EQUESTRIAN

Take a fresh look at equine anatomy and biomechanics with this graphic guide to how horses move, presented from the inside out

Understand how bones and muscles work together to produce movement by seeing the musculoskeletal system painted on a real equine canvas

Discover how correct riding and training can bring out the best in your horse – increasing fitness, strength and balance – by seeing exactly what happens as he moves

Practical exercises and stretches demonstrate how you can improve suppleness, reduce the risk of injury, gain confidence and develop a deeper rapport with your horse

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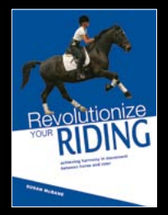

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How your Horse MOVES

Gillian Higgins with Stephanie Martin

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A unique visual guide to improving performance

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This book is dedicated to Freddie and Quake.
Two very special horses to whom I owe my
passion for anatomy and biomechanics.

A DAVID & CHARLES BOOK

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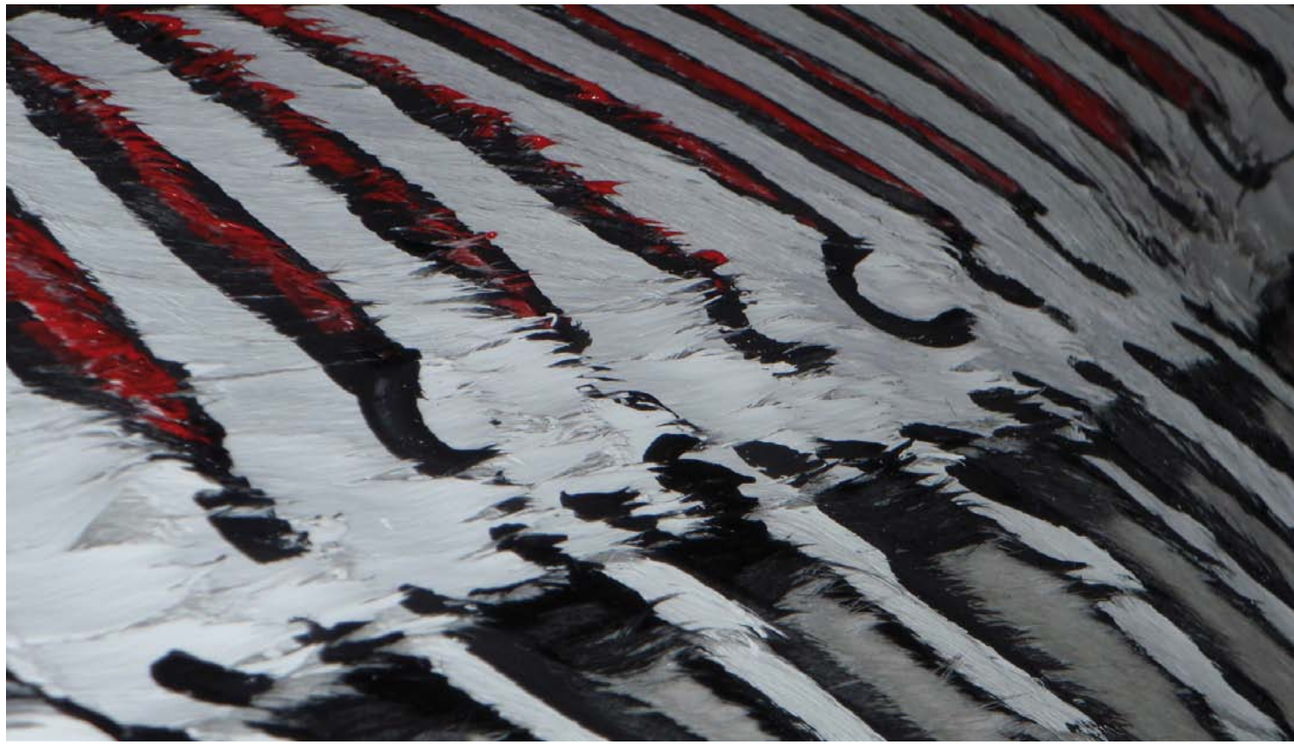


FOREWORD

I first met Gillian as a fellow competitor on the eventing circuit and after my Olympic horse Ringwood Cockatoo experienced some muscle problems. I approached Gillian to come and treat him, knowing that she has a very high reputation in treating horses and also great knowledge about the different jobs an event horse has to excel at.

