MUSCLE	PERIPHERAL NERVE	NERVE ROOTS	MUSCLE LOCALIZATION	MUSCLE ACTIVATION
Abductor Digiti Quinti (hand)	Ulnar	C8, T1	Directly at the medial border of the hand, at the midpoint between the distal wrist crease and the metacarpophalangeal crease. It is the first muscle encountered.	Abduction of digit 5.
Abductor Pollicis Brevis	Median	C8, T1	Parallel to first metacarpal shaft, in line with the mid-shaft of the extended first phalanx of the thumb, where it is the first muscle met by the electrode.	Abduction of thumb, i.e., movement of thumb out of the plane of the palm.
Abductor Pollicis Longus and Extensor Pollicis Brevis	Posterior interosseous branch of radial nerve	C7, C8	In the distal 25% of the dorsal forearm, overlying the radius	Abduction and extension of the proximal phalanx of the thumb
Adductor Pollicis	Ulnar, deep plamar branch	C8, T1	Immediately proximal to the first metacarpophalangeal joint, the electrode is inserted in the groove between the metacarpal bone and first dorsal interosseous muscle and toward the depth of the web space. At this fairly distal location, the bulk of the first dorsal is avoided	Thumb adduction within the plane of the palm.
Anconeus	Radial	C7, C8	The electrode is inserted midway between the olecranon process and the lateral epicondyle. No other muscle is found at this location.	Elbow extension.
Brachioradialis	Radial	C5, C6	Place index finger in the antecubital fossa, pointing proximal. Brachioradialis is the first muscle lateral to your finger.	Elbow flexion, with the forearm in mid pronation-supination.
Extensors Carpi Radialis Brevis and Longus	Radial	C6, C7	Visualize the line connecting the lateral epicondyle and the radial styloid process. In the proximal half of the forearm, this line separates the extensor digitorum communis from the wrist extensors, with a groove between them. The extensors are therefore approached just lateral to this line (i.e., to the thumb side) and are superficial.	If the electrode is too lateral, it will be in the brachioradialis. If it is too medial, it will be in the extensor digitorum communis.
Extensor Carpi Ulnaris	Posterior interosseous branch of radial nerve	C7, C8	In the proximal half of the forearm, just dorsal to the ulnar shaft, and superficial	Wrist extension combined with ulnar deviation.

Extensor Digitorum Communis	Posterior interosseous branch of radial nerve	C7, C8	Brachioradialis and the radial wrist extensors compromise a "movable mass" of muscles. Just medial to this group is a groove separating it from the extensor digitorum communis, which itself is relatively immovable. The division occurs in the proximal half of the forearm, along the line connecting the lateral epicondyle and radial styloid. The electrode is therefore inserted just medial to and parallel to that groove, in the proximal forearm, where the extensor digitorum communis is superficial.	Extension of digits 2 through 5.
Extensor Indicis	Posterior interosseous branch of radial nerve	C7, C8	In the distal 20% of the forearm, midway between the radius and ulna. At this distal location, extensor indicis is the only dorsal muscle that is not primarily tendinous.	Extension of the index finger.
Extensor Pollicis Longus	Posterior interosseous branch of radial nerve	C7, C8	Insert the electrode at the junction of the middle and lower thirds of the dorsal forearm, midway between the ulna and radius. At this point, extensor pollicis longus lies immediately beneath the distal muscle bellies of extensor digitorum communis.	Extension of distal phalanx of thumb.
First Dorsal Interosseous (hand)	Ulnar, deep plamar branch	C8, T1	The electrode is inserted parallel to the second metacarpal shaft, superficially, directly into the middle of the dorsal web space.	Abduction of digit 2 within the plane of the palm.
Flexor Carpi Radialis	Median	C6, C7	Place index finger in the antecubital fossa, pointing proximal. Flexor carpi radialis is the first muscle medial to your finger at the level of the apex of the antecubital fossa (where brachioradialis and the muscle converge) and is superficial at that point.	Wrist flexion.
Flexor Carpi Ulnaris	Ulnar	C8, T1	Middle third of the forearm, superficial and directly medial.	Wrist flexion with ulnar deviation.
Flexor Digitorum Profundus, Ulnar (medial) Heads	Ulnar	C8, T1	In the middle one-third of the forearm, immediately ventral to the ulnar shaft. Here, the muscle lies just below the thin aponeurosis of flexor carpi ulnaris.	Flexion of the distal phalanges of digits 4 and 5.
