Equine Functional Anatomy Key Points:

Cervical Spine - Upper cervical flexion is produced principally by concentric contraction of the ventral muscles, sternocephalicus, longus capitis and longus colli. Sternocephalicus, aslo known as sternomandibularis, is obvious from a surface view as it forms the ventral border of the jugular groove.

Extension is produced by bilateral contraction of the erector spinae and dorsal cervical muscles. Lateral flexion and rotation are produced by cranial and caudal obliqe and straight muscles of the head, assisted by longus colli, splenius, semispinalis and brachiocephalicus. Of these, brachiocephalicus can be seen as the dorsal margin of the jugular groove. Splenius is also fairly superficial at its cranial end and runs caudal to brachiocephalicus.

The lower cervical and cervicothoracic movement is principally one of flexion, extension and lateral flexion. Flexion is produced by the bilateral action of the scalenes, with the longus colli and sternocephalic muscles. Brachiocephalicus may also be involved, although its principal action is to move the forelimb. Extension follows from erector spinae and dorsal cervical contraction. Lateral flexion is the result of unilateral contraction of ventral muscles such as scalenes and sternocephalicus, as well as most of the dorsal cervical muscles. The limited amount of rotation in this region is produced by small, deep muscles such as multifidus cervicis. During normal movement the spenius acts to reduce downward movement of the neck in trot, or to elevate it in walk to allow full protraction of the forelimb by brachiocephalicus.

Thoracic Spine – The muscles are divided into two categories. The epaxial muscles are those dorsal to the transverse processes and can act as extensors of the spine. The rest of the trunk muscles, ventral to the transverse processes are hypaxial muscles.

The Epaxial muscles are often referred in anatomy texts as being numerous and complicated and of which the details are “of no clinical significance”. Some description is necessary the Epaxial muscles divide into two groups the Epaxial cybernetic muscles and the Epaxial gymnastic muscles.

The Epaxial cybernetic muscles are short muscles running between the vertebral segments and include the interspinales, intertransversarii and rotatores. They are richly innervated with proprioceptors which monitor vertebral position and provide a continuous feedback to facilitate appropriate postural adjustments. Multifidus running in short oblique bundles between the spinous processes to the transverse processes are tonically active in all movements requiring trunk stabilization, suggesting a role in intersegmental stability. Interestingly in humans, multifidus activity patterns are altered and reduced in size in back pain patients and these changes remain even when the pain resolves. The continuing dysfunction leaves the patient suseptable to an increased rate of recurrence. This suggests that analgesic treatment alone may not be a long term solution.

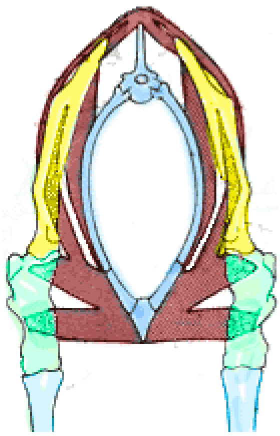
The Epaxial gymnastic muscles are the ones that produce movement. They form an unbroken chain of muscle running from the pelvis to occiput, tending to fuse over the loins, fan out in the trunk and split into additional units in the neck. They ascend in three columns.

The lateral column is formed by the iliocostalis muscle, the middle column is formed by the longissimus muscle and the medial column is formed by spinalis and the juxtavertebral mutifidus. These muscles form the bulk of the topline.

The hypaxial muscles (ventral to the transverse processes) either compliment or oppose the actions of the expaxial muscles. In terms of gross movement, the hypaxial muscles are antagonistic to the Epaxial muscles, but with regard to complex movement they work synergistically to create vertebral column stability and controlled, smooth movement. The hypaxial muscles include psoas and quadratus lumborum as well as the abdominal muscles.

At low speeds such as walk, a fair bit of flexibility in the thoracolumbar spine allows lateral flexion and rotation, to a lesser extent, flexion and extension. At higher speeds , there are advantages to stabilizing the vertebral column so that the “bow” is straightened. Stiffening the column will allow propulsive effort generated by the hindlimbs to be transmitted through the spine to produce forward movement. It will also facilitate balance and stability in those inherently unstable asymmetric gaits, the canter and gallop.

The Limbs: Equine limbs are specifically adapted for speed and in the process have lost versatility. They have been lengthened, particularly below the carpus and tarsus, by bringing the equivalent of the wrist and heel well of the ground, a posture which is referred to as unguligrade. The limbs are carried by two specialized girdles which are different to reflect their particular functions. The Thoracic girdle (60% of weight bearing) carries the forelimb has no clavicle, is without bony connection with the vertebral column and is therefore eminently suitable for a shock absorbing role. This connection is referred to as a synarcosis (syn=connection with; sarcosis = flesh) in the form of a muscular sling, suspended between the struts of the forelimbs. Rotation of the thorax in the sling (sling muscles; serratus ventralis, deep pectoral, rhomboideus and trapezius mucles) is what allows for much of the lateral movement in dressage or fast turns in polo. The contraction of serraturs and pectoral muscles lifts the thorax in relation to the forelimbs which raises the center of gravity. The focus for this union is the scapula which is important in both support and movement. The Pelvic girdle is strongly linked with the spine in order to provide power generated by the hindlimbs that can be transmitted through the spine to produce forward propulsion. Most of the muscle bulk is located in the girdle and proximal limb region. Distal to the carpals and tarsals the mechanism is largely tendinous and the energy acquired by the fibers when these tendons are stretched is released as they are allowed to recoil (elastic recoil).

