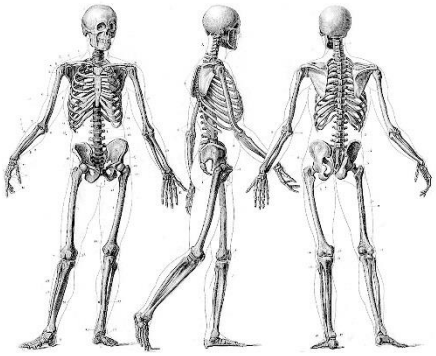
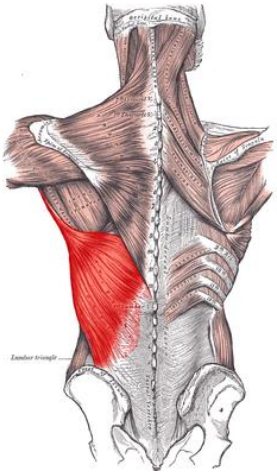
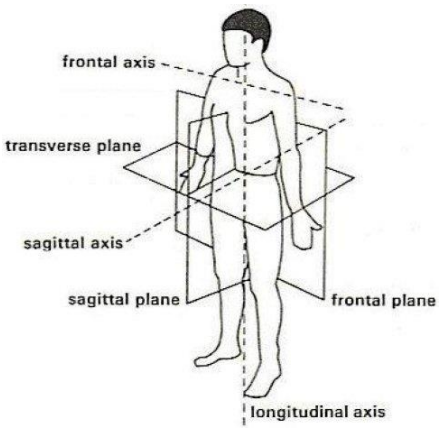
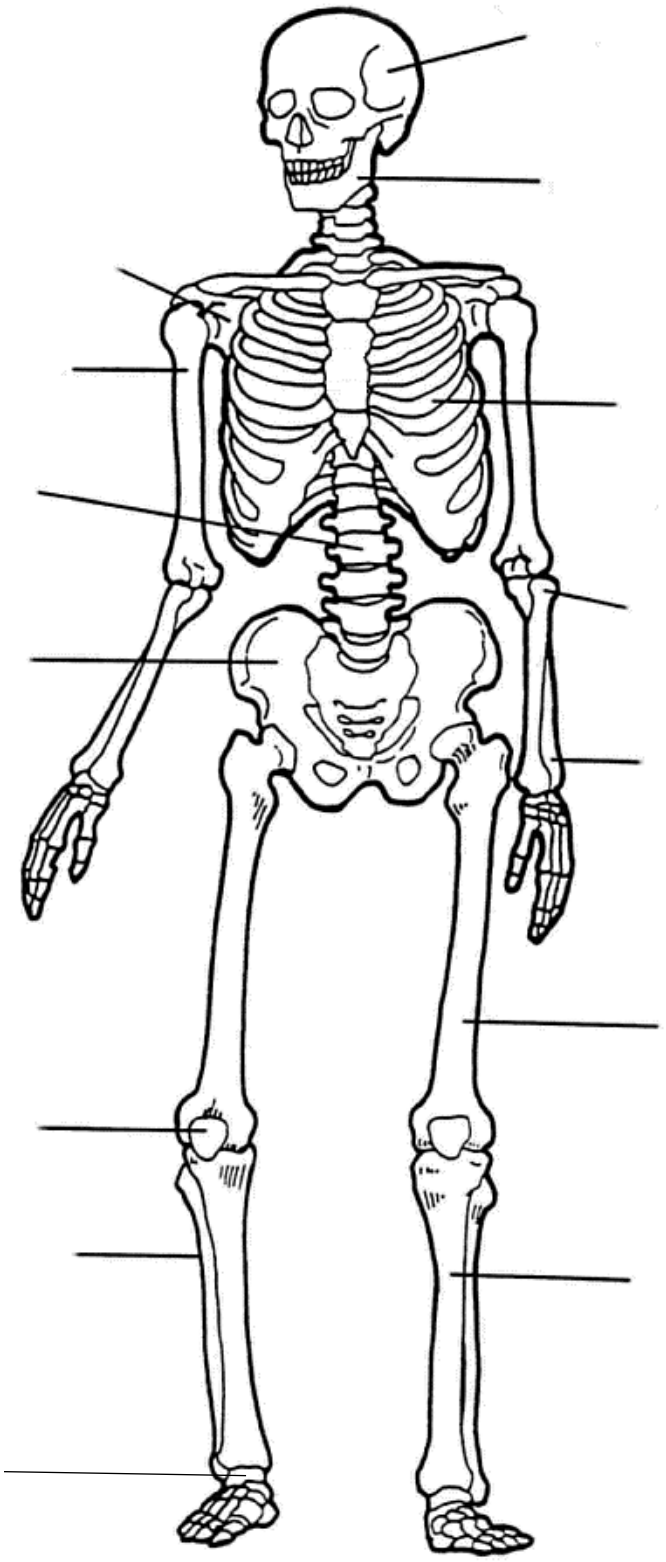
The musculo-skeletal system and analysis of movement in physical activities







Recap your knowledge!