I have been competing at International Level since 1982 and also train many other top event riders from numerous different countries. I have represented my country, Germany, at nine European Championships, four World Equestrian Games and three Olympic Games.

When Gillian came to treat Ringwood Cockatoo, I made sure that I was present to watch her working and also to talk about her philosophy. Being a top athlete myself, I am aware of the importance of certain muscle groups that are used whilst in the saddle, in particular to core stability, which is vital to be able to maintain good balance.

Interestingly Gillian and I shared the same strong views on the way muscles are used in both the rider and in the horse. With riding you always have ups and downs and these are often down to your horse being injured.

By reading *How your Horse Moves* and putting into practice Gillian's thoughts, ideas and concepts I strongly believe that you can reduce unnecessary damage to your horse, be this by getting them fitter, or stronger, or just more balanced.

Obviously only a perfectly balanced rider will be able to train a horse to reach the top level of its chosen discipline and only a perfectly balanced horse will be capable of doing so.

Gillian is gifted in her ability to see and explain what others cannot within a horse. Her lecture demonstrations are thoroughly entrancing and you cannot help but come away with something new to try out. The 300 photographs and illustrations in *How Your Horse Moves* show the anatomy of the horse and its biomechanics, making it very visual and easy to understand.

It doesn't matter what level or discipline you ride in or even if you are preparing for an exam, this book should be read by anyone interested in having a full understanding of the horse.

BETTINA HOY

I first met Gillian Higgins when she came for training with her event horses as a young rider in about 2000. She showed a talent and interest then, not just in competing her horses but also in understanding the system of training. As a trainer I have always wanted to first understand the logic behind a system of training and then to explain to riders, not just what to do but why it makes sense to do it. An understanding of the biomechanics helps a rider to train more sympathetically as well as more effectively. Gillian's obvious interest in the 'why' as well as the 'what' led to her going on to train as an Equine Remedial Therapist.

Having seen Gillian's 'Horses Inside Out' presentation, when I was asked if I would read her book, I was immediately interested and not disappointed. The step-by-step, thorough explanation of the musculoskeletal system and its relationship to schooling and conditioning the sport horse is both sufficiently detailed for the serious student whilst being easy to read and follow. The book is attractively laid out with clever use of live 'models' to show how the various components of the horse's body function and develop during a horse's sporting career. I especially like the 'Top Tips' and the summaries at the end of each section.

Gillian's knowledge of the principles of training combined with the understanding of how the musculoskeletal system functions enables her to offer useful advice and tips on schooling. The sections on 'The Way of Going' and 'The Gaits' help to clarify the relationship between the expressions used in training and dressage judging to the form and function of the horse's body.

As any of us who have participated in sport know, we will be affected by muscle soreness as a result of exercise and we all benefit from deep massage and stretching exercises. The horse is no different so the sections describing common problems and then on how to persuade the horse to perform useful stretching exercises by using a combination of carrot and reflexes is very practical. If performed regularly, it is also useful in assessing if there are any musculoskeletal problems or changes that are the root cause of schooling difficulties. Professional help can then be called upon before the problem causes a mental block on the part of the horse.

The brief section on choice of horse is not just helpful in finding and purchasing a horse but also in understanding where the horse may struggle to perform when their conformation or type does not lend itself ideally to a chosen discipline. The combination of this understanding together with correct and sympathetic training will enable riders and trainers to get the most out of the horse that they have.

I am always looking for books and other ideas to recommend to my students to improve their understanding of how a horse performs and the logic of the training system. This will certainly be one of them.

