Lab Exercise 8
BIOPAC Exercise
Muscle Tissue
Muscles

Textbook Reference: See Chapters 9 & 10

**What you need to be able to do on the exam after completing this lab exercise:**

Be able to answer questions covering the Muscle Physiology Pre-Lab Assignment.

Be able to answer questions covering muscle physiology and the BIOPAC exercise you did in class.

Be able to identify the three types of muscle tissue on microscope slides.

Be able to name the distinguishing features of each type of muscle tissue, including nuclei, striations, and intercalated disks.

Be able to identify the listed muscles on the head/neck model, the muscle man model, the arm models, and the leg models.

Be able to give the listed functions of the muscles.
**Muscle Physiology Pre-Lab Assignment**

Muscle Physiology Pre-Lab Assignment

The Muscle Physiology Pre-Lab Assignment is due this week. The assignment is located on the Virtual Lab to the right of Lab Exam 2.

Please print and use the Interactive Physiology CD that came with your lecture book to answer the questions.

**BIOPAC Exercise**

BIOPAC Exercise

This exercise deals with muscle physiology. You will use a computer program to collect data from the measurements of the electrical activity generated during muscle contractions.

The BIOPAC Instructions are located on the Virtual Lab under Virtual Lab Eight. Please print these instructions and bring to lab.

There is also a BIOPAC Worksheet located on the Virtual Lab under the BIOPAC Instructions. Please print this Worksheet and bring to lab. It is worth **20 points** and is due the following week.

**Be able to answer questions from the Muscle Physiology Pre-Lab Assignment and the BIOPAC Worksheet.**
# Muscle Tissue

There are three types of muscle tissue: **skeletal muscle**, **cardiac muscle**, and **smooth muscle**.

## Skeletal Muscle

**Identification**: Teased or l.s. section shows distinct, very large, straight fibers that are striated (striped) and multinucleate (many nuclei).

**Features to Know**: striations composed of dark A-bands and light I-bands; nuclei pushed to edge of fiber; sarcolemma (plasma membrane surrounding fiber).

**Where Located**: skeletal muscles; under voluntary control.

## Cardiac Muscle

**Identification**: Note faint striations across fibers. Fibers distinct, typically with numerous small gaps between them.

**Features to Know**: nuclei (1), intercalated disk (2).

**Where Located**: involuntary muscle of the heart.
Smooth Muscle

**Identification:** Muscle cells are packed tightly together (no gaps between cells) and usually not distinct. Nuclei (arrow) may or may not be visible. Note lack of striations. Two views are shown. To find smooth muscle look near the outer portions of the organs on the slides.

**Features to Know:** nuclei (if visible) (arrow).

**Where Located:** under involuntary control; found surrounding most hollow organs.

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**Identifying Muscle Tissues under the Microscope**

**Procedure:**

**Skeletal Muscle Tissue**

1. Obtain a **skeletal muscle slide** and bring into focus using the **scanning lens** (4X). Look for long, cylindrical muscle fibers with fine stripes and many nuclei.

2. Focus on the cells, position them to the center of your field of view, and switch to the **low power lens** (10X).

3. Focus on a cell or two and position them to the center of your field of view, and switch to the **high power lens** (40X).

4. Make a drawing of the tissue on high power in the space below. Label the **striations** and **nuclei**.
Cardiac Muscle Tissue

1. Obtain a **cardiac muscle slide** and bring into focus using the **scanning lens** (4X). Look for cells with fine stripes and dark pink **intercalated disks** between them.

2. Focus on the cells, position them to the center of your field of view, and switch to the **low power lens** (10X).

3. Focus on a cell or two and position them to the center of your field of view, and switch to the **high power lens** (40X).

4. Make a drawing of the tissue on high power in the space below. Label the **striations**, **intercalated disks**, and **nuclei**.

Smooth Muscle Tissue

1. Obtain a **smooth muscle slide** and bring into focus using the **scanning lens** (4X). Look for long cells with many nuclei.

2. Focus on the cells, position them to the center of your field of view, and switch to the **low power lens** (10X).

3. Focus on a cell or two and position them to the center of your field of view, and switch to the **high power lens** (40X).