Top tip: you will not be asked to label a skeleton in your exam but you do need to know the names of the bones that articulate at the ankle, knee, hip, shoulder and elbow.

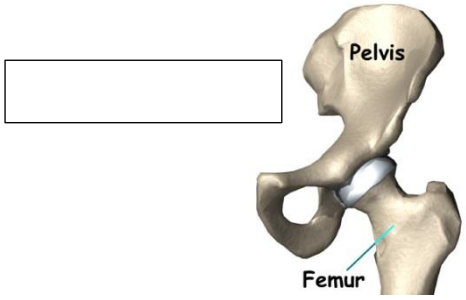
In this pack you will analyse five joints (ankle, knee, hip, elbow and shoulder). You will learn to identify the joint actions that occur in a range of physical activities and name the agonists and antagonists for these actions, explaining the type of contraction that is taking place as either isotonic or isometric.

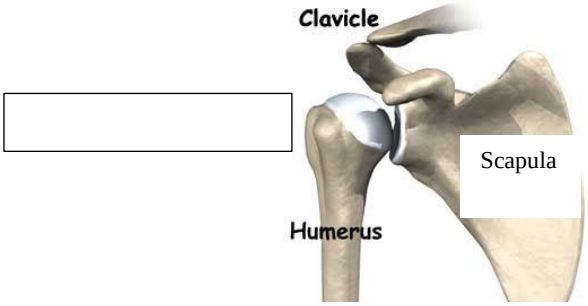
Types of Joints

The skeleton is a framework joined together by joints. Joints are necessary for muscles to lever bones, thus creating movement. A joint is formed where any two or more bones meet. Joints are classified by how much movement they allow. There are three types: fibrous or fixed joints, cartilaginous or slightly moveable joints and synovial or freely moveable joints. For your exam you just need to study two types of synovial joints as the syllabus only requires knowledge of the hip, shoulder, elbow, knee and ankle: the ball and socket joint and the hinge joint.

Ball and socket joint.

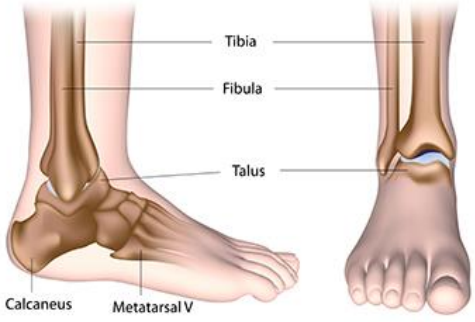
This allows movement in every direction. It is formed by the round head of one bone fitting into the cup shaped capsule of the connecting bone. The hip and the shoulder are ball and socket joints.





Hinge joint.

This allows movement in only one direction, due to the shape of the bones making up the joint. The ankle, knee and hip are hinge joints.



[TASK]
There are four bones labelled in the picture of the knee joint –why do you think the patella and the fibula are not articulating bones

Key term:
Articulating*: refers to the bones that* ***meet*** *and* ***move*** *at the joint*

.....
.....
.....

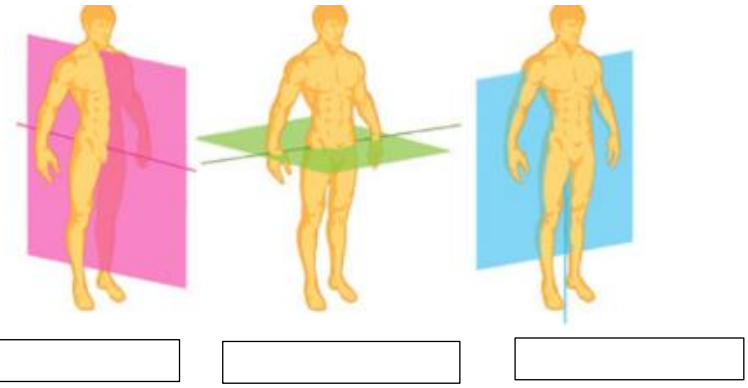
[TASK]
As the syllabus only requires knowledge of the hip, shoulder, elbow, knee and ankle *copy and complete the table and identify the joint type and articulating bones*

Joint	Joint type	Articulating bones
Ankle		
Knee		
Hip		
Shoulder		
Elbow		

Planes and Axes

To help explain joint action it is possible to view the body as having a series of imaginary lines running through it. These are referred to as planes of movement and divide the body up in three ways:

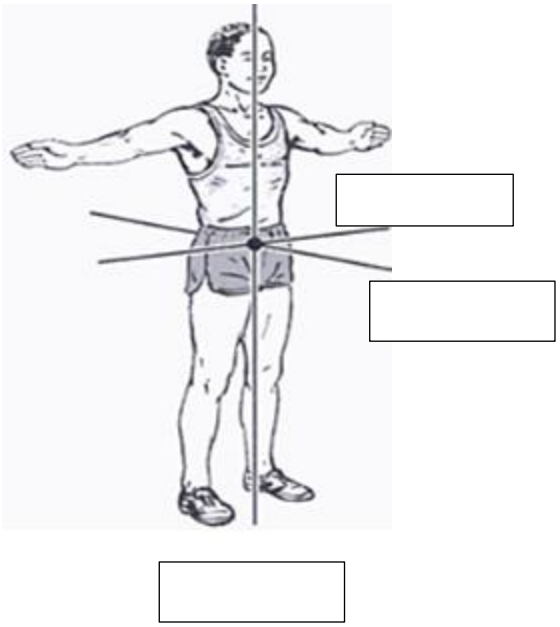
- The sagittal plane: this is a vertical plane, which divides the body into right and left halves.
- The frontal plane: this is also a vertical plane that divides the body into front and back halves.
- Transverse plane: this divides the body into upper and lower halves



When performing an activity a body or body parts will move in one of these planes or in all three of them depending on the action being performed. In a full twisting somersault, for example, the gymnast will move in all three planes.

There are three axes of movement about which rotation occurs:

- Transverse axis that runs from side to side across the body
- sagittal axis which runs from front to back
- longitudinal axis that runs from top to bottom



The joint action taking place can be related to both planes and axes. What you need to remember for your exam is:

- Flexion, extension, plantar-flexion, dorsi-flexion and hyperextension occurs in a sagittal plane about a transverse axis
- Abduction and adduction occurs in a frontal plane about a sagittal axis
- Horizontal abduction and horizontal adduction occurs in a transverse plane about a longitudinal axis

REMEMBER

F*lexion, extension,* ***p****lantar-flexion,* ***d****orsi-flexion and* ***h****yperextension occur in a* ***s****agittal* ***p****lane about a* ***t****ransverse axis. Try to remember this with the acronym* ***FEST***

[TASK]

Try to think of your own acronym or pneumonic to remember which plane and axis the joint actions take place in:

Abduction and adduction occurs in a frontal plane about a sagittal axis

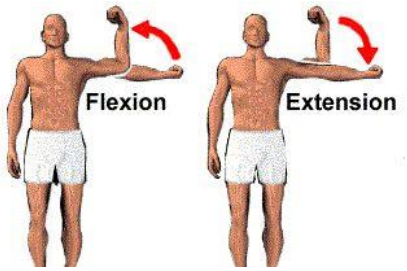
A A F S …….

Horizontal abduction and horizontal adduction occurs in a transverse plane about a longitudinal axis

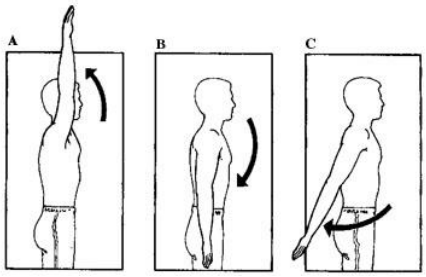
H A H A T L ……..

Joint actions in the sagittal plane about a transverse axis.

The joint actions that take place in the sagittal plane and transverse axis are **flexion, extension and hyperextension.** All five of the examined joints flex and extend but in the ankle joint the action is called **plantarflexion and dorsi flexion.**



Flexion occurs when there is a decrease in the angle around a joint. When there is an increase in the angle that occurs around a joint extension occurs. If the angle increases by more than 180 degrees then hyperextension takes place.

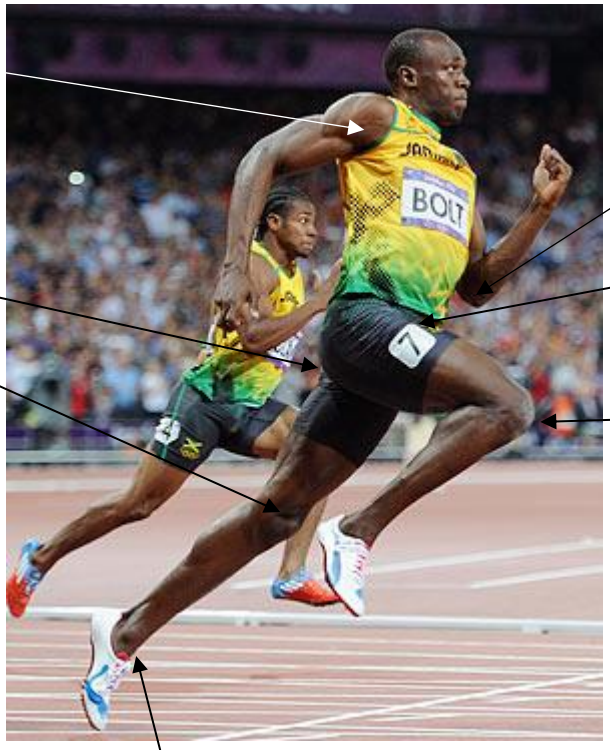


Raising the arms forward is flexion of the shoulder(A) and lowering the arm down and backwards is extension (B) then further back for hyperextension (C)

The hip joint mirrors the shoulder joint-raising the leg forward is flexion, backwards is extension and further back for hyperextension.

