Objectives:
- To observe and understand the microscopic anatomy of the muscle cell and its function
- To investigate muscle fatigue in the muscles of the hand
- To identify the major muscles of the human body and their actions

Nerve and Muscle Tissue
Obtain micro-slide set 221, Nerve and Muscle Action
- View images 1 through 8
- SKETCH the neuromuscular junction shown in image 5.

Sliding Filament Theory
Muscle cells are packed with contractile proteins called myofilaments that slide past each other using energy from ATP molecules to pull them along. The sliding filament theory states that small proteins on the thick filaments (B) grab the thin proteins (A) and pull them together, thereby shortening the muscle cell. When multiplied many times in many cells and focused by the connective tissue wrappings you then have muscle power. (Consult your notes/textbook for more info).

Name these two parts of a sarcomere in a relaxed state:
Myofilament A: ____________________________
Myofilament B: ____________________________

Now DRAW a sarcomere in a contracted state
**Investigating muscle fatigue**

Work with a partner. **Hypothesize** how many times you and your partner will be able to stretch a rubber band between your thumb and pinky finger in 20 seconds, repeated 5 times with NO REST between each trial. You will be using your dominant hand. Record your predictions on the table below.

<table>
<thead>
<tr>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Trial 4</th>
<th>Trial 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Person 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Use a stopwatch or the second hand on the wall clock and count the number of times you can **completely** stretch a rubber band between the thumb and pinky fingers in 20 seconds using your dominant hand. Make sure that you stretch the rubber band as far as you can each time. Do it as rapidly as possible and repeat five times with NO REST between each trial. **Always use the same hand for each trial.** Record the count in the table below. Important note: if you suffer or have suffered from carpal tunnel syndrome or other ailments in your fingers, hands, or wrists, DO NOT PERFORM this exercise. Instead, watch and record your lab partners data.

<table>
<thead>
<tr>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Trial 4</th>
<th>Trial 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Person 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Answer the following questions. Use the back of this handout if necessary.*

1. How did your results compare to your hypothesis? Was there anything that surprised you?

2. Did you notice any changes in the numbers or how your hand felt during the five trials?

3. How did your numbers compare to your partners? If there are differences, are there any possible explanations for these differences? If they are the same, why do you think they are the same?

4. How do your observations relate to muscle fatigue? What energy sources might your muscles have been using for each trial? Could these energy sources explain any changes in how you felt or the number of times you were able to stretch the rubber band?
Skeletal Muscles and their Action
Choose several of your favorite yoga poses, martial art, hip-hop or other dance moves. Break down each move and describe the major muscle(s) involved and the corresponding action in the following table. Select a total of 14 muscles. Scoring is ½ point per correctly named muscle, ½ point per correctly named action. Refer to your notes, the textbook, and muscle system handouts. Be prepared to demonstrate your moves to the class or at least to the instructor.

<table>
<thead>
<tr>
<th>Description of &quot;Move&quot;</th>
<th>Muscle(s) Involved</th>
<th>Muscle Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Muscle Actions and Major Muscle Groups

**Important note:**
Muscle actions are always described as departures from the anatomical position of the body.

Certain muscle actions are general and can be applied to several regions of the body while others are quite specific to a single region or even a single joint.

**Flexion/Extension**
*Flexion:* the movement at a joint that decreases the angle between two adjacent body segments. The opposite action is *extension*, where the angle between body segments is increased.

- Flexor muscles are located on the anterior surfaces of joints when the body is in the anatomical position (exception: knees and toes which bend the "wrong" way).
  - Examples of flexion: touch your chin to your chest, bend over and touch your toes, clench your fist, bend your elbow, bend your wrist inward, point straight ahead, curl your toes.
- Extensor muscles are located on the posterior surfaces of joints when the body is in the anatomical position (exception: knees and toes).
  - Example of extension: look at the ceiling, do a back bend, straighten your elbows, straighten your wrist, stretch your arm straight behind you, with your knee straight stretch your leg backward, straighten your knee, uncurl your toes.

*Examples of Lateral Flexion:* touch your ear to your shoulder, bend your body sideways.

**Abduction/Adduction**
A movement of a body part away from the midline, either of the body as a whole or that of the hand or foot, is termed *abduction* (Ab=away). Think of absent. Abductor muscles are located *lateral* to their joints.

- Examples of abduction: raise your arms out to the sides, raise thigh and leg out to the side, spread your fingers apart.
A movement of the body part back toward the midline is known as *adduction*. Ad=to or towards. Adductor muscles are located *medial* to their joints.
- Examples of adduction: pull your arms back down, pull your thigh and leg back down, pull your fingers together.