Flexor Digitorum Superficialis	Median	C7, C8, T1	At mid-forearm, halfway from the ventral midline to the medial border of the forearm. At this location, it is the first muscle reached.	Finger or wrist flexion.

Flexor Pollicis Longus	Anterior interosseous branch of median nerve	C7, C8	In the middle of the ventral forearm, the electrode is inserted just distal to the convergence of the muscle bellies of flexor carpi radialis and brachioradialis, virtually at the midline-i.e., needle okacenebt us just distal to the apex of the antecubital fossa. Direct the needle perpendicular to the skin and deep until bone is reached (the flat anterior surface of the radius). The last muscle traversed is flexor pollicis longus, so pull the needle out a few millimeters after reaching bone.	Flexion of distal phalanx of thumb.
Opponens Pollicis	Median	C8, T1	At the midpoint of the first metacarpal shaft, in the groove between the metacarpal bone and abductor pollicis brevis. The muscle is studied where it attaches to the medial side of the bone. If abductor pollicis brevis is moved aside, no other muscle overlies the opponens at this point.	Opposition of thumb across the palm.
Pronator Quadratus	Anterior interosseous branch of median nerve	C7, C8, T1	The muscle width is the same as its length, covering the distal 20% or so of the forearm, anterior to the interosseous membrane. Insert the electrode just anterior to the distal ulnar shaft, perpendicular to it, and direct the electrode horizontally to meet the thick medial border of the muscle.	Forearm Pronation
Pronator Teres	Median	C6, C7	With the index finger in the antecubital fossa pointing proximal, pronator teres is the first muscle medial to you finger, immediately distal to the antecubital vein.	Elbow flexion or, if necessary, forearm pronation.
Supinator	Radial	C5, C6	In the proximal 20% of the dorsal forearm, insert the electrode in the groove between the radial wrist extensors (movable) and extensor digitorum communis (immovable). The electrode is directed deep, where supinator is found lying against the radius.	Forearm supination.
Biceps Brachii	Musculocutaneous	C5, C6	Middle one-third of the arm, directly into and paralelling the muscle belly, appraoching biceps from its lateral side	Elbow flexion, with the forearm in supination.
Brachialis	Musculocutaneous	C5, C6	In the distal one-third of the arm, push the biceps medially and insert the electrode in the groove between biceps and triceps. Direct it down and medially, toward the anterior aspect of the humeral shaft.	Elbow flexion; the degree of forearm pronation-supination is irrelevant.
Deltoid, Anterior	Axillary	C5, C6	Midpoint of the line connecting the lateral one-third of the clavicle and the deltoid insertion	Arm abduction or shoulder flexion.

Deltoid, Middle	Axillary	C5, C6	One-third of the distance down the line between the acromion process and the deltoid insertion. Deltoid is the only muscle encountered in this location.	Arm Abduction.
Deltoid, Posterior	Axillary	C5, C6	Midpoint of the line connecting the distal scapular spine and the deltoid insertion	Arm abduction or shoulder extension.
Infraspinatus	Suprascapular	C5, C6	Halfway between the scapular spine and the inferior tip of the scapula, midway between the lateral and medial borders of the scapula-i.e., directly in the center of the infraspinous fossa. The electrode should first gently touch the posterior surface of the scapula, then be pulled back slight to examine the infraspinatus.	External rotation of the arm. Activation is usually possible simply by the patient lifting the arm off the table.
Latissimus Dorsi	Thoracodorsal (middle subscapular)	C6, C7, C8	Posterior axillary fold, directly lateral to the inferior tip of the scapula	Extension/adduction of the humerus.
Levator Scapula	Cervical plexus	C3, C4, C5	Midpoint of the line connecting the superior medial scapular border and the nuchal line. Levator scapula is found deep to the overlying upper trapezius.	Scapular elevation. Have the patient shrug the shoulder.
Pectoralis Major	Medial and lateral pectoral nerves	C7, C8, T1	Anterior axillary fold, in direct vertical line with the coracoid process	Adduction of the arm.
Rhomboid Major	Dorsal scapular	C5, C6	At the level of the midpoint of the medial scapular border, midway between the border and the high thoracic (T1-T4) spinous processes. The muscle lies deep to middle trapezius.	Scapular adduction. Have the patient lift the elbow off the table against resistance.