Plantarflexion occurs as you point your toes or raise up onto your toes and dorsi flexion takes place as you move your toes backwards towards your knee

Flexion, extension, hyperextension, plantarflexion and dorsiflexion in action!



Shoulder hyperextension - arm moves further back than body line

Hip hyperextension - moves further back than body line

Knee extension – leg straightens

Elbow flexion – arm bends

Hip flexion – leg moves forward

Knee flexion – leg bends

Ankle plantarflexion- going up on your toes to push off

Flexion of both hips- legs move forwards

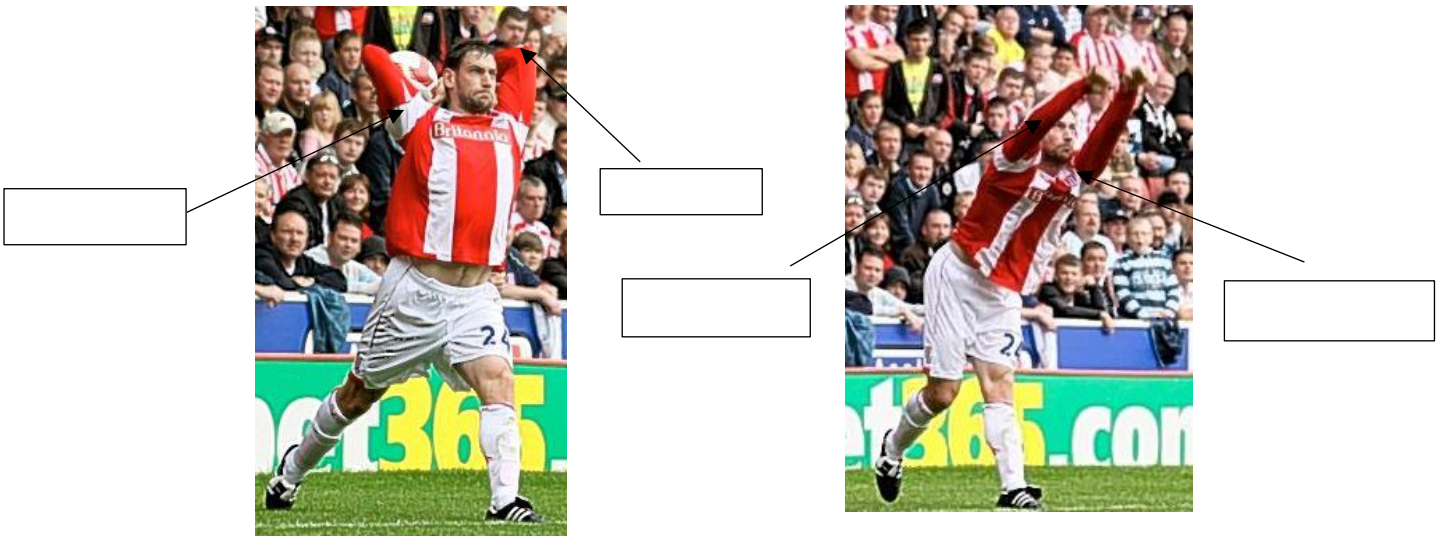
Flexion of the knees – legs bend

Dorsiflexion of the ankles – toes nearer to knees

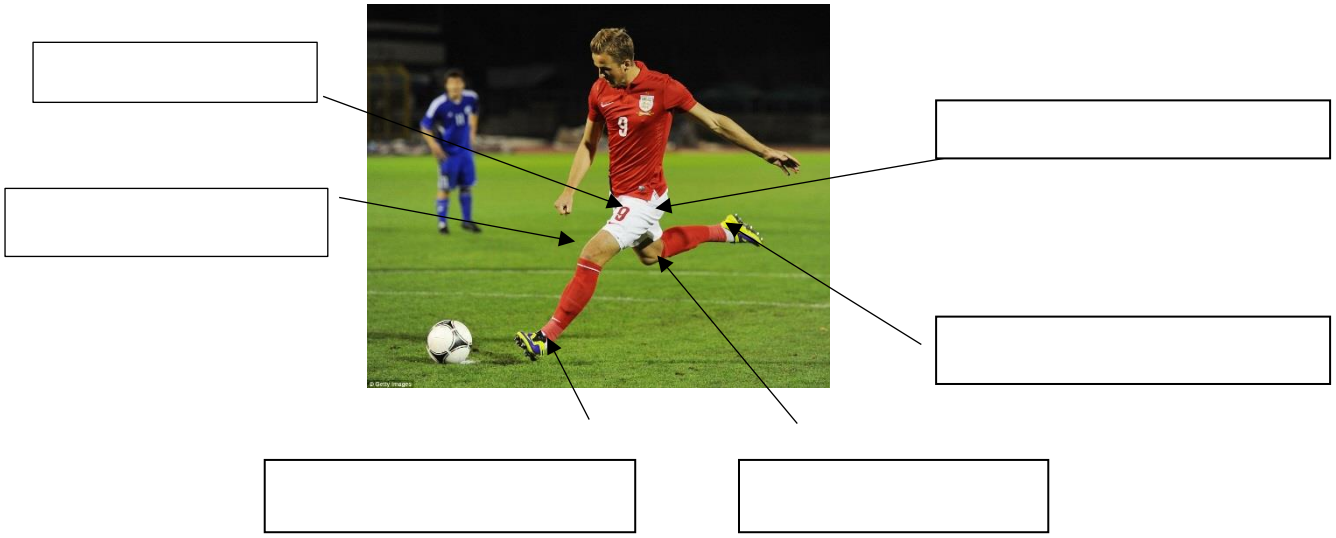
Now label your own!

