[The Synapse: Intercollegiate science magazine](https://digitalcommons.denison.edu/synapse)

Volume 12 | Issue 1 Article 6

2017

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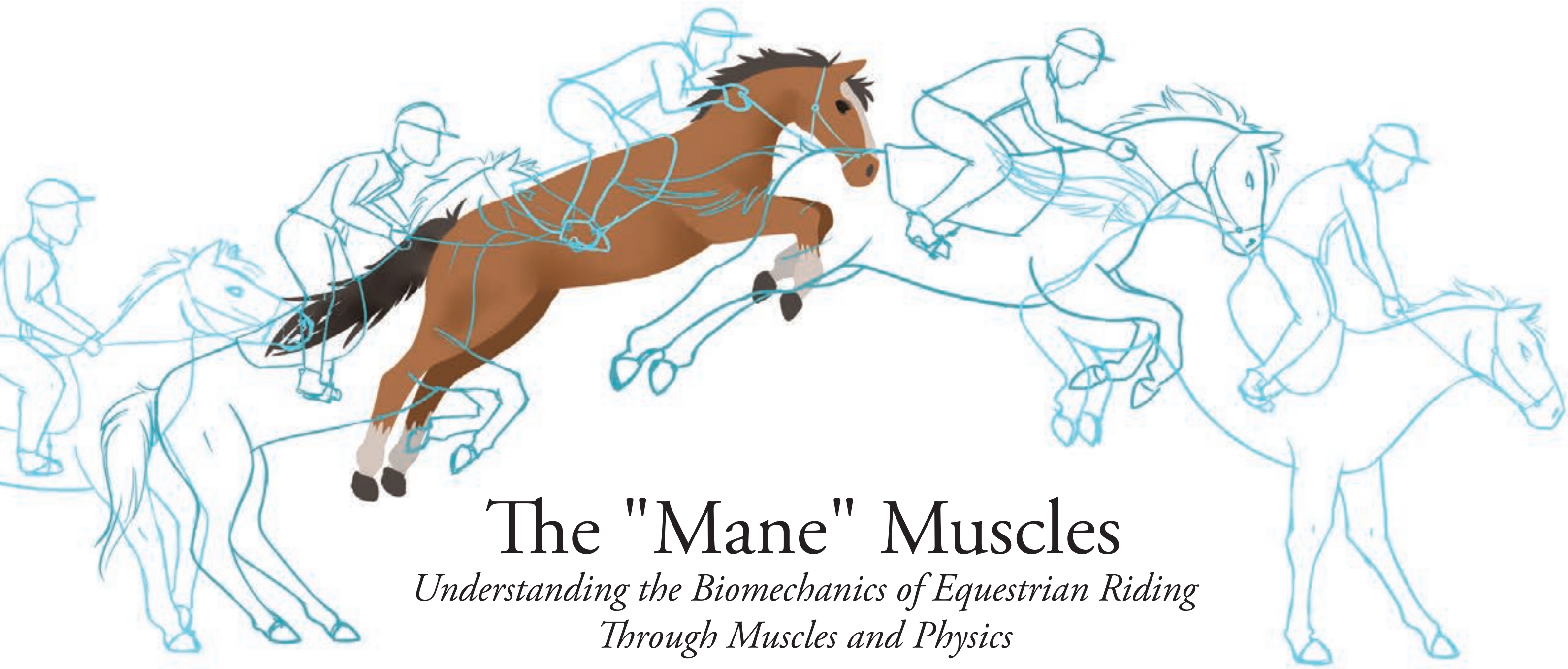

The "Mane" Muscles

Understanding the Biomechanics of Equestrian Riding Through Muscles and Physics

Written by Jayla Johnson
Illustrated by Jack Bens

Don't you just sit there?" "The horse does most of the work, though, right?" The specific mechanics that go into this sport and the coordination involved between horse and rider are perhaps the most misunderstood features of equestrian riding. The muscle movement of the lower back and legs of the rider and the muscles, tendons and bones that enable a horse to carry out the rider's commands all get lost in the awe of watching show jumping or dressage. The actions and physics required of both horse and rider are invisible, masking the complexity of the performance. To truly understand how a horse and rider jump over five foot fences, we must recognize and inspect the minuscule muscle interactions that occur in both the human body and in the horse.

