

Figure 4.13 Muscles of the back

Major muscles involved in movement

When we use the term 'muscular system' we are referring to skeletal muscle only. Figures 4.12 and 4.13 show the major muscles of the skeletal system. Remember, these figures provide a superficial view only. We have many other muscles beneath these major surface muscles. To remember the major muscles, it is helpful to know that muscles are named according to:

- the action they perform (for example, the extensor carpi ulnaris and levator scapula)
- their shape (for example, the trapezius)
- their origin and/or insertion points (for example, the sacrospinalis)
- their having multiple points of origin (for example, the bicep, tricep and quadricep)
- their location (for example, the tibialis anterior)
- their size (for example, the gluteus maximus)
- the direction of their fibres (for example, the external obliques and rectus abdominus).

The movement that a muscle produces is called its *action*. Muscles are arranged to work together or in opposition to produce movement. Most muscles cross over at least one joint. Movements are produced when muscles exert force on tendons, which pull on articulating bones or other structures; for example, skin.

Note that muscles *can only pull; they do not push*.

Usually the origin of a tendon is on the most stationary bone, and its insertion is on the movable bone. The fleshy portion of the muscle between the origin and insertion of the tendons is called the *muscle belly*.

Muscle relationship

Usually it is the action of muscles *in groups* that cause us to move. Most skeletal muscles are arranged in opposing (antagonistic) pairs at joints; for example, extensor–flexor or adductor–abductor.

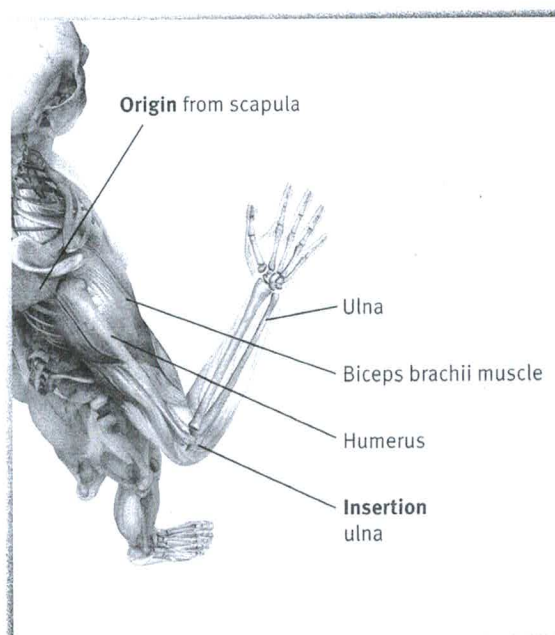


Figure 4.14 Relationship of skeletal muscle to bones: origin and insertion of the biceps brachii muscle

Table 4.2 Origins, insertions and actions of major skeletal muscles

Muscle	Origin	Insertion	Actions
Deltoid	Clavicle and scapula	Humerus	Abducts, flexes, extends, medially and laterally rotates arm
Biceps brachii	Scapula	Radius	Flexes and supinates forearm; flexes arm
Triceps	Scapula and humerus	Ulna	Extends forearm and arm
Latissimus dorsi	Lower 6 thoracic vertebrae, all lumbar vertebrae, lower 4 ribs, iliac and sacral crests	Humerus	Extends, adducts and medially rotates arm; draws arm downward and backward; depresses scapula
Trapezius	Occipital bone, spines of C7 and all thoracic vertebra	Clavicle and scapula	Elevates clavicle; extends head; adducts, rotates upward, elevates and depresses scapula
Pectorals			
• Major	Ribs 2–6, clavicle and sternum	Humerus	Flexes, adducts and medially rotates arm; pulls rib cage upwards
• Minor	Ribs 3–5	Scapula	With ribs fixed: draws scapula forward and downward With scapula fixed: draws rib cage superiorly
Erector spinae (sacrospinalis): group of 3 muscles (medial, lateral and intermediate)	Vary along vertebral spines and transverse processes, ribs and iliac crest	Vary along vertebral spines and transverse processes, ribs and jaw	Maintains erect posture; extends vertebral column Acts on one side to: bend vertebral column laterally; extend head and rotate face to side
Gluteus maximus	Iliac crest, sacrum and coccyx	Femur	Extends and laterally rotates thigh
Hamstrings: group of 3 muscles (biceps femoris, semitendinosus and semimembranosus)	Ischium and femur (biceps femoris) Femur (semitendinosus and semimembranosus)	Tibia and fibula (biceps femoris) Tibia (semitendinosus and semimembranosus)	Flexes leg and extends thigh
Quadriceps: group of 4 muscles (rectus femoris, vastus group—medialis, lateralis and intermedius)	Iliac spine (rectus femoris) Femur (vastus group)	Common insertion to patella and tibia through the patella ligament	Extends leg and flexes hip (rectus femoris) Extends leg (vastus group)
Gastrocnemius	Lateral and medial sides of femur	Calcaneous via Achilles tendon	Plantar flexes foot; flexes leg
Soleus	Fibula and tibia	Calcaneous via Achilles tendon	Plantar flexes foot
Tibialis anterior	Tibia	First metatarsal	Dorsiflexes and inverts foot
Rectus abdominus	Pubic crest	Xiphoid process and ribs 5–7	Flexes and rotates lumbar vertebra; fixes and depresses ribs; stabilises pelvis
External obliques	Lower 8 ribs	Iliac crest and linea alba	As pair—flexes vertebral column, compresses abdominal wall Singular—trunk rotation and lateral flexion

