"Perfect Stretching"
Rod Johnson IV degree thesis 2001

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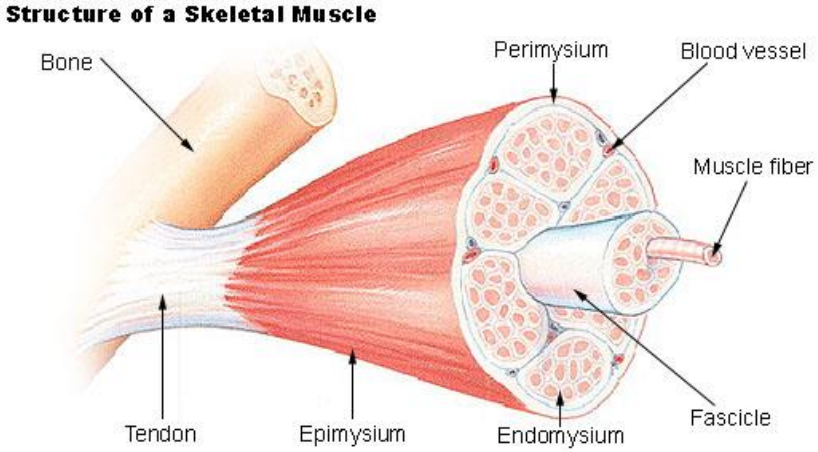
For many of us stretching means "making our muscles get longer". Additionally, most of us believe that the harder we stretch a muscle the longer it gets. This leads people to think stretching is similar to pulling a rubber band. Discomfort (no pain, no gain) is seen as part of the process to stretching our muscles. However this approach to "stretching" is incorrect. It can lead to muscle damage and eventually joint hyper mobility problems.

This paper will outline what a muscle is, why there is initial discomfort when you stretch, what is happening as your muscle relaxes and elongates (stretches) and the correct approach to perfect stretching. By better understanding the biomechanics of muscle "stretching" my hope is that students will avoid unnecessary pain and discomfort while stretching and develop improved flexibility over time.. The paper will consist of five (6) parts:

- Muscle structure
- The key "players" in stretching
- How muscles stretch
- Correct stretching protocol including the four golden rules for stretching
- How do you improve long flexibility
- Benefits of stretching.

Muscle Structure

Knowledge of muscle structure can help visualize the inner workings of your muscle tissue to focus on the specific mechanisms that help you stretch. You can optimize your efforts if you know whether the tightness in your legs, hips, arms, etc… is due to poor skeletal alignment, stiff connective tissues or nerve reflexes designed to keep you from hurting yourself.

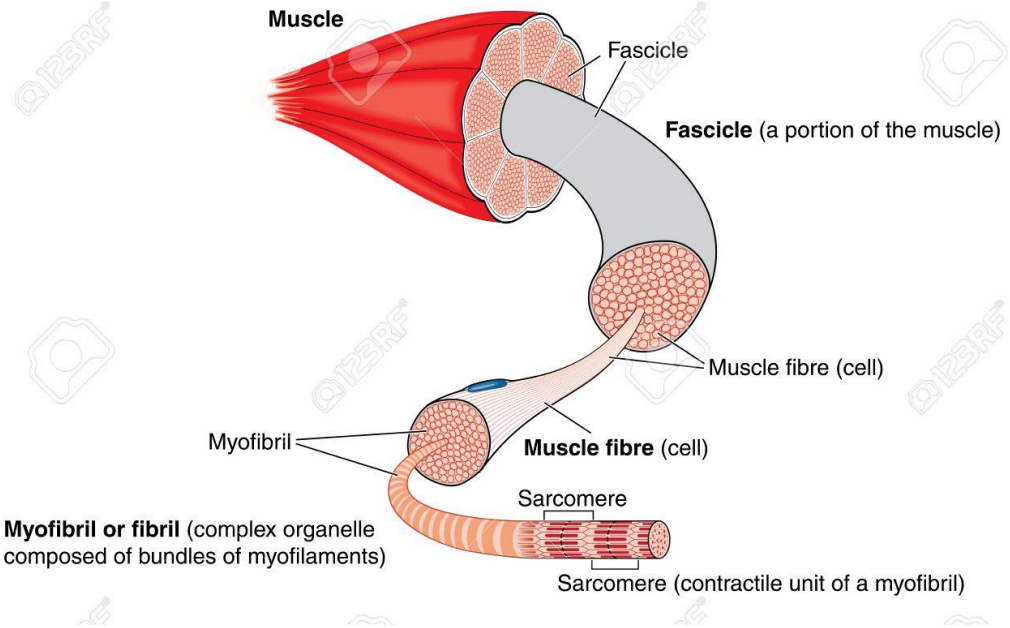


A muscle can be defined as several groupings (or bundles) of fibrous tissue/muscle fibers that has the ability to produce movement or maintain body position. Each bundle of muscle fibers is called a fascicle and is surrounded by a layer of connective tissue called the perimysium.