CHRISTOPHER BARTLE

'Why is an anatomy lesson worth your time – time you perhaps feel is better spent actually riding your horse? It is my feeling that in order to truly consider oneself a rider one must be educated in the horse's basic physiology, conformation and behaviour. If you know how the horse is built, how its skeletal, muscular and ligament systems work together, and how its actions are controlled in part by instinct along with other aspects of the mind, then it only follows that you know better how to ride it.'

Dr Gerd Heuschmann
Tug of War
Classical versus 'Modern' Dressage, 2006, translated 2007

INTRODUCTION

This book is all about getting the best from your horse, improving his performance and more importantly his welfare. Not every horse is going to be a world beater and many disappointments could be averted if riders' understood how and why their horses move in the way they do. It would enable them to accept physical limitations, train with empathy, achieve realistic goals and bring out the best in their horse.

As a therapist, I constantly see horses with muscle imbalances and tension, caused by rider imbalance, asymmetrical muscle development or by expecting too much too soon from a horse whose musculature is not up to the challenge. For a horse to perform well, it takes time for the musculoskeletal system to develop the appropriate strength for the task, time to learn to balance both himself and the rider and time to assimilate that which he is being asked. The rider needs the time and patience to forge a relationship with his horse. This requires empathy, tact and respect. Time spent in this way is never lost. It is far better to prevent a problem than to have to find a cure.

Seeing the musculature and skeleton painted on the horse enables riders to see how the horse moves from an anatomical perspective. The unique artwork used in Horses Inside Out lecture demonstrations provides a living equine canvas that shows how bones and muscles work together to produce movement. The reaction to these lectures has been overwhelming and comments such as 'I wish I had known this 20 years ago!' I have ridden all my life and now everything I have been taught has fallen into place!' are not uncommon.

The book is divided into three sections:

- **Part one** looks at the component parts of the musculoskeletal system and takes the reader on an anatomical journey through the technical aspects of 'How Your Horse Moves'. It is designed to inform readers of the basic principles that will be referred to in the text that follows
- **Part two** looks at various applied aspects of 'How Your Horse Moves', from how he bends and jumps to how he uses his limbs and maintains an outline. This basic understanding can be very useful in riding, training, analysing ways of going, improving performance and caring for your horse
- **Part three** suggests ways in which the reader can keep the horse moving freely, paying particular attention to the musculoskeletal system. It contains a wealth of practical advice and suggestions showing the reader how the horse's musculature can be maintained in optimum condition.

The book is designed either to be read as a whole, or to be dipped into as required. Although there are suggestions on how to achieve some of the desirable qualities required for good movement, it is not intended to be a training manual. It attempts to explain how and why the horse moves as he does.
We all want our horses to perform to the best of their abilities but ultimately it is up to us to be sensitive to their individual requirements, physical capabilities and wellbeing.

