

## Background

One of the biggest deterrents for those wanting to start exercising is that they simply don't know where to begin. The idea of muscle training is to group muscles into working “units” and target their training specifically for the group of muscles. Exercises are then tailored to work the individual muscles in the group. By measuring electromyogram (EMG) activity for each of the muscles in the group, it is easy to tell if the muscle you want to be using is the one that is actually doing the work.

The easiest way to understand muscle movements is by the motion you must make to target and work that particular muscle or muscle group. The best way to simplify all of the movement patterns is to call them "push" or "pull" movements. "Push" movements describe any motion you must make to push the weight away from your body and "pull" movements are those motions you must make to pull the weight into your body. Certain muscle groups complement one another in that they require the same "push" or "pull" movement type to target the muscle.

An example of a "push" movement exercise is the bench press. This exercise is used to work the muscles in your chest but also incorporates your shoulders and triceps which are all "push" movement muscles. An example of a "pull" movement exercise is the bent-over row. This exercise is used to work the muscles in your back but also incorporates your biceps which are all "pull" movement muscles.

To make this easier to understand: "Push" movement body parts include: the muscles of the chest, shoulders, triceps, quadriceps (vastus muscles and rectus femoris), and the muscles in the calves. "Pull" movement body parts include: the muscle of the back, biceps, hamstrings (semimembranosus, semitendinosus and biceps femoris), and the abdominal muscles. It is important to note that there are exceptions and variations to these movements, especially in working the leg muscles. Leg muscles are large and are often worked using compound movements that incorporate the gluteus muscles, the quadriceps and the hamstrings.

This lab will allow for the recording EMG activity while doing certain exercises and will give immediate feedback as to whether the muscle being targeted by a specific exercise is the one that is actually being used.

Any muscle can be used for this lab and appropriate exercises for the targeted muscles can be found online and by speaking to the campus athletic trainer or physical therapist. The muscles that are easy to focus on would be the quadriceps, the hip flexors, as well as the abdominal muscles.

## Hardware Setup

The SEMG signal generated by the muscle fibers is captured by the electrodes then amplified and recorded with an iWorx recorder. It is then sent to the computer to be processed, displayed and recorded by the LabScribe software.

### Wireless Systems:

#### ROAM Wireless USB system:

- ROAM Wireless EMG (1 Channel) – IXR-B1
  - with Accelerometer – IXR-B1A
- ROAM Wireless EMG (2 Channels) – IXR-B2
  - with Accelerometer – IXR-B2A



#### ROAM Wireless Expandable system (RS-WEMGx):

The IX-RA-834 versatile data recorder can be used with multiple iWire-B2 ( or iWire-B2A) wireless EMG modules to record upto 8 channels of wireless EMG



### Wired Systems:

Recorders and Amplifiers that can be used for recording EMG include:

#### RS-EMGx EMG System

Based on the IX-Bxx series, such as IX-BIO4, IX-BIO8, 4 channel or 8 channel USB powered recorders.



#### Expandable EMG system

Based on the IX-RA-834 or the IX-TA-220

Add the iWire-B3G, iWire-BIO4, iWire-BIO8 modules to the IX-TA-220 or the IX-RA-834 recorders to record upto 20 EMG channels, as well as other physiological parameters. The IX-TA-220 includes a High voltage, constant current stimulator, safe for use on Humans.

## Amplifiers:

In addition to the above complete systems, the following iWorx sensors and Amplifiers can be used with any recorder:

- C-ISO-256 used with the IA-400D or the ETH-256 Amplifier
- IA-100B



## Surface Electrodes & Cables

The silver-silver chloride electrodes are the part of the instrument that is in contact with the skin. They make electrical contact between the skin and the sensor. Silver-silver chloride electrodes are best electrodes for recording EMG signals.

A-GC-7165 or smaller A-GC-7165P electrodes can be used for measuring EMG.

Proper skin preparation is important to get a good signal and avoid artifacts.

- Before applying electrodes, make sure the skin surface is clean and dry:
- Abrade the skin with an abrasive cream, such as NuPrep, to remove dead skin.
- Alternatively, you can also clean skin with an alcohol wipe and let it dry, but this is not as efficient as the abrasive cream.

