time for this ion imbalance to improve.

# Lesson/Activity Answers:

## Activity #2 Answers:

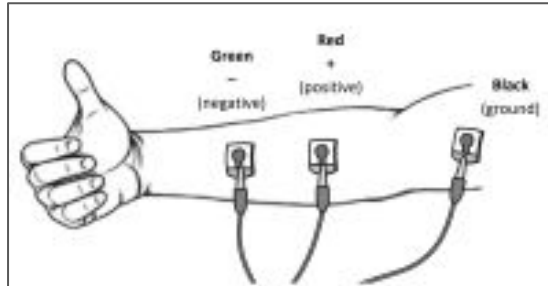
1. What is a dynamometer and what does it measure?
  - a. Handgrip Dynamometers are instruments for measuring the maximum isometric strength of the hand and forearm muscles, used for testing handgrip strength of athletes involved in strength training, or participants in sports in which the hands are used for catching, throwing or lifting such as gymnasts, tennis players and rock climbers, and for tracking improvements with strength training and during rehabilitation.
2. How do you use a hand dynamometer?
  - a. The patient holds the dynamometer in the hand being tested, with the arm at right angles with the elbow by the side of the body. Adjust the handle of the dynamometer as necessary, making sure that the base rests on the first metacarpal (heel of the palm), while the handle rests on the middle of the four fingers. The patient then squeezes the hand dynamometer with maximum isometric effort for at least 5 seconds. The patient is required to not move any other part of the body and is encouraged to use maximum effort.



# Lesson/Activity Answers:

## Activity #3 Answers:

1. What does an EMG measure?
  - a. Electromyography (EMG) measures muscle response or electrical activity in response to a nerve's stimulation of the muscle. The test is used to help detect neuromuscular abnormalities.
2. How does an EKG measure?
  - a. An electrocardiogram – abbreviated as EKG or ECG – is a test that measures the electrical activity of the heartbeat. With each beat, an electrical impulse (or “wave”) travels through the heart.
3. We can use an EKG as an EMG in experiments. How is this possible?
  - a. Both devices measure electrical signals.
4. Describe how to use a Vernier EKG as an EMG.
  - a. To conduct EMGs, the red and green leads need to be placed on electrodes that are attached to the muscle of interest. The two leads are interchangeable for EMGs. Click [HERE](#) to see specific instructions.





## Practice:

Watch video: [Vernier Tech Tips: Using a Hand Dynamometer for Grip Strength Comparison](#)

Practice: Now that you know how to use a Vernier hand dynamometer and a Vernier EKG/EMG, develop an experiment to measure the electrical activity of a muscle during a hand exercise. You may choose your hand exercise and where you place the EMG electrodes. Make sure to include a step-by-step procedure describing your procedure. Use the video above for guidance in developing your procedure.



# Practice Answers:

## Practice answers:

Question: Now that you know how to use a Vernier hand dynamometer and a Vernier EKG/EMG, develop an experiment to measure the electrical activity of a muscle during a hand exercise. You may choose your hand exercise and where you place the EMG electrodes. Make sure to include a step-by-step procedure describing your procedure.

Answer: Answers will vary. Click [HERE](#) to view how to use a Vernier hand dynamometer. Click [HERE](#) to view how to use a Vernier EMG.



# Additional Practice and/or Resources:

Learn More:

## [HBS Unit 4.4.1 & 4.4.2 Flashcards](#)

Test your knowledge by clicking on the link above.

## [Electromyography \(EMG\)](#)

Check out how a physiatrist, a doctor of physical medicine and rehabilitation, performs an EMG test on a patient.

## [Proper Breathing While Running](#)

Oxygen is important for aerobic respiration. See how the biomechanics of breathing and how your brain play a pivotal role in your overall performance.