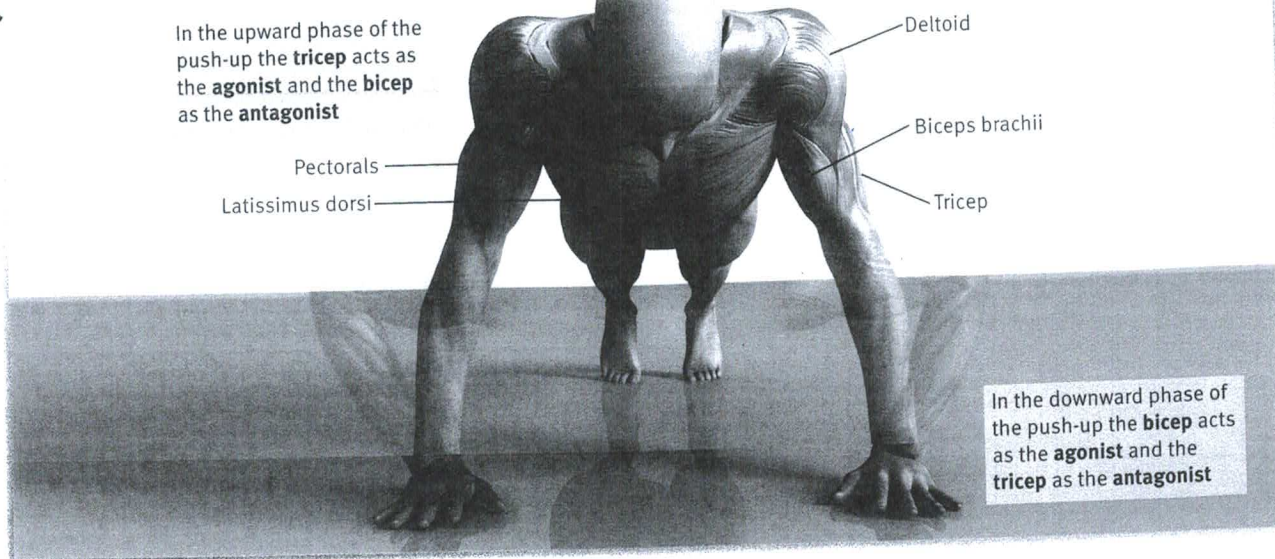


Figure 4.15 Muscles of the shoulder girdle in action

Muscles can be classified functionally into three groups:

- **agonists** (prime movers)—the agonist muscle provides the main force that causes the desired movement
- **antagonists** (muscles that react)—the muscle that opposes or reverses a particular movement
- **stabilisers** (synergists and fixators)—the muscle that aids agonists by promoting the same movement or by reducing unnecessary movement or undesired action. When a synergist immobilises the head of a muscle or a bone, it is called a fixator.

A muscle may act as an agonist in one movement, an antagonist in another and a stabiliser in yet another. All muscles are important in creating coordinated, smooth and precise movement.

An example to explain this is the paired muscles of the shoulder girdle:

- The pectorals and latissimus dorsi work to create flexion and extension at the shoulder joint.
- When the pectorals (agonist) contracts, flexion of the arm occurs and the latissimus dorsi (antagonist) is relaxed. In this movement, the deltoid, biceps brachii and trapezius act as stabilisers.
- During extension, the latissimus dorsi (agonist) contracts and pectorals (antagonist) relax. The triceps and trapezius act as stabilisers.