ACKNOWLEDGMENTS

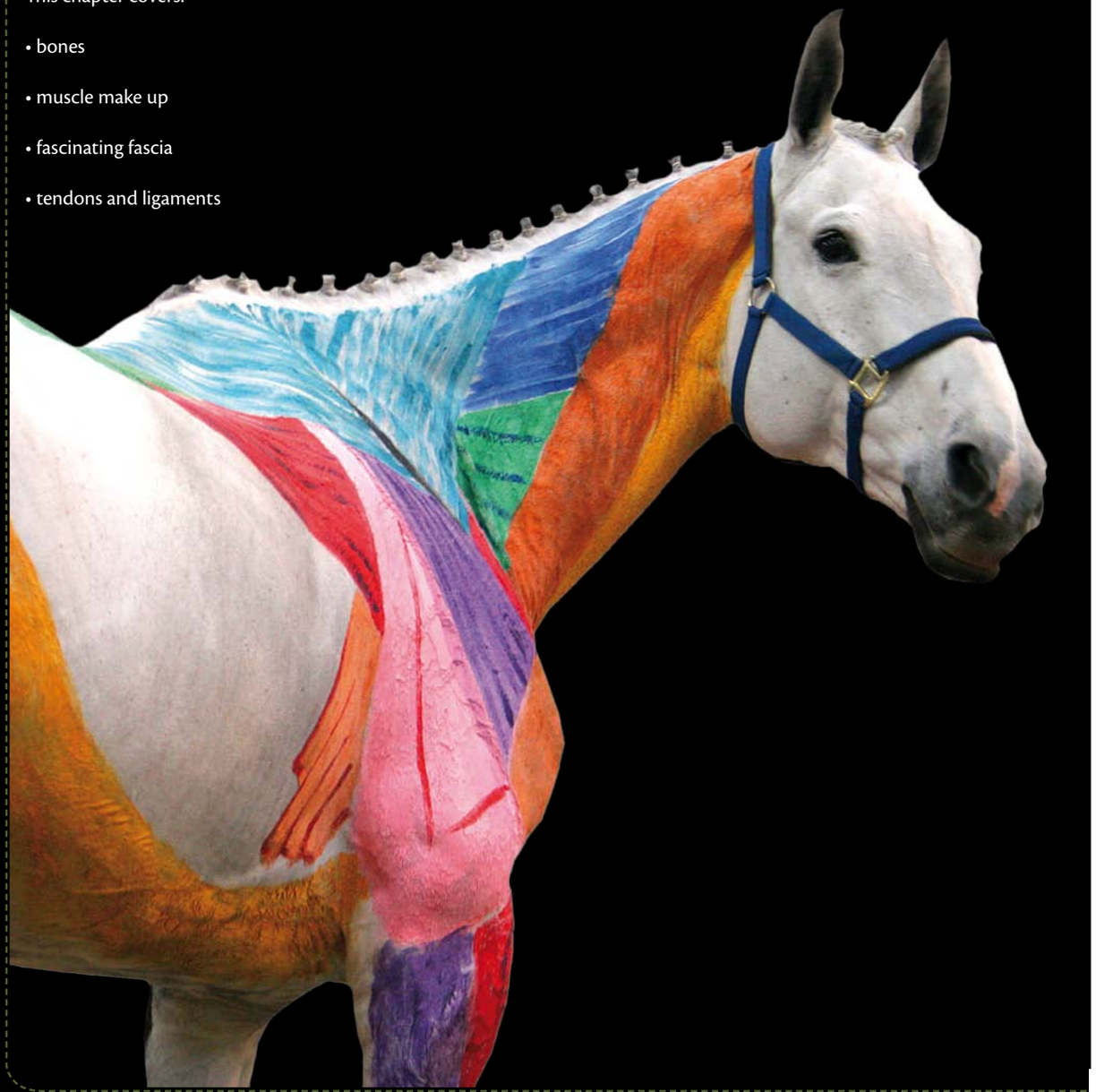
I would like to thank my father David for his photography, IT support and for providing an oasis of calm at times of stress. I would especially like to thank Caroline Moore who has taught me so much, has been and continues to be an inspiration. Finally, thanks go to my friend Sam Rahmatalla and her beautiful Grand Prix dressage horse Bungle and to my horses for their patience.

A FIRM FOUNDATION

Before we can really understand how our horses move, we need a sound knowledge of the component parts that make up the musculoskeletal system.

This chapter covers:

- bones
- muscle make up
- fascinating fascia
- tendons and ligaments



BONES

Bone is living tissue with nerves and blood vessels that contains proteins and minerals, such as calcium and phosphorus. The horse must receive adequate amounts of these minerals to remain healthy. Bone is the second hardest substance in the horse's body after tooth enamel.

A bone consists of a hard outer cortex, encasing a spongy cavity. The surface of the bone is covered by the periosteum, a tough protective membrane, which provides for the attachment of ligaments and tendons. (See illustration of cross-section of a synovial joint on page 11.)