## Tips:

*It is easier to connect the electrodes to the snap cable before placing the electrode on the subject.*

*Braiding the electrode cables helps to reduce noise that may be picked up by the cables.*

*EMG signals should be recorded at at least 1000 samples per second.*

# Tech Notes

## SEMG Measurements



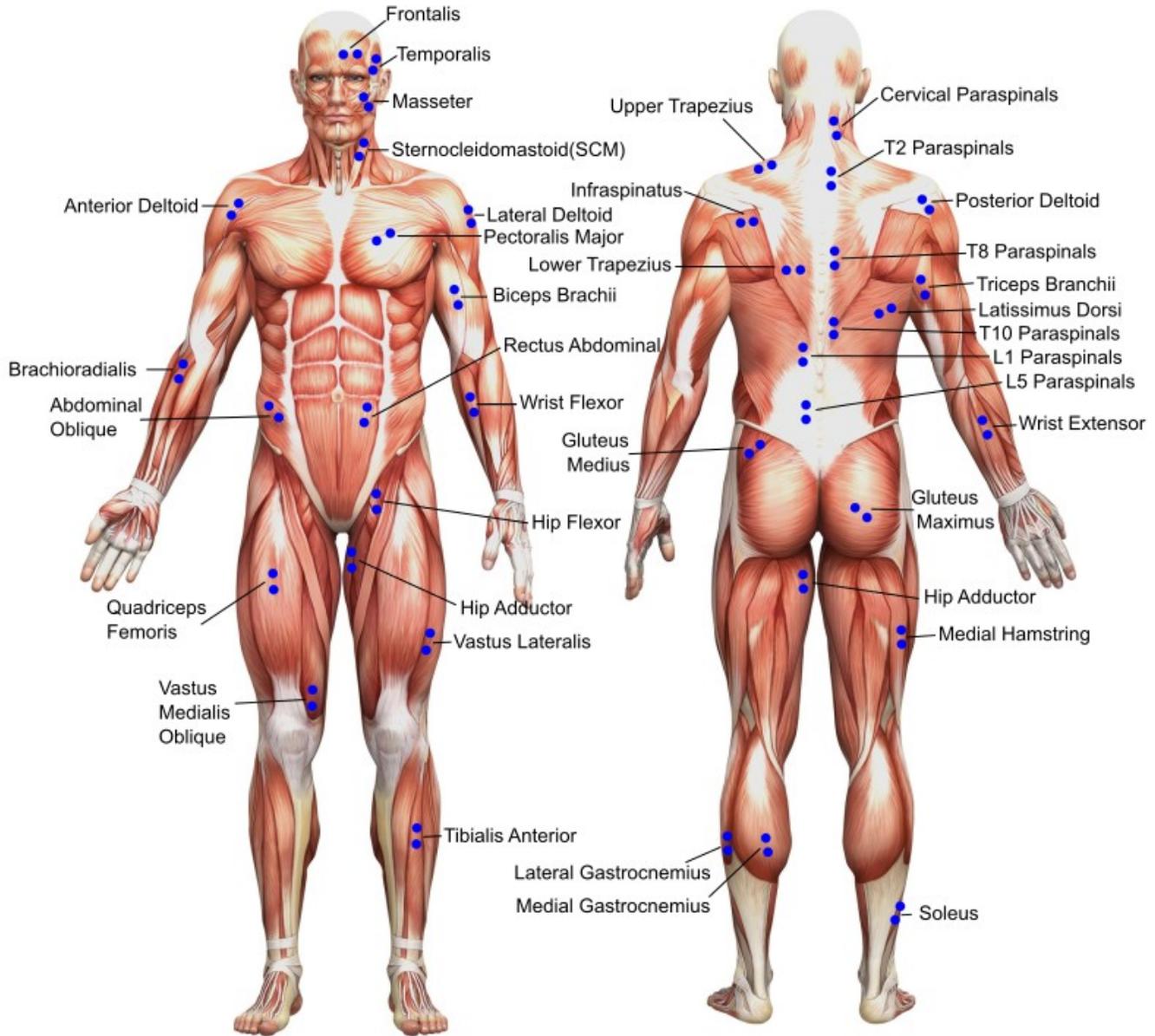
Major Muscle Group	Location	Functional Role	Exercise to Strengthen	Sample Stretch	Notes
Abdominal	Stomach	Sitting up, postural alignment	Crunches, leg raises, twisting crunches	You typically don't stretch your abs. For most people, the abs are not strong enough, so you need to work on strengthening them rather than stretching them	The rectus abdominus is the muscle that is visible. The transversus abdominus muscle, which stabilizes your back, is underneath.
Biceps	Front of upper arm	Lifting, pulling	Bicep Curls	Sit on floor. Place hands behind you with fingers pointing away from your body. Walk your hips away from your hands.	Anytime you move your hand toward your shoulder, you are using your biceps.
Deltoids	Top of shoulder	Overhead lifting	Pushups, bench press, side & rear arm raises	"Scratch your Back" - Put both hands over your head. Bend one elbow and place hand on back. With other hand, push elbow to stretch triceps, deltoids, lats	The deltoids are composed of three parts, anterior, posterior & medial. Anytime you "flap" your arms, your deltoids are working.
Erector Spinae	Low back	Postural alignment	Back extensions	"Cat Stretch" - Kneel on all fours, round back like a cat. Sit on chair with feet shoulder distance apart. Bend over and place shoulders between your knees	The erector spinae is sometimes called the "low back" muscle, although it runs up your entire back.
Gastrocnemius & Soleus	Back of lower leg	Push off for walking, standing on tiptoes	Standing calf raises, seated calf raises	Lunges with a straight back leg for gastrocnemius. Lunges with bent knees for soleus.	The gastrocnemius gives your legs a rounded shape. The soleus is underneath the gastrocnemius.
Gluteus	Buttocks	Climbing stairs, walking, standing up	Squat, leg press	Sit on chair, cross other leg over thigh of bent leg, lean forwards.	Made up of several muscles. The largest muscle in the body is the gluteus maximus.
Hamstrings	Thigh - back	Walking	Squats, lunges, leg extensions, leg curls	While standing, place heel of leg to be stretched on a chair. Keep your leg as straight as possible, your hips square and your back flat. Bend at the waist toward your leg.	The hamstrings are made up of three muscles. Don't squat below 90 degrees, otherwise you could damage your knees.