Posture is vital for the rider and horse, keeping the rider on the horse and the horse balanced as he carries the rider over fences or around the arena. Strong abdominal muscles, including the linea alba, rectus abdominis, internal oblique, external oblique, transversus abdominis and tendinous intersection, are crucial for stabilizing the rider's midsection and spine while riding. The transversus abdominis, located right above the internal oblique and across from the rectus abdominis, provides stability between the rider's hips, ribs, and pelvis. For the rider to use seat aids correctly and remain in control over their arms, strong abdominal muscles are necessary. Engaging the abdominal muscles prevents the rider from losing their balance, and enables control over the hips to help them shift from side to side to cue and move the horse in specific directions.

The resilience and elasticity of the multifidus muscle, quadratus lumborum muscle, interspinales lumborum muscle, and other lower back muscles create a deeper seat and supple pelvis, both of which are crucial for good posture. These lower back muscles, in combination with the transverse abdominus, control the stability of the pelvis and must be strong enough to extend the rider's lower back in the canter so the rider can remain seated in the saddle as if they were "one" with the saddle. Specific positions in the saddle, such as the sitting trot, where the rider remains seated fully in the saddle with minimum bounce as the horse trots, are only possible with the use of these lower back muscles, which absorb the horse's movement. Stiffness of the rider's lower back muscles will cause the rider to bounce out of the saddle and make the horse less responsive to the rider's aids. The hip adductors, like the gracilis, adductor longus, sartorius, and pectineus muscles, provide riders with the ability for their thighs to grip. Given that the leg is constantly bent while riding, the grip of the rider's thigh provides stability for the bent leg.

The iliacus and psoas are muscles with roles that often overlap as the rider utilizes their lower muscles, together forming the iliopsoas or hip flexors. The psoas is involved with flexing the rider's hip and laterally rotating it, as well as flexing the spine sideways to extend and rotate it. The psoas attaches itself down the last thoracic vertebra, the lumbar vertebrae, and the discs between them, from the inside and top of the femur. Since the psoas manages the pelvis and controls the front to back motion, it has the power to restrict or release the rider's shock absorption of the horse's gait. When it is engaged with the rectus abdominis, it holds the rider in the center of the saddle so that the rider's seat bones are connected to the horse's back muscles on each side of the horse's spine. The iliacus begins at the iliac fossa on the interior side of the hipbone and releases the movement of horse below the rider. The psoas and iliacus muscles carry the torso vertically and prevent the rider from falling behind the line of gravity under the hip joints.

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Riding would be nearly impossible without engagement of the quadriceps, muscles found in the upper leg, and the calf muscles. Equestrian riders can thank their vastus lateralis, vastus medialis, and rectus femoris which allow them to rise in the trot and to grip the saddle during the canter. These muscles are among the strongest muscle groups in riders, and are constantly conditioned and worked during riding. The tensor fasciae latae muscles are responsible for turning the rider's thighs inwards to grip the horse, opening the hips for the rider to sit more easily (and comfortably) on the horse. While riding, the calf muscles in the human body rest against the horse's sides and convey aids to the horse by applying or lessening pressure against the horse's sides. It is also not uncommon for equestrian coaches to shout, "heels down!" at their riders if they notice a rider lifting their heel and pointing their toes down. If this happens, the rider could lose the support of their stirrup, a support that is especially helpful when jumping because it absorbs the impact of landing. The rider uses their tibialis anterior muscle to hold the foot up and the heel down.

The biomechanics of both horse and rider when jumping a fence occur in mere seconds, but determine rider and horse's clearance over the jump. Equestrian jumping involves four phases: the approach, the takeoff, the flight, and the landing. In the approach, the horse gathers energy as he prepares to jump and raises his head to better view the jump. Since horses are prey animals, they have monocular and binocular vision, giving them far better peripheral vision than humans. When the horse is about four feet in front of a jump, the obstacle simply vanishes from its line of vision. The horse must not only measure the jump and its own takeoff point during the approach, but must place its faith in the rider to correctly guide them over the obstacle. At the base of the jump, the horse lengthens his frame and reaches forward and down with his neck to lower his front legs and his center of mass. The horse's front legs are propped out in front of his body, and a sudden brake-like motion allows his momentum to carry his hind legs further under his body. This brief stopping of the forward momentum of the horse allows the horse to gather enough energy to clear the fence.

