NEURO-MUSCLE ESSENTIALS

ROLES OF MUSCLES IN MOVEMENT

- **Prime movers** -- also known as agonists, are the primary muscles which initiate, carry out, or maintain movement. During a movement, they may contract concentrically (shorten) or eccentrically (lengthen).
- **Antagonists** -- oppose the action of another muscle. Antagonists work eccentrically to control or decelerate the motion created by the prime mover. They are inhibited by a reflex mechanism originating from the agonist known as reciprocal inhibition (keys 46).
- **Stabilizers** -- contract to control, or fix, the position of the bones to provide a stable base for the prime mover to act on. Stabilizing muscles engage just prior to the prime movers.
- **Synergists** -- cooperate, or help, with the prime mover and others to perform a movement. Synergists are part of slings, chains, and force couples that create synchronized movement.

MUSCLES DO NOT HAVE ORIGINS AND INSERTIONS.
Rather, muscles have attachment points. A muscle’s action may differ from what is taught in traditional anatomy class, depending on its role in the movement and its orientation relative to the movement. Oftentimes, a muscle serves multiple roles in function and may influence function at both its distal and proximal end. Below are a few examples:

- The biceps bring the forearm to the shoulder in a typical curling movement, but bring the shoulder to the forearms in a chin-up movement. This is the same muscle and same movement (elbow flexion), but with a different point of stability in each exercise.
- The distal hamstring brings tibia toward the pelvis to flex the knee, and the proximal hamstring extends the ilium over a fixed femur in standing. This is the same muscle, but different movements based off which end is being stabilized.
- The proximal end of the vastus lateralis is an internal rotator of the femur when the foot is planted on the ground and it works with the biceps femoris and co-contracts to stabilize orientation of the femur in stance.
OUR MUSCLES NEVER FUNCTION IN ISOLATION.
Muscles organize 3-dimensionally in slings, chains, or force couples. Movement patterns are produced by activation of these muscle chains to manage our position in space and balance limb and joint position against the load of gravity and the loads we place on our body in the gym. Therefore, even with targeted isolation training as seen in physique or bodybuilding, no muscle ever functions alone:

“If larger loads are imposed on a given muscle group by intense resistance, isolation becomes virtually impossible. **Immediately, once a load is applied, stabilizing muscles become involved to ensure that the body or specific joints remain stable, while the prime movers attempt to cope with the load.** If the nervous system signals that the prime movers are inadequate to execute the desired joint action, assisted movers, shunt muscles, emergency muscles, and neutralizers * maybe all recruited to augment the action of the prime movers. The higher the intensity or the greater the duration of exercise, the less likely is isolation of the prime mover. In many cases, the tension developed in the stabilizers or assistant stabilizers will equal or exceed that of the prime mover”. – Verkhoshansky

* “assisted movers, shunt muscles, emergency muscles, and neutralizers” refer to stabilizers or synergists

THE FUNCTION AND ROLE MUSCLES HAVE IN MOVEMENT ARE DIRECTLY AFFECTED BY POSITION
Traditionally, if muscle weakness has significant effect on performance, we “strengthen” it, and if a muscle has poor flexibility affecting performance, we “stretch” it. Not in PRI, while we value that muscles have length-tension relationships we appreciate how balancing position affects muscle tone and we use muscle facilitation and inhibition to help restore functional tri-planar balanced tone around our joints.

The nervous system will signal certain muscles to work based off their position in relation to gravity and other surrounding structures. The tone at which muscles organize around body segments is neurological. How muscles control position is neurological. How position affects movement behavior is neurological. Therefore we must always respect the brain and the neurological system’s superior influence on muscles, orthopedics, movements and posture. In order to have a solid appreciation of this, we need to understand two key neuromuscular terms: FACILITATION and INHIBITION.
BALANCED TONE

Movement patterns involve sequences of muscle activity that respond to postural demands and challenges. These patterns are heavily influenced by cortical postural centers (visual-oculomotor and vestibular) and, to a lesser degree, spinal reflex centers. The CNS constantly monitors the loads placed on the body through the information it receives from sensory receptors. The sensory input is perceived and interpreted by the CNS to determine which muscles to facilitate, or “turn on”, and which to inhibit, or “turn off”, in order to perform a movement efficiently with minimal deleterious effects to our joints and soft tissues. The CNS has a range of options to protect and promote function. Under normal conditions, the higher cortical centers allow us to move with minimal attention and effort. However, under increasing stress – i.e. faulty position or too much load -- spinal reflex centers increase in activity. The result is an increase in tone of the trunk muscles that stabilize and extend, thus dys-synchronous patterns of muscle activity. Through repetition, patterns are reinforced and become habit.

“Tone” is the state of tension that is maintained continuously, minimally even when relaxed, and which increases in resistance to passive stretch. Compromised position of a limb or joint alters the normal length-tension properties of their associated muscles, creating 2 situations:

1. Hypertonicity – overly-facilitated secondary to reflexive, protective response to noxious, tensile stressors; may lead to tight/short antagonistic muscles and movement limitations in one or more planes.
2. Hypotonicity – overly-inhibited secondary to pain or over-stretching; leads to excessive movement in one or more planes.

*Tone that is not opposed or balanced leads to altered, compensatory patterned movement.

The pictures below exemplify how proper start position of a loaded squat effects alignment of joints, and thus muscle activity, throughout the maneuver. The individual in 2a has his thorax in a compromised position, therefore affecting the position of the surrounding joints and muscles via common attachment points and interdependent relationships. Articular surfaces become incongruent risking tissue damage. Is this position really the most favorable to bear maximum load? Balancing the position of the thorax can promote well-balanced loading throughout the spinal column, discs, and various articulations.
The answer to maintaining balanced tone, and restoring neuromotor control, is not simply to strengthen weak, hypotonic muscles and stretch tight, hypertonic ones. This approach fails to address underlying positional faults and the subsequent altered afferent input. This course of action will only contribute to the abnormal tonic states.

Instead, restoring balanced tone first requires placing the joint(s) in a position that fosters healthy afferent input to, in turn, inhibit hyperactivity. Incorporation of healthy respiration further regulates stress inputs. For this reason, breathing techniques are emphasized in every PRI program. Once sufficient inhibition is achieved, a new movement pattern can be introduced, with retraining of specific muscles to maintain the new position. The muscles that were habitually underused must be retrained for muscular strength and endurance, to reinforce and maintain the new, healthy patterns of movement.

SKILLED MOVEMENT
Patterns usually begin early on as an individual trains or performs certain skills specific to their sport. The specific kinetic requirements of the skill contribute to the neurologic feedforward developmental process that can result in desirable or undesirable movements. As new movements and tasks are introduced, motor learning takes place with repetitive practice. Inhibition helps an individual master movement. Initial crude movements become more refined and economical as unwanted and unnecessary muscle tension is reduced.

While it is important for patterns of behavior to exist for one to excel in sport, it is also important that symmetry and maximal joint movement are maintained and not sacrificed due to contralateral or antagonistic over use. Patterns need to remain challenged and balanced through biomechanically sound, rhythmic, alternating, and asymmetrical activity that protects against injury due to overuse, underuse, or misuse.

Skilled, synchronous movement patterns occur when there is the correct amount of muscle activity, in the correct muscles, at the correct time.