Table 4.2 describes the origins, insertions and actions of some major skeletal muscles.

Types of muscle contraction

When muscles are in a relaxed state, they are soft and loose. When they contract to produce a force, they become hard and elastic. To feel this difference, put your left hand on your right bicep when it is down by your side. Then flex your arm towards your chest. Feel how it goes from long and soft to short and hard.

Now pick up a heavy book. Feel your muscle become even harder and bigger. *Muscle tension* is the force that is produced when a muscle contracts; the *load* is the force exerted on a muscle by a weight.

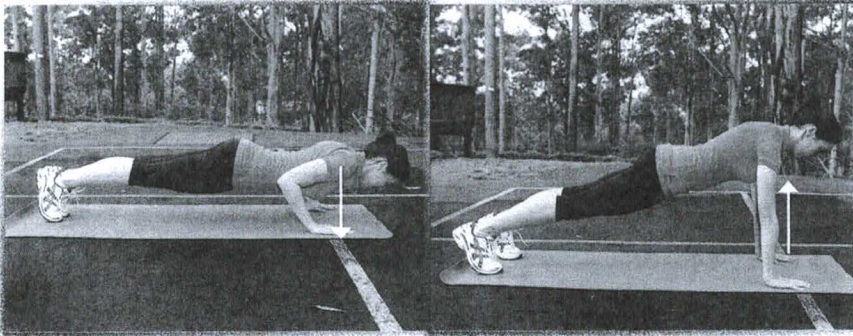
Two main types of contractions are possible within muscles:

- isotonic contraction
- isometric contraction.

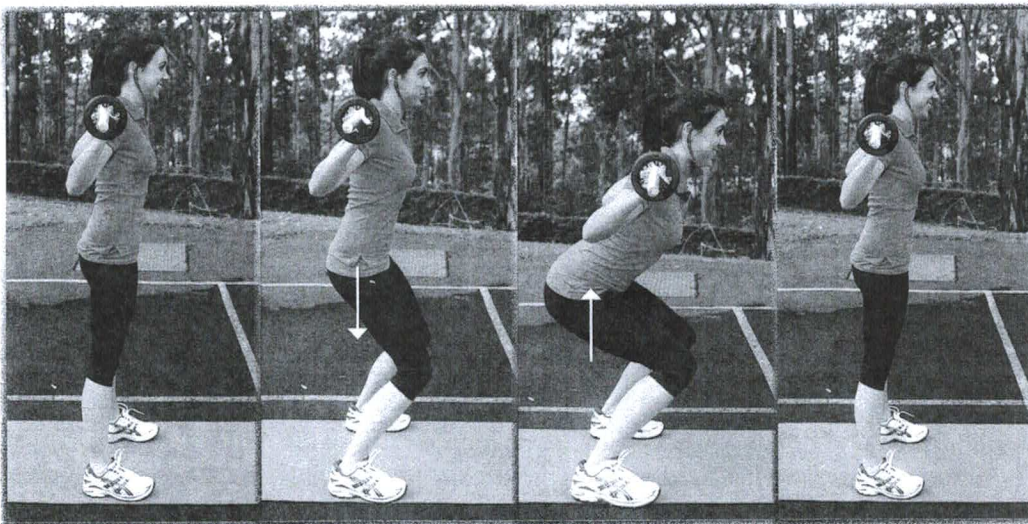
During an **isotonic contraction**, the muscle fibres produce a tension, or force, as they lift the load through the range of movement. The muscle length changes (shortens and lengthens) as tension develops, so there are two possible types of isotonic contractions:

- In a *concentric* isotonic contraction, the muscle shortens to pull on bones and bring them closer together, as when you picked up the heavy book.
- In an *eccentric* isotonic contraction, the muscle lengthens, as when you put the book back down.

Squats, deep knee bends, push-ups, pull-ups, kicking a ball and running up and down hills are examples of sporting activities during which concentric and eccentric contractions occur.