**Rotation** is movement of a bone around its longitudinal axis. It is a common movement of ball-and-socket joints and also describes the movement of the atlas around the odontoid process of the axis (1st and 2nd cervical vertebrae).

- Examples of rotation: shake your head "no"; with stiff ankles and knees, turn your thigh and leg outward and inward; with a stiff wrist and elbow, turn your arm and forearm toward your body and away from your body.

**Circumduction** is a combination of flexion, abstraction, extension, and adduction commonly seen in ball-and-socket joints like the shoulder. The limb as a whole outlines a cone.

Actions of the Scapula
Several special muscle actions occur in the movement of the scapula.

**Elevation/Depression**
The elevation of the scapula or "shrugging the shoulders" and the opposite action, depression involves pulling down the scapula to a more inferior position.

**Protraction/Retraction**
Movement of the scapula forward is termed protraction (as in "hunching the shoulders"). The action opposite to this would be one of retraction, or movement of the scapula backwards (as in "squaring the shoulders").

Actions of the Ankle and Foot
**Dorsiflexion/Plantar Flexion**
*Plantar flexion* is movement of the foot downward as in pointing the toes or standing on tip-toe. *Dorsiflexion* is movement of the toes and foot back towards the leg.
Inversion/Eversion
These are also special actions of the foot. Inversion is the action of turning the sole of the foot inward, towards the opposite foot. Eversion is the movement of turning the sole of the foot outward, away from the midline.

Actions of the forearm
Pronation/Supination
Another special action occurs in the forearm, where the radius and ulna are arranged in such a way as to allow the crossing of the distal end of the radius over the ulna. Pronation is the movement of crossing the radius over the ulna. This movement results in the dorsal surface of the hand turning forward, or prone. Supination is the opposite action, wherein the radius is uncrossed and the palmar surface of the hand is returned to the anatomical position, or supine (forward).

Major Muscles and their Actions
Head and Neck:
Frontalis—Wrinkles forehead and lifts eyebrows.
Orbicularis oculi—Closes eye (winking).
Zygomaticus—Rises corner of mouth (smiling).
Temporalis and Masseter—Closes jaw.
Orbicularis oris—Closes and protrudes lips (kissing).
Sternocleidomastoid—Turns head to side if one side contracts; flexes neck and head if both sides contract.
Trapezius—Extends head; raises and abducts shoulders dorsally.

Upper Limb and Trunk:
External and internal obliques—Flex, rotate, and laterally flex the vertebral column (trunk). Compresses abdomen.
Rectus abdominis—Flexes trunk, compresses abdomen.
Pectoralis major—Flexes the arm, medially rotates and adducts arm at shoulder (pulls arm across chest).
Deltoïd—Abducts and raises arm at shoulder joint. Anterior portion flexes and medially rotates arm at shoulder; posterior portion extends arm and laterally rotates arm at shoulder.
Biceps branchii—Flexes forearm at elbow and supinates hand.
Triceps branchii—Extends forearm at elbow.
Pronator teres—Pronates and flexes the forearm.
Latissimus dorsi—Extends and adducts shoulder and arm dorsally (pulls arm across back).
Levator scapulae—Elevates the scapulae, bends the neck laterally.
Trapezius—Elevates, rotates, and lowers the shoulder
Flexor carpi radialis and flexor carpi ulnaris—Wrist flexors
Flexor digitorum superficialis—Flexes wrist and middle phalanges of second through fifth fingers
Extensor carpi radialis longus and extensor carpi ulnaris—Extend wrist
Extensor digitorum—Finger extension, can flare (abduct) fingers

Lower Limb and Buttocks:
Iliopsoas—Flexes and laterally rotates the thigh (femur) at hip joint; flexes the vertebral column
Adductor longus—Adducts and flexes thigh at hip.
Sartorius—Rotates thigh, flexes, abducts and laterally rotates knee (permits us to sit cross-legged).
Quadriceps femoris group—Extends leg at the knee.
Peroneus longus—Everts foot.
Tibialis anterior—Dorsiflexes the foot at the ankle and inverts foot.
Gluteus medius—Abducts thigh at hip, anterior fibers medially rotates thigh, posterior fibers laterally rotate thigh.
Gluteus maximus (forms buttocks)—Extends, laterally rotates thigh at hip; upper fibers help abduct the thigh.
Hamstring group—Flexes leg and extends thigh at hip joint.
Gastrocnemius—Plantar flexes the foot at the ankle (tiptoeing); extends leg at the knee.
Flexor digitorum longus—Flexes the toes.
Extensor digitorum longus—Extends the toes.