Rhomboid Minor	Dorsal scapular	C5, C6	Midpoint of the line connecting the superior medial scapular border and the cervical prominence. Middle trapexius fibers overlie rhomboid minor.	Scapular adduction. Have the pateint move the scapulae closer together.
Serratus Anterior	Long thoracic	C5, C6, C7	In the mid or anterior axillary line, isolate one rib by placing two fingers in the adjacent interspaces, anterior to the bulk of the latissimus dorsi but posterior to the breast tissue in a woman. Needle electrode insertion is directly between your fingers, as serratus anterior is the only muscle between the skin and the rib.	Eelvation and reaching forward with the arm, i.e., scapular protraction. Providing resistance is sometimes necessary.
Supraspinatus	Suprascpular	C5, C6	At the medial one-third of the scapular spine, insert the electrode immediately superior to the scapular spine. Aim the electrode perpendicular to the skin (not parallel to it) into the depth of the supraspinous fossa, where only supraspinatus is encountered. The aponeurosis of the lateral trapezius fibers is pierced first.	Arm abduction.
Teres Major	Lower subscapular	C5, C6	Immediately laeral to the lower one-third of the lateral scapular border.	Internal rotation of the arm.

Teres Minor	Axillary	C5, C6	Immediately lateral to the middle third of the lateral scapular border.	External rotation of the arm.
Trapezius, Middle	Spinal accessory, cervical (subtrapezial) plexus	Cranial nerve X1, C3, C4	Directly medial to the medial edge of the scapular spine. Keep the electrode superficial, just under the subcutaneous tissue.	Scapular adduction.
Trapezius, Upper	Spinal accessory, cervical (subtrapezial) plexus	Cranial nerve X1, C3, C4	Supeior border of the shoulder, immediately medial to the acromioclavicular joint. The free border of the upper trapezius can be grasped between two fingers at this point, and the electrode parallels the slope of the shoulder.	Sholder elevation. Have the patient shrug the shoulder.
Tricpes, Lateral Head	Radial	C7, C8	Distal one-third of arm, directly in line with lateral peicondyle, and superficial	Elbow extension.
Triceps, Long Head	Radial	C7, C8	At the level of the midshaft of the humerus, the electrode is inserted just medial to the posterior midline of the arm.	Elbow extension.
Abductor Digiti Quinti (foot)	Lateral plantar branch of tibial nerve	S1, S2	At the lateral border of the foot, locate the base of the fifth metatarsal bone, the prominence of which is easily felt. The electrode is inserted immediately proximal to and to the plantar side of the prominence, parallel to the long axis of the foot.	Small toe abduction. Ask the patient to fan the toes. Voluntary activation of this muscle can be difficult.
Abductor Hallucis	Medial plantar branch of tibial nerve	S1, S2	Halfway between the prominence of the navicular bone and the plane of the sole, where it is the most superficial muscle. Insert the electrode parallel to the long axis of the foot.	Can be difficult. Ask the patient to fan or curl the toes.
Anterior Tibialis	Deep branch of peroneal nerve	L4, L5	At the junction of the middle and upper thirds of the leg, one-quarter of the distance from the tibial shaft to the lateral border of the leg. In this location, it is the only muscle encountered.	Ankle dorsiflexion. The patient will sometimes reflexively extend the toes in the same motion, and extensor digitorum longus can substitute for anterior tibialis in producing ankle dorsiflexion. If necessary, hold the toes in plantarflexion while the patient dorsiflexes the ankle.
Extensor Digitorum Longus	Deep branch of peroneal nerve	L5, S1	At the junction of the middle and upper thirds of the leg, halfway between the tibial shaft and lateral border of the leg. At this point, extensor digitorum longus is the first muscle encountered.	Extension of digits 2 through 5.
Extensor Hallucis Longus	Deep branch of peroneal nerve	L5, S1	At the junction of the middle and lower thirds of the leg, one-third of the distance from the tibial shaft to the lateral border of the leg. The electrode is directed deep and medially.	Great toe extension; be certain the needle is pulled back into the subcutaneous tissue before the patient contracts this muscle.

First Dorsal Interosseous (foot)	Lateral plantar branch of tibial nerve	S1, S2	Place your index finger in the dorsal web space between the first and second toes, pointing distally. Pull your finger proximal until it wedges between the first two metatarsal heads. Insert the electrode immediately distal to your finger and angle it slightly toward the second toe. The muscle is at the depth of the metatarsals; no other muscle is encountered.	Have the pateint curl or fan the toes. Many cannot voluntarily activate the first dorsal interosseous.