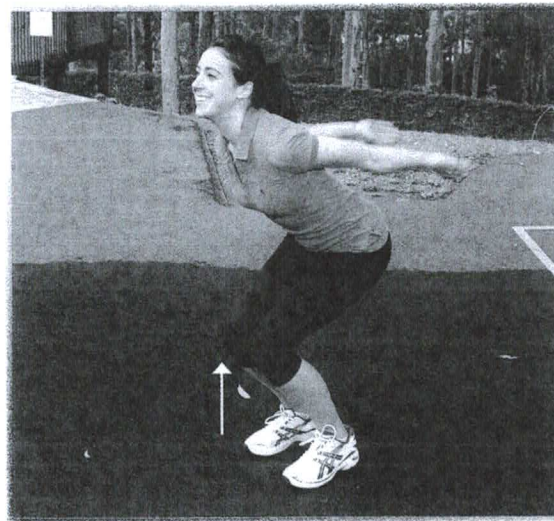
Push-up



Squat lift



Running on the spot



Standing jump

Figure 4.16 Range of movements

An **isometric contraction** occurs when tension develops in the muscle, but it neither shortens nor lengthens. An example is holding a book in a steady, flexed position, sitting upright in a chair or pushing against a load greater than the force applied. Isometric contractions produce energy although there is no movement.

Most movements involve both isotonic and isometric contractions, as few muscles operate in isolation.

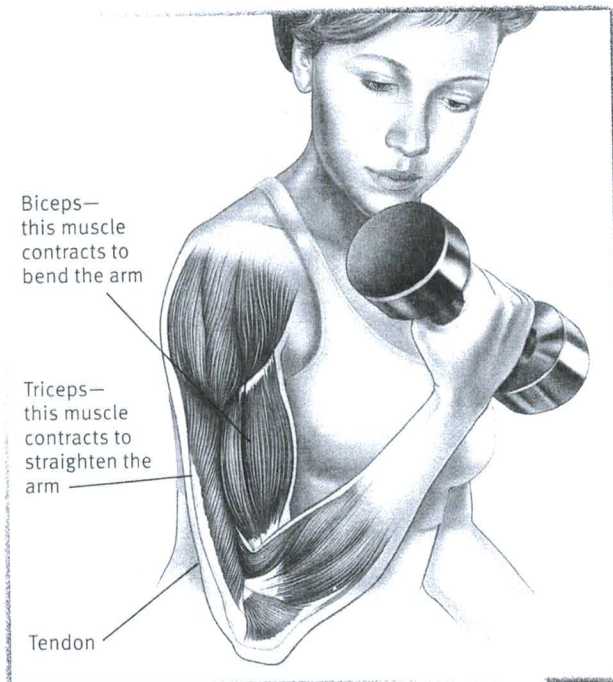


Figure 4.17 Lifting a hand weight involves an isotonic contraction

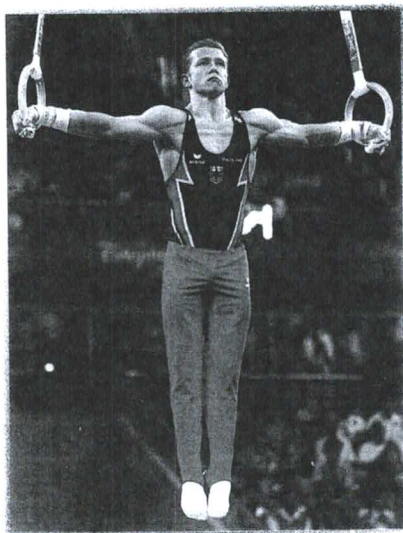


Figure 4.18 Holding the 'iron cross' position on the rings involves an isometric contraction: the muscle length remains unchanged



Figure 4.19 Basketballers are vulnerable to injuries such as shoulder dislocations and hamstring tears

practical application

Muscles

- 1 **Analyse** the range of movements shown in Figure 4.16 (page 86) and **describe**:
 - a the bones involved and the joint action
 - b the muscles and the muscle actions.
- 2 **a** Participate in the following athletic events:
 - shot put
 - long jump
 - 100-metre sprint
 - 1500-metre run
 - overarm throw.

b For each activity you participated in, **identify** the:

 - major muscles involved
 - movements performed at each joint
 - type of muscular contraction
 - predominant muscle fibre type used.

Research and Review

- 1 **Describe** how skeletal muscles produce movement by pulling on bones.
- 2 **Define** the role of the agonist, antagonist and stabiliser in the production of movement.
- 3 **a Describe** the movements that are possible at the shoulder joint and the muscles involved in producing these movements.

b Identify the agonists, antagonists and stabilisers.
- 4 **Identify** which of the following is the muscle of the arm that both flexes the elbow and supinates the forearm:
 - a triceps brachii
 - b biceps brachii
 - c deltoid
 - d brachialis.
- 5 **a Explain** the difference between an isotonic contraction and an isometric contraction.

b Suggest three exercises and three sporting activities that produce both types of contraction.
- 6 **Investigate** the reasons why basketballers are prone to injuries such as shoulder dislocations and hamstring tears.