There are three main types of muscles; skeletal, smooth muscle (found in the internal organs) and heart muscles. Skeletal muscles are the voluntary contractile muscles that move us about. They have the ability to contract (shorten) or lengthen (stretch). They are attached directly to the bones by tendons. There are roughly 640 skeletal muscles in a body

Skeletal muscles compose 42% of a male's weight and 25% of females. This accounts for the usual strength difference between men and women. Each muscle contains 200,000 to 500,000 muscle fibers. A muscle fiber

is typically 40-100 micrometers thick and, with some exceptions, 1-40 millimeters long (the Stapedius muscle is the shortest muscle at 1mm in length, the Sartorius muscle can grown to 600mm or 2 feet).



Each muscle fibre is sheathed by surrounded by connective tissue called the endomysium. The endomysium contains capillaries and nerves.

The muscle fibre consists of small segments called myofribils which in turn consist of even smaller repeating units called sarcomeres. There are between 2,000 and 2,500 sarcomeres found together in linked coils in each 10 millimeters of muscle fibre.

A sarcomere is the basic contractile and elongation unit of muscle fibers. It is composed of two main protein filaments (thin actin and thick myosin filaments) which are the active unit responsible for muscular contraction and elongation. The filaments are 6-8 nanometers in length. A sheet of paper is roughly 100,000 nanometers wide.

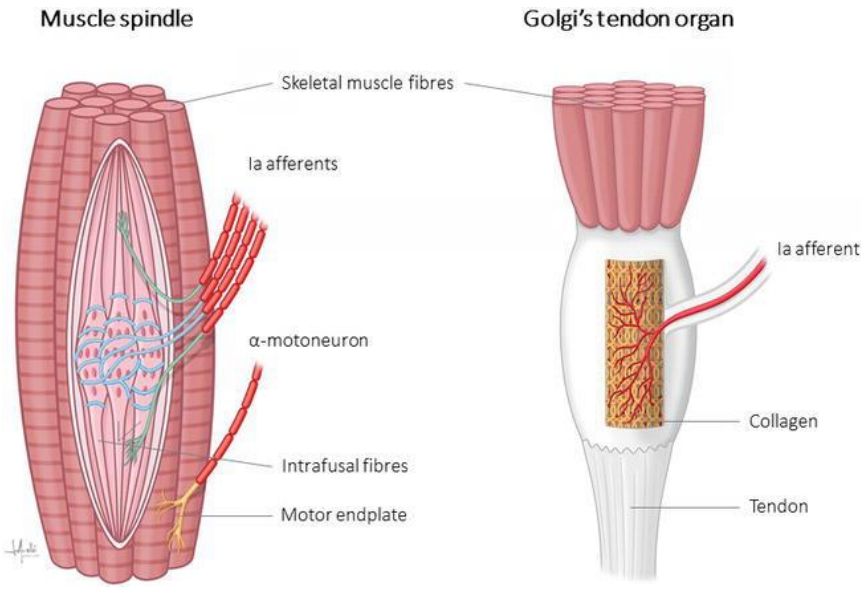
The whole thing is absolutely mind boggling.

Key “players” in stretching

The biochemistry of muscle movement is extremely technical and beyond the scope of this paper. Briefly, body movement and flexibility revolve around the relationship between the actin and myosin protein filaments found in the sarcomere. (Additionally three other proteins troponin, tropmyosin and titin contribute to the successful process of stretching)… And if you are looking for a heady diner conversation topic titin is the largest protein known to science and its correct name consists of 189,819 letters making it not only the longest word in the English language but the longest word in human lexicon.

Two other components integral to a muscle stretching are muscle spindles and the golgi tendon organs. Both are proprioceptors.

Proprioception (or kinesthesia) is the sense through which we perceive the position and movement of our body, including our sense of equilibrium and balance. Proprioceptors are nerve endings which detect changes in physical displacement (movement or position) and any changes in tension or force within the body.

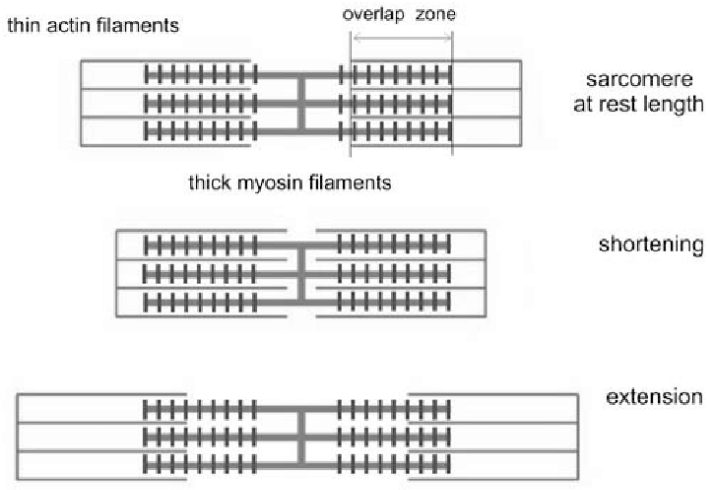


Muscle spindles are proprioceptors which run parallel to the muscle fibers. They sense changes in muscle length.