Identify the following joint actions in the elbow and shoulder:

Overarm throw



Identify the following joint actions in the ankle, knee and hip:



Joint actions in the frontal plane and sagittal axis

Abduction is movement away from the midline of the body, for example raising your arms and legs out to the side away from your body. Adduction is movement towards the midline of the body, for example lowering the arms and leg back to the sides of the body

Joint actions in the transverse plane and longitudinal axis

Horizontal adduction is movement of the arm forward across the body at 90 degrees to shoulder abduction. For example raise your arm out to the side until it is parallel to the floor (abduction of the shoulder) and then move it across the body. Horizontal abduction is movement of the arm backwards across the body to shoulder abduction. For example, raise your arm and hold it at 90 degrees (flexion of the shoulder), then move it away from the body.

As you prepare to hit the ball:
Horizontal abduction of the shoulder

Execution of the forehand:
Horizontal adduction of the shoulder

REMEMBER - if something is abducted it is taken away. Look at the word ***add***uction- think of adding the arm or leg back to the body

Now label your own!

TASK

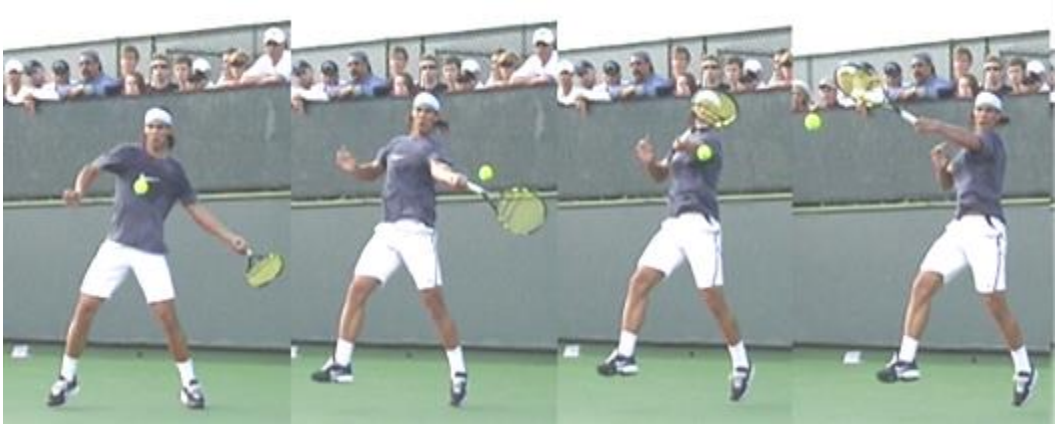
Complete the table to show the joint actions needed for the exam:

Joint	Joint actions
Shoulder	
Elbow	
Hip	
Knee	
Ankle	

In the spaces below construct the sentences to connect the key words

1.	hinge		joints	
2.	ball and socket		joints	action
3.	squat	downward	hip, knee and ankle	action