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During the takeoff, the horse's front and back ends undergo two shifts of energy. The first burst of energy comes during the takeoff, and is initiated by the forelimbs, using the stored kinetic energy released when the front leg muscles contract and straighten the fetlocks through the superficial and deep digital flexor tendons. The horse's trailing forelimb stretches out and propels the horse upward because it acts a slight braking force that converts forward movement into upward momentum, because the fetlock joints are briefly contracted by the muscles. As the horse lifts his head and neck, the front end is further pushed into the air by the contraction of the triceps brachii, biceps brachii, and supraspinatus muscles that straighten the shoulder and elbow joints. The horse's neck continues to shorten, stopping the normal forward movement of the canter. The thoracic sling, a system of muscles that lie deep against the skeleton under the shoulder blades, surrounds the thorax of the horse. The pectoral muscles of the front chest and between the front legs, and the ventral serratus that rests against the rib cage are the most vital muscles of the thoracic sling, because they lift the thorax of the horse between the shoulder blades. This movement is enabled by the structure of the scapulae of the horse, because they are attached to the horse's body through soft tissue structures and not through skeletal joints. The horse's withers rise relative to the top of the shoulder blades, providing crucial support as the horse's center of gravity shifts back and his front end lifts into the air. The back muscle, longissimus dorsi, runs from the sacrum along the back to the lower cervical vertebrae. When the horse's hind legs are stationed on the ground, the contraction of the longissimus dorsi creates a lever action on the horse's front end, allowing the horse to lift himself off the ground.

The flight of the jump begins with a rotation around the horse's center of mass. His front end tips upward at the takeoff, then becomes level with his haunches over the top of the obstacle before lowering the landing. The shape of a horse's trajectory through the air is the "bascule." The trapezius, brachiocephalic, and latissimus dorsi muscles contract to flex the horse's joints in the elbow and shoulder and lift the scapulae, lifting the forelimbs to clear the jump. The horse's folded forelegs bring his weight closer to his center of gravity, increasing his speed. Tension along the nuchal and supraspinous ligament helps further raise his center of gravity. After the bascule of the jump, the horse's head and neck begin to come up, shifting his center of gravity back. This action is a reflex to flex the hind limbs to clear the fence and to extend the forelimbs as the horse prepares to land. As the horse's forelimbs are extending for landing, the abdominal muscles are contracting to help lift the back while the gluteal and hip flexor muscles flex the hips, hock, and stifle to successfully clear the jump.

The dynamic nature of riding requires the human body to move and flow with the horse, and requires the muscles to follow and absorb the impact of the horse's motions and gaits.

For the horse to land a jump, he must slow his forward momentum so that the force of impact is reduced by swinging his neck and head up as his forelegs touch the ground. The trailing is often perpendicular to the ground, landing first and absorbing much of the impact of the jump. The deep digital flexor tendon and suspensory ligament are stretched so much so that the horse's fetlock usually touches the ground. The navicular bone is strained through the deep digital flexor tendon when the horse lands on his heel. The thoracic sling and the forelimb muscles contract to brace the leg and support the horse's joints. As the forefeet reach the ground after clearing the obstacle, the hooves push the horse's body up into the next canter stride, reversing the rotation of the body axis, allowing the horse's hind legs to step under his body and continue forward to the next jump. This entire jump sequence happens in a matter of seconds, displaying not only fast thinking on the horse's part, but also on the rider's side, because the rider must adjust their body before and after the jump and brace their body.

It's easy to forget or misjudge equestrian riding as a "simple" pastime that requires little skill or effort. The ease and lack of apparent effort by the horse and the rider is a big part of impressing the judges and putting on a good performance, but cloaks the complexity of this sport. The dynamic nature of riding requires the human body to move and flow with the horse, with the rider's joints remaining static but not stiff, and requires the muscles to follow and absorb the impact of the horse's motions and gaits. While unseen and unacknowledged, the strength, ability, and endurance of the muscles in the rider's body and the horse's body affect every aspect of this sport, from the physics in show jumping to casual riding around an arena, establishing balance, stability, symmetry and coordination that create the imposing sight of equestrian riding.