Golgi tendon organs are proprioceptors located at the point where muscle is connected to tendon. The sense changes in muscle tension.

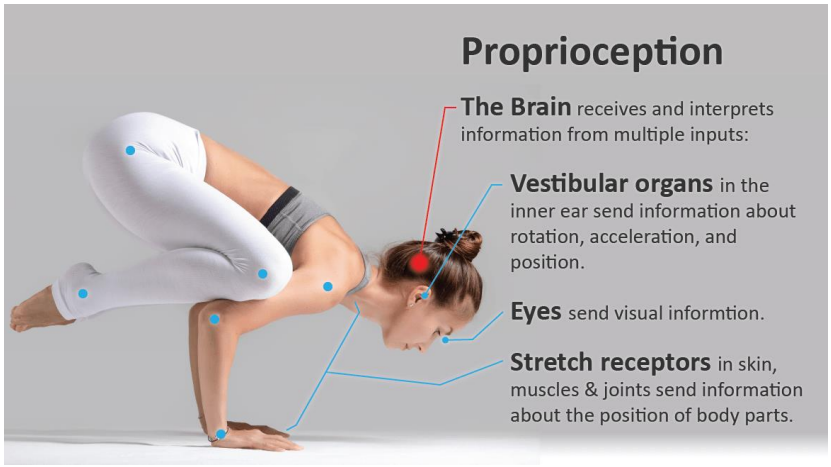
How muscles *stretch:* A moment in the life of actin and myosin filaments

When a muscle is at rest there is a small overlap of the actin and myosin proteins within the muscle fibers sarcomerse. This positioning of the proteins is referred to as the resting length of the myofilament. In the diagram you can see the overlap of the actin filaments over the "spiky" myosin filaments. The initial tension on the muscle stimulates the muscle spindles to send an impulse to the spinal cord. This impulse results in the activation of more motor neurons at spinal level that send an impulse back to the muscle resulting in the actin and myosin muscles contracting (or shortening) to protect the muscle. The contraction creates stress on the golgi tendon organ which then overrides the shortening or contraction. The Golgi tendon organ tendon reflex operates as a protective feedback mechanism to control the tension of an active muscle by causing relaxation before the tendon tension caused by the muscle spindles reaction to stres becomes high enough to cause damage.



Correct stretching protocol:

Prior to stretching muscle tissue it is important to warm up the muscles. This will increase tissue temperature and blood flow resulting in safer and more productive stretching. Pushups, sit ups, walking, isometric exercise, and gentle movements for five minutes or so will generally prepare the muscle for stretching. Incorrect warm ups such as jumping rope, jumping jacks and slow running should be avoided. When a muscle is cold it cannot effectively absorb the shock these exercise produce. The sudden ballistic



loading of the landing impact causes thousands of micro tears which, over a period of time, may result in discomfort or even extreme pain in the lower leg muscles.

The Four (4) Golden Rules for Stretching:

Once the muscles are warmed up perfect stretching should follow the following guidelines:

1) Isolate the muscle group to be stretched in a position where the muscle group is not expanding energy to maintain a position. For example many of us think that leaning over to touch our toes provides a good stretch for our hamstrings. However when we lean over the hamstrings actually contract to help maintain our balance. In this position the hamstrings will not relax and allow the hamstrings to stretch

2) Stretch only until you feel the first gentle tension in the muscle group. At this point the stretch reflex has set in and the isolated muscle is group now contracting.

3) Allow the loss of tension. Do not attempt to stretch through the initial tension. Wait for the muscle to feel relaxed again. At this point the lengthening reaction is in place to overcome the stretch reflex. At this point muscle will start to comfortably elongate.

4) Only increase stress on the muscle until you feel the next gentle tension. Again wait for the tension to disappear before attempting to elongate the muscle any further.

It is often said that stretches should be held for 15 – 30 seconds. It should be noted though that stretches cannot be timed. The duration of a stretch changes daily. Various factors such as muscle fatigue, amount of warm up, initial stress on the muscle etc…will affect how your muscle responds. When stretching the focus should be on allowing the muscles the time required for relaxation/elongation. With practice a student will learn to listen to his/her body and depend on its biofeedback for proper timing.

Benefits:

A martial student stretches to improve his/her flexibility. Improved flexibility means better technique, increased power and more enjoyment in training. Correct stretching also provides many health benefits. Some of these are improved circulation, reduced anxiety, stress and fatigue, improved mental alertness, better posture, and decrease in the risk of muscle injury and muscle inflammation. By paying close attention to correct stretching a Taekwon-Do student can enjoy years of training and prolonged good health and well being.