

# Muscle Coordination

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Functional movements require integrated **coordination** of many muscle groups:

EXAMPLE - grasping ball:

- primary movement is *flexion of thumb and fingers* with *opposition of thumb and little finger* - this requires contraction of several muscles (these prime movers are called **AGONISTS**).
- in order for grasping to be smooth and forceful, *thumb and finger extensors* need to relax (at same rate as flexors contract) - these muscles (that act in directly opposing manner to agonists) are **ANTAGONISTS**.
- secondary action of thumb and finger flexors is to flex wrist; because wrist flexion tends to weaken finger flexion if both occur, activation of *wrist extensors* assists grasping movement - muscles that produce such complementary movements are **SYNERGISTS**.
- finally, arm needs to be held in stable position as grasp occurs, so that ball is not knocked away before it is secured - muscles that stabilize limb position are **FIXATORS**.

Coordination is **regulated** by three-level hierarchy of motor control:

**Lowest level** - **segmental reflexes in spinal cord:**

- 1) facilitate agonists and reciprocally inhibit antagonists.
- 2) control rhythmic patterns of movement that involve more than single pair of agonists and antagonists (e.g. lumbosacral spinal cord contains basic programming for cyclical stepping movements).

*automatic (spinal) stepping* can be elicited in humans with clinically complete cervical or thoracic cord transection by having patients partially supported on moving treadmill.

**Intermediate level** - **bulbospinal pathways** - integrate visual, proprioceptive, vestibular feedback into execution of action (e.g. locomotor center in mesencephalon is required to modify cyclical stepping movements in order that balance be maintained and forward movement occur).

**Highest level** - **cerebral cortex** - necessary for activities to be goal-directed; precise movements (that are learned and improved through practice) are also initiated and controlled by motor cortex.

Execution of these actions also involves input from **basal ganglia** and **cerebellum** (to facilitate agonists, synergists, and fixators and to inhibit undesired antagonists).

BIBLIOGRAPHY for ch. "Muscle Coordination, Postural Control" → follow this LINK >>  
"Harrison's Principles of Internal Medicine", 1998