The skeleton is made up of a combination of bones classified as:	
Long bones 	These are literally long bones that contain marrow. They manufacture new blood cells, and have joint surfaces at either end. Operated by muscles and joints, they act as levers for the appendicular skeleton. Examples are the cannon, femur, radius and ulna, and humerus.
Short bones 	Short bones are strong and compact. Some examples are the short pasterns, the carpal bones in the knee, and the tarsal bones in the hock.
Flat bones 	Flat bones have broad, flat surfaces that enclose and protect organs and provide a large area for muscle attachment. The ribs, skull, scapula, and sternum are examples of flat bones.
Sesamoid bones 	Sesamoid bones lie within tendons or ligaments and add strength to them. An example is the navicular bone working within the deep digital flexor tendon. The sesamoid bones lie behind the bones of the fetlock and help to keep the tendons and ligaments in that area functioning correctly.
Irregular bones 	The vertebral column consists of irregular bones. These protect the central nervous system.

The skeleton

The skeletal system of the horse consists of approximately 205 bones divided into:

- the axial skeleton comprising the skull, vertebrae, sternum and ribs
- the appendicular skeleton which is made up of the fore and hind limb bones.

The number of bones varies as some fuse together as the horse matures and because the number of tail bones varies from horse to horse.

The skull protects the brain.

Functions of the skeleton

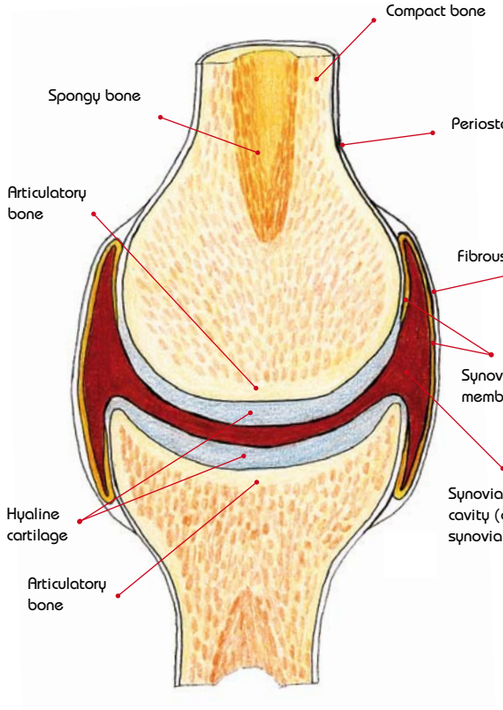
The skeleton has five major functions. These are:

- **to act as support**. The skeleton provides a stable and rigid framework for the attachment of muscles and tendons
- **to assist movement**. When skeletal muscles contract, they pull on bones to produce movement
- **to protect the internal organs**
- **to produce and store blood cells** in the bone marrow
- **to store minerals**, especially calcium and phosphorus, which contribute to bone strength.

What is a joint?

A joint allows movement. It is the area where two or more bones meet. They are stabilized by a complex network of tendons, ligaments, and muscles. Movement is dependant on the contraction and relaxation of muscles and the associated articulation of the joints.

Understanding the relationship between the skeleton and muscles helps us understand how our horses move.



Cross-section of a synovial joint.

Cartilage is a dense connective tissue containing collagen and elastic fibres covering the ends of bones at some joints. It reduces friction within the joint and aids shock absorption. It contains no blood vessels or nerves.

Joints can be classified as:

- **fibrous**, where bones are held by fibrous connective tissue. There is no joint cavity and little movement, an example is the skull
- **cartilaginous**, which are held together by cartilage. These joints have little articulation or movement. Important examples are the pelvis and the larger joint surfaces between vertebral bodies
- **synovial**, which are fully moveable, modified shock absorbers. They are composed of a fibrous capsule, ligaments, and a joint lining, which manufactures lubricating synovial fluid. The ends of the bones are lined with hyaline cartilage, which provides a smooth surface between the bones and compresses to act as a shock absorber; for example, when taking off or landing after a jump. This type of joint is the most active, therefore most susceptible to injury. The fetlock is a synovial joint.

There are two main types of synovial joint:

- **ball and socket** – the ball-shaped end of the bone sits in its socket and is able to move in almost any direction. Examples are the shoulder and hip joints.

- **hinge** – these resemble an opening door. They allow flexion and extension in one plane only. The elbow and pastern joints are examples of hinge joints.