4. Make a drawing of the tissue on high power in the space below. Label the **nuclei**.
**Know the following head and neck muscles on the Head and Neck Model.**
Muscle Man – Anterior Side

**Know the following muscles on the Muscle Man model.

1. Frontalis
2. Orbicularis Oculi
5. Zygomaticus
6. Orbicularis Oris
11. Sternocleidomastoid
14. Trapezius
16. Latissimus Dorsi
17. Gluteus Maximus
18. Deltoid
20. Pectoralis Major
21. External Oblique
22. Rectus Abdominis
24. Triceps Brachii
25. Biceps Brachii
31. Sartorius
32. Rectus Femoris
34. Gracilis
35. Adductor Longus
36. Biceps Femoris
39. Gastrocnemius
43. Tibialis Anterior
45. Fibularis (Peroneus) Longus
48. Vastus Medialis
49. Vastus Lateralis
65. Tensor Fasciae Latae
**Muscle Man – Posterior Side**

**Know the following muscles on the Muscle Man model.**

1. Frontalis  
2. Orbicularis Oculi  
5. Zygomaticus  
6. Orbicularis Oris  
11. Sternocleidomastoid  
14. Trapezius  
16. Latissimus Dorsi  
17. Gluteus Maximus  
18. Deltoid  
20. Pectoralis Major  
21. External Oblique  
22. Rectus Abdominis  
24. Triceps Brachii  
25. Biceps Brachii  
31. Sartorius  
32. Rectus Femoris  
34. Gracilis  
35. Adductor Longus  
36. Biceps Femoris  
39. Gastrocnemius  
42. Tibialis Anterior  
45. Fibularis (Peroneus) Longus  
48. Vastus Medialis  
49. Vastus Lateralis  
65. Tensor Fasciae Latae
Arm Muscles

**Know the following muscles on the Arm Muscle Model**

- Deltoid
- Biceps brachii
- Triceps brachii
- Brachioradialis
- Extensor carpi radialis longus
- Flexor carpi ulnaris
- Palmaris longus
- Extensor digitorum
Leg Muscles

**Know the following muscles on the Leg Muscle Model**

- Rectus femoris
- Biceps femoris
- Vastus lateralis
- Gastrocnemius
- Tibialis anterior
- Gracilis
- Sartorius
- Adductor longus
- Vastus medialis

*also known as Peroneus longus*
Know the following muscles on the models in the lab and the function of each.

### Head and Neck Muscles

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontalis</td>
<td>Raises eyebrows and wrinkles forehead</td>
</tr>
<tr>
<td>Orbicularis oculi</td>
<td>Closes eye</td>
</tr>
<tr>
<td>Orbicularis oris</td>
<td>Closes lips; kissing and whistling</td>
</tr>
<tr>
<td>Sternocleidomastoid</td>
<td>Flexes, tilts, and rotates head</td>
</tr>
<tr>
<td>Zygomaticus</td>
<td>Raises corners of mouth; smiling</td>
</tr>
<tr>
<td>Masseter</td>
<td>Elevates (closes) and protracts jaw, as when chewing</td>
</tr>
</tbody>
</table>

### Torso Muscles

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trapezius</td>
<td>Shrug shoulders</td>
</tr>
<tr>
<td>Latissimus dorsi</td>
<td>Extends, adducts, and medially rotates arm</td>
</tr>
<tr>
<td>Pectoralis major</td>
<td>Flexes, adducts, and medially rotates arm</td>
</tr>
<tr>
<td>External oblique</td>
<td>Lateral rotation of the vertebral column; twisting</td>
</tr>
<tr>
<td>Rectus abdominis</td>
<td>Flexion of the vertebral column; sit ups</td>
</tr>
</tbody>
</table>

### Upper Limb Muscles

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deltoid</td>
<td>Abducts, flexes, and rotates arm</td>
</tr>
<tr>
<td>Triceps brachii</td>
<td>Extends forearm</td>
</tr>
<tr>
<td>Biceps brachii</td>
<td>Flexes forearm</td>
</tr>
<tr>
<td>Brachioradialis</td>
<td>Flexes arm</td>
</tr>
<tr>
<td>Extensor digitorum</td>
<td>Extends fingers and hand</td>
</tr>
<tr>
<td>Extensor carpi radialis longus</td>
<td>Extends hand</td>
</tr>
<tr>
<td>Flexor carpi ulnaris</td>
<td>Flexes hand</td>
</tr>
<tr>
<td>Palmaris longus</td>
<td>Flexes hand</td>
</tr>
</tbody>
</table>

### Lower Limb Muscles

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensor fasciae latae</td>
<td>Flexes, abducts, and rotates thigh</td>
</tr>
<tr>
<td>Adductor longus</td>
<td>Adducts, flexes, and rotates thigh</td>
</tr>
<tr>
<td>Gluteus maximus</td>
<td>Extends, abducts, and rotates thigh</td>
</tr>
<tr>
<td>Gracilis</td>
<td>Adducts thigh and flexes leg</td>
</tr>
<tr>
<td>Sartorius</td>
<td>Crosses the leg</td>
</tr>
<tr>
<td>Vastus medialis</td>
<td>Extends leg</td>
</tr>
<tr>
<td>Vastus lateralis</td>
<td>Extends leg</td>
</tr>
<tr>
<td>Biceps femoris</td>
<td>Extends thigh and flexes leg</td>
</tr>
<tr>
<td>Rectus femoris</td>
<td>Flexes thigh and extends leg</td>
</tr>
<tr>
<td>Tibialis anterior</td>
<td>Dorsiflexion of the foot; inverts foot</td>
</tr>
<tr>
<td>Fibularis longus</td>
<td>Plantar flexion of the foot; everts foot</td>
</tr>
<tr>
<td>Gastrocnemius</td>
<td>Plantar flexion of the foot; flexes leg</td>
</tr>
</tbody>
</table>
BIO 137 — Human Anatomy & Physiology I