Gastrocnemius, Lateral head	Tibial	S1, S2	Midway between the fibular head and the posteior midline of the leg, and superficial	Ankle plantarflexion.
Gastrocnemius, Medial Head	Tibial	L5, S1, S2	Medial border of the leg, junction of the upper and middle thirds, and superficial.	Ankle plantarflexion.
Peroneus Longus	Superficial branch of peroneal nerve	L5, S1	Straddle the fibular head with your index and middle fingers, pointing proximal. Pull straight down to the junction of the upper and middle thirds of the leg; your fingers will be surrounding peroneus longus, which is the first muscle encountered.	Evrersion/plantarflexion of the ankle.
Posterior Tibialis	Tibial	L5, S1	There are two acceptable approaches: 1. At the junction of the middel and lower thirds of the leg, insert the electrode under the medial tibial shaft and direct it along the bone and deep, where the muscle lies against the interosseous membrane. The full width of flexor digitorum longus is traversed before posterior tibialis is entered. The illustration depicts this approach. 2. Through anterior tibialis, directly against the lateral border of the tibial shaft, at the junction of the middle and lower thirds of the leg. The electrode crosses the full width of anterior tibialis against the periosteum of the tibia until the interosseous membrane is reached and pierced. Beyond the membrane is posterior tibialis.	Plantarflexion/inversion of the ankle.
Soleus	Tibial	S1, S2	At the junction of the middle and lower thirds of the leg, the needle electrode is inserted immediately adjacent (either medial or lateral) to the posterior midline.	Ankle plantarflexion. If the examiner holds the patient's knee in flexion during activation, gastrocnemius contribution to ankle plantarflexion is minimized.
Adductor Longus	Obtruator	L2, L3, L4	In the proximal 20% of the thigh, one-quarter the distance from the medial border to the anterior border of the thigh.	Thigh adduction.
Adductor Magnus	Obtruator and sciatic	L2, L3, L4	Upper one-third of thigh, immediately posterior to the medial border of the thigh.	Thigh adduction.

Gluteus Maximus	Inferior gluteal	L5, S1, S2	Midpoint of the line connecting the posterior inferior iliac spine and greater trochanter. Gluteus maximus is the first muscle underlying the subcutaneous tissue.	Hip extension. Flex the knee to 90° to minimize hip extensor action of the hamstrings, and then have the patient lift the knee off the table. As an alternative, hip abduction.
Glueteus Medius	Superior gluteal	L4, L5, S1	The anterior border of gluteus medius is defined by the line joining the anterior superior iliac spine (ASIS) and greater trochanter. The electrode is inserted parallel to this line, at its midpoint and just posterior to it. The muscle is the first reached.	Internal rotation of the thigh. Needle insertion as described above places it in the anterior fibers of gluteus medius, allowing internal rotation to be used for activation. This motion can be carried out smoothly, as opposed to thigh abduction, which a cruder motion and which less easily allows for smooth recruitment of motor units.
Gracilis	Obtruator	L2, L3, L4	At the junction of the upper and middle thirds of the thigh, directly medial. At this point, gracilis can usually be surrounded by two fingers, facilitating localizing.	Thigh adduction.
Hamstring External, Biceps Femoris Long Head	Tibial portion of sciatic nerve	L5, S1, S2	At midthigh, there is a palpable groove from the iliotibial band between vastus lateralis and the external hamstrings. The needle electrode is inserted just posterior to (i.e., above in the prone position) the groove and parallel to the femur. At this location, the long head is the first muscle reached.	Knee flexion; be certain the electrode is first pulled back into subcutaneous tissue. A strongly contracting muscle can easily bend a imbedded EMG electrode.
Hamstring External, Biceps Femoris Short Head	Peroneal portion of sciatic nerve	L5, S1	At the level of the superior crease of the popliteal fossa, immediately medial or lateral to the tendon of biceps femoris long head. The electrode is directed down and under the tendon. At this distal level, long head is tendinous and short head is muscular. The tendon of the long head is shown in dashed outline.	Knee flexion.
Hamstring Internal, Semimembranosus and Semitendinosus	Tibial portion of sciatic nerve	L4, L5, S1, S2	At mid-thigh, at or just medial to the midline and immediately subcutaneous.	Knee flexion.