SUMMARY

- **Bones are the hard living tissue that forms the skeleton.**
- **They can be classified by shape.**
- **The skeleton provides support, produces movement, protects internal organs, and manufactures blood cells.**
- **Joints are the point at which bones meet.**
- **They allow movement.**
- **Joints are stabilized by muscles, tendons and ligaments.**

MUSCLE MAKE UP

There are three types of muscle found within the body:
- **cardiac**, which is specific to the heart and cannot be consciously controlled
- **smooth**, which is also involuntary and plays a part in the circulatory and digestive systems
- **skeletal**, which produces movement, maintains posture, and stabilizes joints. This muscle type is under conscious control although it will contract involuntarily as a reflex response.

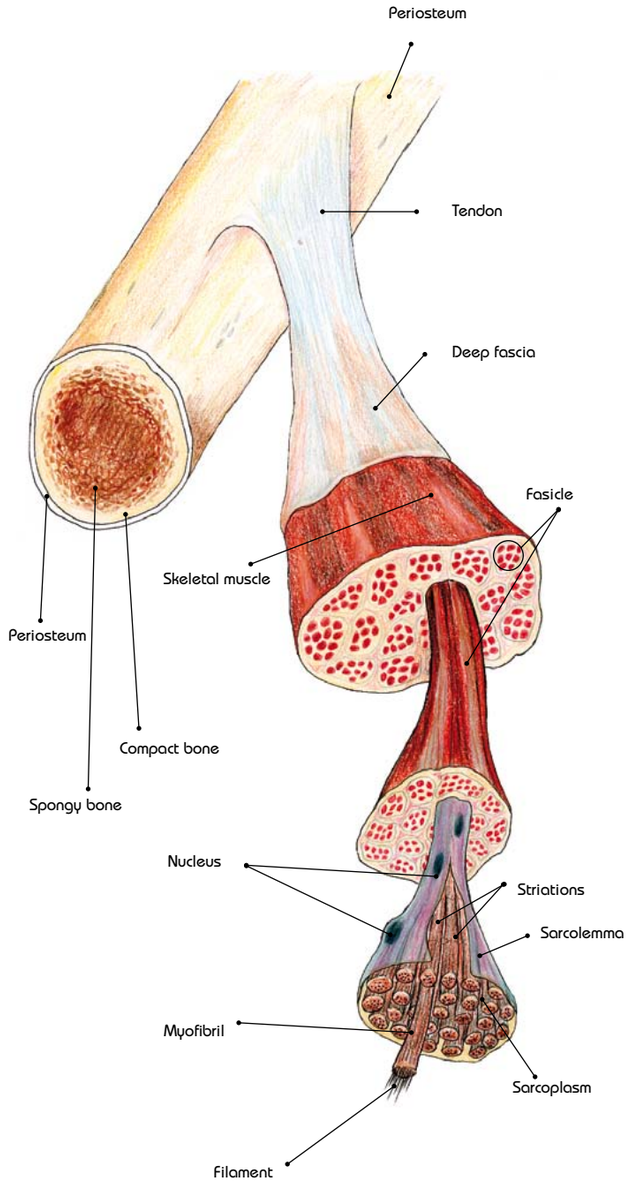
More about skeletal muscle

Skeletal muscles come in all shapes and sizes. They respond to motor nerve impulses, are highly elastic, and have strong contractile power.

Muscles have a fleshy 'belly' comprising thousands of muscle fibres intertwined with connective tissue called fascia (page 14). Muscle fibres decrease towards the ends of a muscle, reducing its circumference until only the longitudinally arranged collagen fibres remain in the form of a tendon. This attaches to the bone via a tough fibrous membrane known as the periosteum. Muscles are attached to, and therefore move the skeleton by passing over joints (see page 16).

The points at which the skeletal muscles attach to the bones via the tendons are known as:
- the point of **origin** – nearest to the body centre
- the point of **insertion** – furthest away from the body centre.

THERE ARE APPROXIMATELY 700 SKELETAL MUSCLES IN THE HORSE!



Skeletal muscles – up close

Muscles consist of fibres made up of many thousands of individual muscle cells that run parallel to each other. The fibres are bound together in bundles, called fascicles, by very thin layers of connective fascia.