1. Work out the joint action that has taken place in the shoulder and elbow joints to get from picture A to picture D

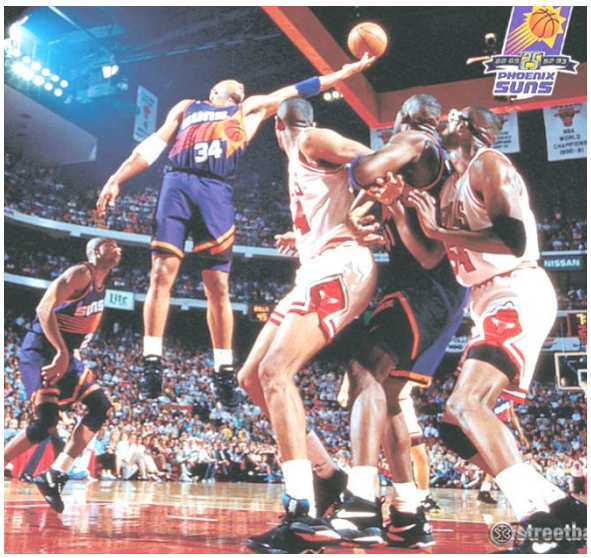


A B C D

Elbow =

Shoulder =

2. Work out the joint action that has taken place in the ankle, knee and hip joints to jump to achieve this position



Ankle joint =

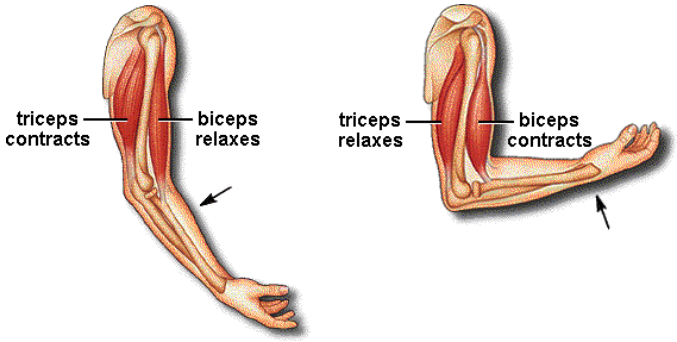
Knee joint =

Hip joint =

Agonists and antagonists.

A joint cannot move by itself, it needs muscles to move bones into position. When a muscle contracts one end is anchored in place and the other end pulls the bone causing movement. If we use the biceps as an example, the anchor point is on the scapula (shoulder) and the other end of the muscle attaches on the radius (forearm). The bicep is responsible for flexion of the elbow and when the muscle contracts the radius moves upwards towards the shoulder.

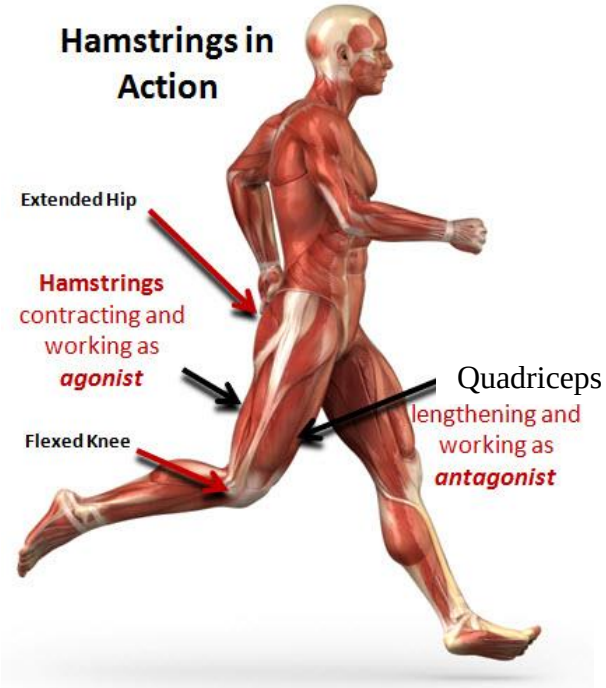
When the biceps contracts it is responsible for the movement that is occurring and is said to be acting as an **agonist.** There can be more than one agonist acting at a joint although this does depend on the type of movement that is being performed. An antagonist muscle is one that works in opposition to the agonist, so when the biceps is shortening as it contracts the triceps is lengthening and acting as the **antagonist.**



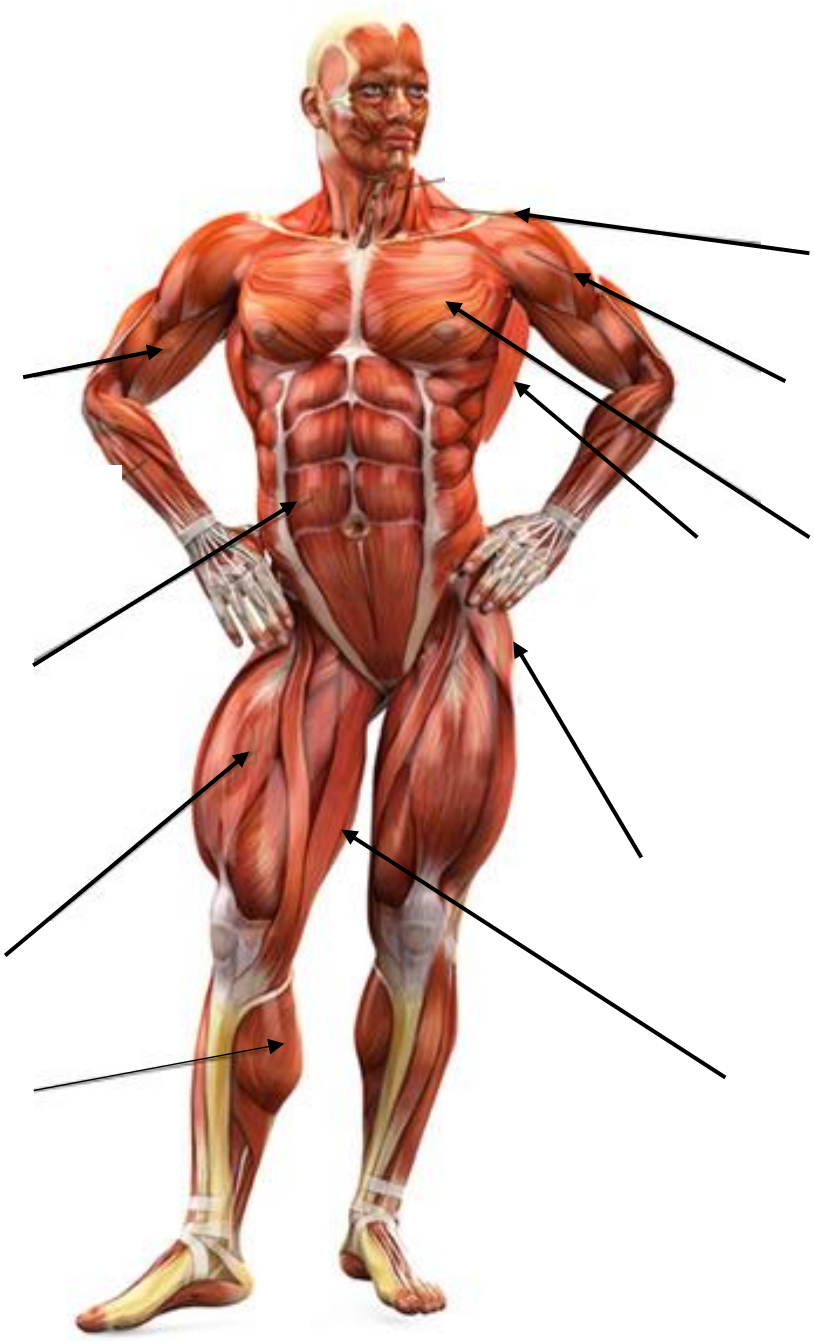
Key term:
Agonist *is the muscle that is responsible for the movement that occurring*