Iliopsoas	Femoral	L2, L3, L4	Immediately distal to the inguinal ligament, haflway between the femoral artery pulse and the anterior superior iliac spine. The electrode is directed laterally, away from the neurovascular bundle.	Hip flexion.
Quadriceps, Rectus Femoris	Femoral	L2, L3, L4	At the midpoint of the line connecting the anterior superior iliac spine (ASIS) and the superior pole of the patella. This places the electrode insertion slightly lateral to the geographic center of the anterior thigh.	Knee extension.

Quadriceps, Vastus Lateralis	Femoral	L2, L3, L4	Mid-thigh, directly lateral. In most patients there is a visible and palpable groove between the external hamstring group and vastus lateralis, caused by the iliotibial band. The needle is therefore inserted just anterior to (i.e., above the supine position) the groove.	Knee extension. Have the patient push the back of the knee down into the table or into your hand. Alternatively, have the patient lift the entire leg off the table with the knee straight.
Quadriceps, Vastus Medialis	Femoral	L2, L3, L4	The distal 20% of the medial thigh. At this level, the oblique fibers of vastus medialis are angled at nearly 45° toward the patella, and the electrode should parallel them.	Knee extension. Have the patient push the back of the knee into the table or your hand. If necessary, have the patient lift the leg off the table with the knee straight and the thigh in external rotation.
Anal Sphincter	Inferior rectal branch of prudendal nerve	S2, S3, S4	With a gloved finger in the rectum, insert the electrode at the mucocutaneous junction, and angle it toward your finger.	Ask the patient to tighten the sphincter around your finger. Relaxation is best obtained by having the patient strain, simulating pushing to have a bowel movement.
Diaphragm	Phrenic	C3, C4, C5	Anterior axillary line, eighth or ninth rib interspace. The intercostal muscles encountered first, then the diaphragm, identified by its cyclic contractions with breathing. If there are no voluntary contractions with breathing. If there are no voluntary contractions originating from the diaphragm, correct localization relies on recognizing that the first insertional activity heard is from the intercostal muscles, followed by an electrically silent gap, then the insertional activity from the targeted muscle.	Respiration.
Orbicularis Oculi	Temporal and zygomatic branches of facial nerve.	Cranial nerve VII.	Two-thirds the distance from the eanterior border of the ear to the lateral edge of the orbit. From that point, direct the electrode toward the lateral canthus of the eye and remain superficial.	Closing or squeezing of the eyelids.
Orbicularis Oris	Buccal branches of facial nerve	Cranial nerve VII.	Two-thirds the distance from the angle of the jaw to the corner of the mouth. From that point, direct the electrode toward the corner of the mouth and remain superficial.	Whistling motion of the lips.
Paraspinals, Cervical (Erector Spinae)	Posterior primary rami	C1 through T1	Adjacent to the cervical spine, in vertical line with the midpoint of the nuchal ridge. The electrode is inserted perpendicular to the skin and must travel through trapezius before reaching the paraspinals. This transition is a fascial plane separating the two. The insertion point shown is for the midcervical paraspinal muscles.	Gentle isometric neck extension, with the electrode in subcutaneous tissue first.

Paraspinals, Lumboscral (Erector Spinae)	Posterior primary rami	L1 though S1, (S2)	The point halfway between the posterior superior iliac spine and the midline corresponds to the low lumbar paraspinal muscles. Needle electrode insertion for more proximal or distal levels is through the same point and along the line parallel to the spine. The electrode is directed perpendicular to the skin and somewhat medially, toward the deeper paraspinal layers.	Hip extension. This will secondarily cause the paraspinal muscles to contract.
Sternocleidomastoid	Spinal accessory, cervical plexus	Cranial nerve XI, C2, C3	Midway between the mastoid and clavicular attachments of the muscle. Enter it from its lateral side and parallel to its course.	Have the patient turn the head to the opposite side, against your hand.
Tongue (Genioglossus)	Hypoglossal	Cranial nerve XII	Midpoint between tip of chin and the angle of the jaw, medial to the mandible. The tongue is found deep here, after the electrode passes through mylohyoid and geniohyoid muscles.	Protraction of the tongue. Ask the patient to stick out the tongue.
Practice Session!!				
Write any 5 muscles below from the Upper extremity and fill the adjacent columns				
1				
2				
3				
4				
5				
Do the same for Lower extremity!				
1				
2				
3				
4				
5				
Try different muscles now and keep practicing!				