Within each fibre are thousands of smaller threads known as myofibrils, which give the muscle its ability to lengthen and shorten. Within the myofibrils are millions of minute bands known as sarcomeres, which comprise myofilaments made up of proteins. Actin produces thin myofilaments and myosin produces thick ones. These are responsible for muscle contraction. They slide over one another when the muscles contract thereby shortening it. They slide back to their original position as the muscle relaxes.

Very simply, muscles convert chemical energy into movement. Skeletal muscle fibres come in different types. These are inherited, so although you can train to get the best from your horse, you can not actually change them. In other words you cannot change a cob into a racehorse any more than you can change a weight lifter into a long distance runner!

The muscle types are:
- **slow twitch** that produce energy slowly over a long period. They work aerobically, requiring oxygen to create energy. Horses with a predominance of these types of muscle fibres are less likely to fatigue and are good for endurance
- **fast twitch** that are physically larger than slow twitch fibres. They work anaerobically producing small amounts of energy quickly and explosively but they tire out easily. Horses with muscles that have a predominance of fast twitch fibres are good for jumping.

Like people, all horses have a combination of both types of muscle fibre. It is a predominance of one fibre type that determines activity.

In show jumpers fast twitch fibres predominate.

Endurance horses have a predominance of slow twitch fibres.

SUMMARY

- **Skeletal muscle produces movement, stabilizes joints, and maintains posture.**
- **Muscles have a fleshy belly that tapers into a tendon at the distal end.**
- **They have a point of origin and a point of insertion where they attach to bone.**
- **Muscle has slow twitch fibres, which contract slowly but keep going for a long time, and fast twitch fibres, which contract quickly but tire rapidly.**

UNDERSTANDING TERMINOLOGY

Movement is often described in the following terms:
aduction – when the leg is brought out from the body
adduction – when the leg is brought across the body
asymmetrical gait – a gait in which the limb movements on one side are not exactly repeated on each side, for example, canter and gallop
cadence – rhythm combined with impulsion
impulsion – this is energy
overtracking – when the hind foot is placed in front of the imprint of the forefoot. This is a desirable quality as it denotes a supple musculature and good range of movement. With extended gaits, it is essential
rhythm – the regularity of the steps or strides in each gait. Strides should be of equal distance and duration
stride length – the distance from the placement of one hoof to where it next falls. In canter this is between 3–3.5 metres (10–12 feet)
symmetrical gait – gait in which limb movements on one side are repeated on the opposite side half a stride later, for example, the trot and pace
tempo – the speed or rhythm of the gait
tracking up – when the hind hoof steps into the imprint of the fore.

Stride phases

Stance phase – when at least one foot is in contact with the ground. This can be further subdivided into:
- initial ground contact – heel or flat foot in slow gaits, heel first in fast gaits, and toe first in some dressage moves, such as piaffe
- impact phase – rapid deceleration immediately following initial ground contact. The muscles do not have time to completely protect the joints at this point, so concussion is at its maximum
- loading phase – the body passes over the foot. The tendons and suspensory ligaments are stretched and the fetlock sinks towards the ground
- breakover – the point at which the heels leave the ground. On hard ground the foot stays flat until the heel leaves the ground. On soft ground the foot rotates as the toe digs in to the ground. This puts less pressure on the bones of the foot
- toe off – the point at which the toe leaves the ground allowing the tendons to recoil.

Swing phase – when the hoof is lifted and brought forward in a pendulum action. The forelimb pivots around the upper part of the scapula while the hind limb pivots around the hip joint in walk and trot and the lumbo-sacral joint in canter and gallop.

Suspension phase – when no hooves are in contact with the ground, for example, mid-stride in the faster paces.

Directional terms

Caudal	**Towards the tail**
Cranial	**Towards the skull**
Distal	**Away from the point of attachment**
Dorsal	**Towards the top**
Lateral	**Towards the side of the body**
Medial	**Towards the midline of the body**
Proximal	**Towards the point of attachment**
Ventral	**Towards the underside**

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