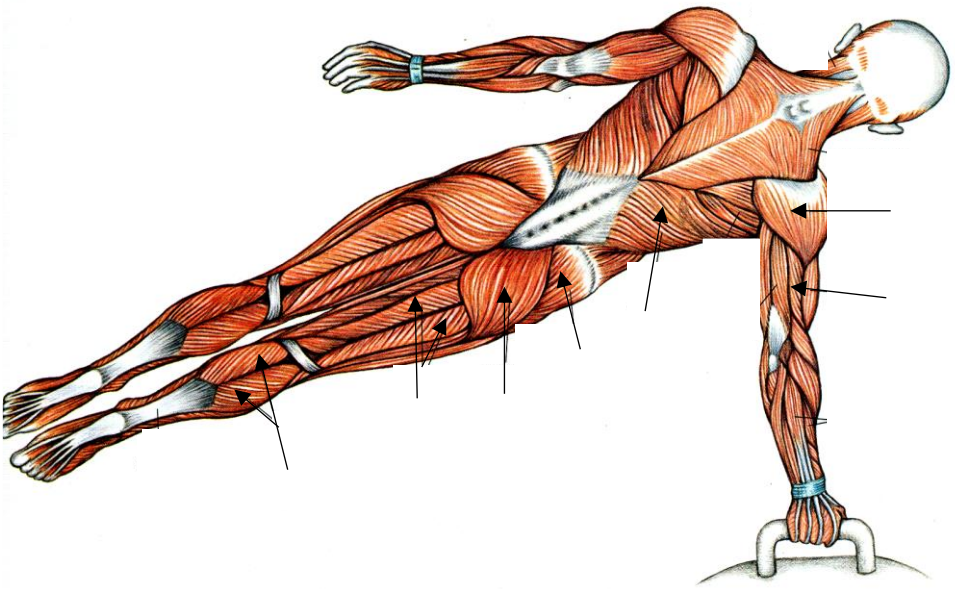
Key term:
Antagonist is the muscle that works in opposition to the agonist (to help produce a co-ordinated movement)

When one muscle is acting as an agonist and the other is acting as the antagonist, the muscles are said to be working together as a pair to produce the required movement. This arrangement is commonly referred to as antagonistic muscle action. If we look at flexion of the knee, the hamstrings are the agonist and the quadriceps are the antagonist.



Try to label these muscles!





These are the names of the agonists you need to know for each joint action!