 Muscles of the thoracic sling

The hindlimbs take only 40% of the weight of the horse but generate 85% of the power for forward propulsion. In contrast to the forelimb there are firm connections between the legs, pelvis and spine. The limbs also have a mechanism (reciprocal apparatus) involving the stifle and hock which provides a rigid strut through which force can be transmitted from the ground into the spine.
It is suggested that the patella locks as a result of a slight medial rotation of the tibia and unlocks with a slight lateral rotation. The hock acts as a shock absorber therefore a region susceptible to strains and degenerative changes.

Stabilizing structures of the fore and hind limb: An arrangement of ligaments and tendons provides support for a bony column which is not straight. It is a low energy system which allows the horse to stand for longer than other domestic species. The "Stay Apparatus" which is present in all legs, and the "Reciprocal Apparatus" present in the hindlimbs and the Suspensory Apparatus which is a part of the "Stay Apparatus" provide the mechanism for stability.

Remember conformation is structural and unchangeable whereas posture is moldable.
A well balanced horse can be divided into 3 equal parts.

1. Cranial third: from just behind the poll to the scapula
2. Middle third: from the scapula to the point of the hip (tuber coxae)
3. Caudal third: from the point of the hip to the buttocks (tuber ischia)

Observation:

Walk – The amount of time each leg should be in contact with ground, and the position of each foot in relation to the other.

From Behind: Watch how the ilia move up and down like pistons, stiffness in the In the SIJ and lower lumbar regions may suppress this movement Unilaterally or bilaterally also look for a flattened appearance of Hindquarters.
As the horse moves forward the hindquarters should show a degree Of lateral movement. Pelvic dysfunction may cause this

movement to be greater to one side than the other is the tail held to one side?
Line of flight and elevation can be assessed by watching the hoof it Should be possible to see the underside of all the hooves equally. The hindlimbs should swing freely backwards and forwards with minimal lateral or medial deviation. Lumbar spine and pelvic stiffness cause exaggeration of lateral & medial deviation.

<u>From the Side</u>: Look for a serpentine type of movement where the flow moves all the way from front to back without interruption. Check for evenness of step and stride length. Look for the 'V' formed by the ipsilateral fore and hind limbs.

<u>From the Front:</u> Look for structural dysfunction (winging, dishing etc.) Lower cervical issues will show a pinched pectoral region dysfunction further down the spine causes the hindlimb to fail to track into the fore foots track.

Pain is difficult to quantify in animals. As a herd animal its survival depends on being able to keep up with the group so predators stay away. In the case of injury, it is in its best interest to make adjustments and carry on moving (compensation) leading to long standing dysfunction. Treating the local acute area of may be effective in the short term, but problems tend to recur, generally with increasing frequency, intensity and duration. Movement restriction leads to dysfunction which leads to pain.

Movements are made by complex interactions of agonist and antagonist muscles. This interaction is largely unconscious and is orchestrated by patters of neuronal activity originating from within the spinal cord, called central pattern generators (CPG's). However, for optimum function, this neuronal activity needs to be modified to reflect changes in the environment. It is the contact stream of proprioceptive information from muscle spindles and Golgi tendon organs that occur as joints are moved and muscles change length that provides the central nervous system with detailed knowledge concerning current position and changes in the orientation of the body.

Central Modification at the spinal cord level: Inputs into the spinal cord from large diameter neurons of joint, muscle and skin receptors, which provide information on the position of the body in space awareness of the external environment. These inputs are largely inhibitory on the small nociceptive fibers responsible for pain perception. Treatment is essentially aimed at improving mobility, which increases afferent input from proprioceptors of muscles and joints which act to inhibit or 'gate' pain pathways. Treatment consists of soft tissue and articulartory, mobilization, and positional release techniques that stretch the skin, fascia and muscles to improve pliability of and nutrition to the periarticular tissues and allows the joints to move through their full range of motion.

Positional Release Techniques: This uses the idea of 'ease' and 'bind'. A normal joint will reach a point, usually at the middle of its range of movement, where there is a minimum tension on the capsular ligaments and overlying muscles, and this is referred to as the point of ease. Any movement away from this point will increase tension or bind. This information will be relayed to the central nervous system where it is processed to map joint position and to generate an appropriate pattern of motor activity. Where the normal relationship between the joint structures has been disturbed, this point of ease will be offset and afferent information from that joint will be changed at rest and for any given movement. Difficulties arise with imposing new reference points on well established networks, and the joint is less able to perform appropriately or to co-ordinate movement with other joints. This new abnormal point may be isolated by testing each range of movement (flexion/extension, side-bending, rotation, translocation from side to side, traction/compression). With the joint held in this position there is minimum tension, and therefore minimum afferent input into the spinal cord. This appears to reduce conflicting information entering the network and allows the old pattern to reassert itself. This pattern is preferred by the system as, over time, neuronal connections have been created the fire more readily to generate a learned response.

Descending Modification: Centers such as the periaqueductal grey and raphe nuclei of the brain stem can inhibit pain. Increasing the activity of these descending pathways by using specific sedatives, together with large fiber inhibition from physical treatment, can provide a powerful dual down-regulating effect on the pain pathways (Yaksh 1999).