Name: ____________________________ Section ____________

BIOPAC Electromyography Worksheet
Due at the start of next week’s lab

PART I — DATA RECORDING
This portion of the worksheet is for recording the data you collected and must be done in lab.

Subject Profile:
Subject name: __________________________________________

Gender: ___________ Age: ___________ Height: ___________

1. Record the data from the EMG and dynamometer measurements for each clench in the following table (you may not need all rows). Limit the results to 3 significant digits. See instructions for rows “0” and “fatigue”.

<table>
<thead>
<tr>
<th>Clench #</th>
<th>Clench Force (kg) [Ch 1-mean]</th>
<th>Peak-to-peak (mV) [Ch 3-p-p]</th>
<th>Mean EMG (mV) [Ch 40-mean]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
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<td>7</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>fatigue</td>
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</tbody>
</table>
2. Use the sustained clenches to measure the time to fatigue, the onset of which will be operationally defined as when a subject no longer is able to produce at least half of the maximum amount of force. Record the results from the sustained contraction:

<p>| |</p>
<table>
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<tbody>
<tr>
<td>Maximum Force:</td>
</tr>
<tr>
<td>(largest observed value of Ch 1-value)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>50% of Maximum Force:</td>
</tr>
<tr>
<td>(calculate by dividing above number by 2)</td>
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<td></td>
</tr>
<tr>
<td>Time to fatigue:</td>
</tr>
<tr>
<td>(Ch 40-delta-T)</td>
</tr>
</tbody>
</table>

3. Record the indicated data from your own and other groups in the table below.

<table>
<thead>
<tr>
<th>Subject Initials</th>
<th>Gender</th>
<th>Age</th>
<th>Height or Other</th>
<th>Clench Force for strongest clench</th>
<th>Mean EMG for strongest clench</th>
<th>Time to fatigue (Delta-T)</th>
</tr>
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<tbody>
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</table>
PART II — DATA INTERPRETATION

This portion of the worksheet will give you an opportunity to further analyze and interpret the data you collected. It may be done at home.

4. As the forces of a muscle contraction increases, the muscle must recruit increasing numbers of motor units. The increased number of active motor units should be reflected in increased EMG activity. To visualize this, plot the mean EMG (question 1, right column) against clench force (left column) in the graph below. The scale on each axis should be such that most of the graph is used.
5. Does the mean EMG increase linearly (in a more or less straight line) with the force being produced? Is this result what you would expect based on your knowledge of motor unit recruitment?

6. Why did the EMG not show zero activity when the subjects hand and forearm were completely relaxed (question 1, row 0)?

7. During **tonus**, muscles are activating only a small percentage of their motor units at any one time. To estimate the percentage of motor units active, divide the mean EMG value for tonus (question 1, row 0) by the mean EMG when all motor units are active (i.e., the maximum strength clench; row with highest force). Express as a percentage by multiplying by 100%. Show your calculation.

8. As the subject squeezed the dynamometer at maximum strength, the force exerted decreased over time. What physiological mechanisms within the muscle fibers could explain this decline in strength?

9. Compare the mean force and mean EMG values for the first two and last two seconds of the sustained contraction (question 1, last numbered row and “fatigue” row). As force declined, did the EMG values remain constant (reflecting a constant level of stimulation from the nervous system) or did EMG values decline in proportional amounts (reflecting reduced stimulation of the muscles)?

10. Based on the results in question 9, was the decline in strength the result of psychological or physiological fatigue (or both)? Explain.
11. Would you expect the subject’s sex, age, height or other characteristics suggested by your instructor to influence how quickly they fatigued? Explain your reasoning.

12. Are the results from the class data on time to fatigue (question 3) consistent with your predictions? Explain.

PART III — GENERAL REVIEW QUESTIONS

13. What is the source of the signals that were detected by the EMG electrodes?

14. What is electromyography?

15. What is a motor unit?

16. What does the term “motor unit recruitment” mean?

17. What is meant by “tonus”?

18. Define “fatigue.”

19. What is the difference between psychological fatigue and physiological fatigue?