# TechNotes SEMG Measurements



Latissimus Dorsi & Rhomboids	Back - Lats are the large triangular muscle in the midback. Rhomboids are between the shoulder blades	Postural alignment, pulling open a door	Lats - pull ups, chin ups, lat pull downs Rhomboids - chinups & bent arm rows	"Scratch your Back" - Put both hands over your head. Bend one elbow and place hand on back. With other hand, To stretch rhomboids, "hug yourself" Cross your hands in front of you, place both hands on your shoulder blades.	Developed lats give your back a "V" shape, making your waist appear smaller.
Obliques	Side of body	Rotation and side flexion of body	Twisting crunches, rotary torso	Lie on your back with your arms extended out ("T" shape) Bend both knees. Rotate your hips and put your bent legs on the floor on your side.	Strong internal and external oblique muscles ward off back pain.
Pectoralis	Front of upper chest	Push up from lying position, push open a door	push-up, pull-up, bench press	While standing, hold both arms out at shoulder height, palms forward. Pull arms back.	The pectoralis muscles pull the shoulder and arm forward.
Quadriceps	Thigh - front	Climbing stairs, walking, standing up	Squats, lunges, leg presses	While lying on side, grasp ankle, push hips forward	The quads are made up of four muscles.
Trapezius	Large muscle in upper and mid-back.	Moves head sideways,	upright rows, shoulder shrugs	Upper trap stretch. Sit in a chair; put your left hand behind you. Tilt your head so your right ear moves toward your right shoulder. Repeat on the other side.	Your upper trapezius connects your head to your shoulders. When you feel "knots in your neck", it's your trapezius.
Triceps	Back of upper arm	Pushing	Pushups, tricep extensions, dips	"Scratch your Back" - Put both hands over your head. Bend one elbow and place hand on back. With other hand, push elbow to stretch triceps, deltoids, lats	Anytime you extend your lower arm, you are using your triceps

## SEMG Electrode Placement



## Sample Exercises

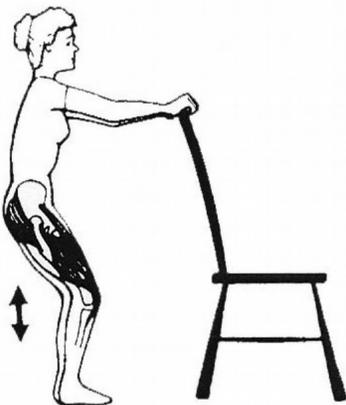
*Note: These exercises should be performed only by individuals in good health, with no lower back, knee, or hip injuries.*

*Exercises should be performed using correct body positioning as shown and explained.*

*Core muscle engagement is critical when doing all of these exercises.*

### Squat

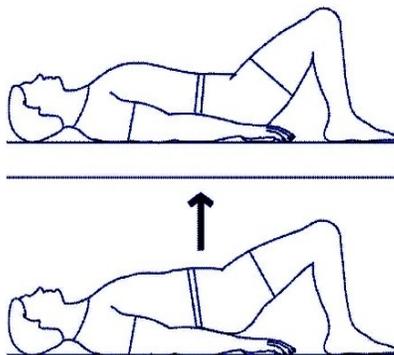
Targeted Muscle = Rectus femoris



- Stand with your head facing forward and your chest held up and out.
- Place your feet shoulder-width apart. Extend your hands and lightly grasp the top of a chair for balance.
- Sit back and down, like you are “sitting”. Keep your head forward and let your lower back arch slightly as you “sit”.
- Allow yourself to lower until your thighs are parallel to the floor, knees over ankles, weight into your heels.
- Keep your core tight and push through your heels to return to the starting position.

### Bilateral Bridge

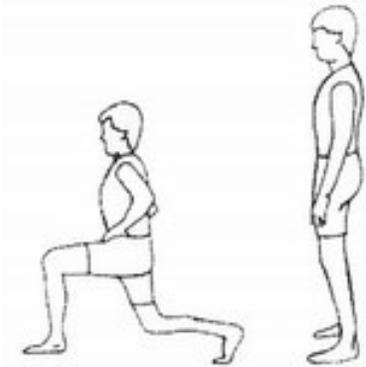
Targeted Muscle = Gluteus medius & Gluteus maximus



- Lay on your back with your hands by your sides, your knees bent and feet flat on the floor.
- Feet and knees should be approximately shoulder width apart.
- Tighten your abdominal and buttock muscles.
- Raise your hips up to create a straight line from your knees to shoulders.

## Forward Lunge

Targeted Muscle = Rectus Femoris



- Stand with your feet hip-width apart, hands on hips (if you prefer).
- Keep your chest lifted and back straight, take a large step forward (about three feet) with the foot so the knee is bent 90 degrees and the thigh is parallel to the floor.
- Keep your knee centered over your foot. Push off the foot to return to the starting position.

## Standing Leg Abduction

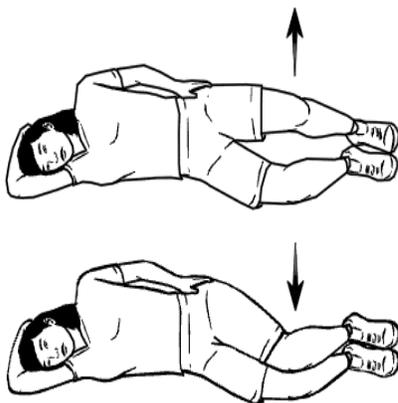
Targeted Muscle = Gluteus Medius



- Hold on to a chair back to help balance.
- Keeping toes pointed forward, foot flexed, and leg straight, lift the foot off the ground and out to the side.
- Lower the leg without letting the foot or leg rest to complete one repetition.

## Clam

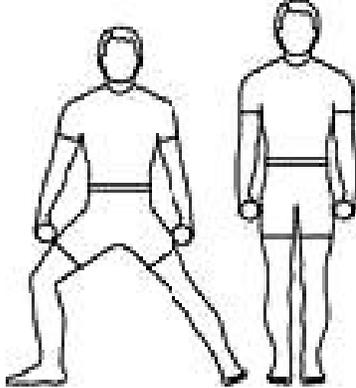
Targeted Muscle = Gluteus medius



- While lying on your side, keep both knees bent and flex the hips to about 30 degrees.
- While keeping your heels touching and pelvis still, open your knees by contracting your glute medius. This is a slow, small and targeted movement.
- You can place your hand on your gluteus medius (just below and behind your hip) to ensure that it is firing during the movement.

## Side-Step

Targeted Muscle = Gluteus medius/Vastus muscles



- Place your feet front and shoulder width apart
- Keep your feet in line with your shoulders, and face forward with your body weight evenly distributed over both feet.
- Shift your weight over one leg and take a step laterally (sideways) with the other leg.
- Keep your hips level during the movement. Try not to bounce up and down or sway side to side.
- Slowly shift your weight to the moved leg and bring the other leg inward to a new ready position and repeat.

## Forward Step-Up

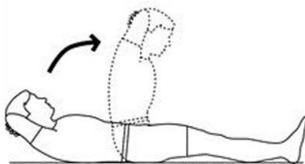
Targeted Muscle = Rectus Femoris, Vastus muscles



- Begin by standing in front of a 4" aerobic step, facing forward.
- Place one foot in the middle of the step.
- Step up as you balance your body for 4 seconds.
- Step down and repeat

## Sit-Ups

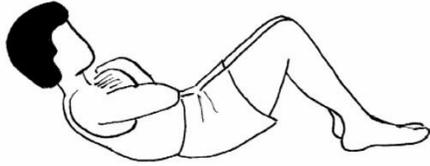
Targeted Muscle = Rectus Abdominus



- Begin by doing a pelvic tilt to flatten the back against the mat.
- Cross hands over the chest and stretch the legs out straight.
- Slowly "curl up" body towards toes until sitting.
- With control, slowly return body to the mat.

## Bent-knee Curl-Up

Targeted Muscle = Rectus Abdominus



- Follow the above, but bend the knees and keep feet flat on floor.
- Raise your upper body off the mat until your shoulders are around 30 degrees off the mat.
- With control, slowly return to lie back on the mat.