Joint action	Agonist	Antagonist
Elbow flexion	*Biceps*	*Triceps*
Elbow extension	*Triceps*	*Biceps*
Ankle plantarflexion	*Gastrocnemius*	*Tibialis anterior*
Ankle dorsiflexion	*Tibialis anterior*	*Gastrocnemius*
Knee flexion	*Hamstrings*	*Quadriceps*
Knee extension	*Quadriceps*	*Hamstrings*
Hip flexion	*Hip flexors*	*Gluteals*
Hip extension/hyperextension	*Gluteals*	*Hip flexors*
Hip adduction	*Adductors*	*Tensor fascia latae and gluteus medius/minimus*
Hip abduction	*Tensor fascia latae and gluteus medius/minimus*	*Adductors*
Hip horizontal adduction	*Adductors*	*Tensor fascia latae and gluteus medius/minimus*
Hip horizontal abduction	*Tensor fascia latae and gluteus medius/minimus*	*Adductors/hip flexors*
Shoulder flexion	*Anterior deltoid*	*Latissimus dorsi*
Shoulder extension/hyperextension	*Latissimus dorsi*	*Anterior deltoid*
Shoulder horizontal abduction	*Latissimus dorsi*	*Pectorals*
Shoulder horizontal adduction	*Pectorals*	*Latissimus dorsi*
Shoulder adduction	*Latissimus dorsi*	*Middle deltoid*
Shoulder abduction	*Middle deltoid*	*Latissimus dorsi*

[CHECK]

The picture below shows a javelin thrower just prior to delivering his throw. As the thrower ***prepares*** to throw the javelin, identify the *joint action* and *main agonist* occurring at the elbow and shoulder joints during this movement *(4 marks)*

Elbow joint action: …… Shoulder joint action: ……

Elbow agonist: …….... Shoulder agonist: …….

Types of muscular contraction

When a muscle works, it contracts. A muscle can contract in different ways, depending on the muscle action that is required. An isotonic contraction is when a muscle contracts to create movement. There are two types of isotonic contraction. When the muscle shortens as the fibres contract a concentric contraction is taking place and when the fibres contract as the muscle lengthens an eccentric contraction occurs. An isometric contraction takes place when the muscle is contracting but there is no movement occurring.

Isotonic contraction

A muscle causes movement in an isotonic contraction and there are two types:

Concentric contraction

This is when a muscle shortens under tension, e.g., during the upward phase of an arm curl, the biceps performs a concentric contraction as it shortens to produce flexion of the elbow.

Key term:
Concentric *contraction when a muscle shortens under tension*

Eccentric contraction

Key term:
Eccentric *contraction is when a muscle lengthens under tension or performs negative work and acts like a brake.*

This is when the muscle lengthens under tension (and does not relax). When a muscle contracts eccentrically it is acting as a brake in helping to control the movement of a body part during negative work. An example could be in landing from a standing jump. Here the quadriceps are performing negative work as they are supporting the weight of the body during landing. The knee joint is in the flexed position but the quadriceps are unable to relax as the weight of the body ensures that they lengthen under tension.

[HINT]
Eccentric is the type of contraction most misunderstood. Remember it is a contraction so the muscle cannot be relaxing, it is lengthening under tension.

Isometric contraction

This is when a muscle can contract without actually lengthening or shortening and the result is that no movement occurs. An isometric contraction occurs when a muscle is acting as a fixator or acting against a resistance. A good example is the crucifix position in gymnastics

Key term:
Isometric *contraction when a muscle is under tension but there is no visible movement*

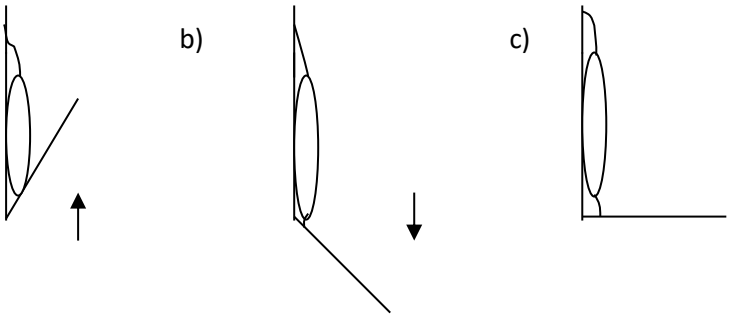
[TASK]
Can you think of another sporting example of an isometric contraction……

[HINT]
When asked to identify the type of contraction in the exam, if the answer is isometric then expect to see the words 'still', 'stationary' or 'held' or their equivalent in the wording of the question.

If we use the bicep curl as an example

a) During the upward phase the bicep brachii is contracting to produce flexion of the elbow joint. In this situation it is performing a concentric contraction.
b) During the downward phase if you put your hand on a partner's bicep brachii you will still feel tension. This means the muscle is not relaxing but performing an eccentric contraction where it lengthens under tension.
c) If the weight is held still at a 90 degree angle, the bicep brachii is under tension even though we do not see any movement. This is an isometric contraction.

a) b) c)



[TASK]

Complete the table below when performing a ***press-up.***

1. Perform the downward phase of a press-up
   - What is happening at the elbow joint?
   - Which muscle is contracting?
   - What type of contraction is it performing?

2. Now perform the upward phase of a press-up
   - What is happening at the elbow joint?
   - Which muscle is contracting?
   - What type of contraction is it performing?

3. Try to hold the press-up in the downward phase
   - Which muscle feels as if it is contracting
   - What type of contraction is it performing?

	Action	Agonist	Type of contraction
1			
2			
3			

Complete the table below when performing a ***squat.***

1. Perform the downward phase of a squat
   - What is happening at the knee joint?
   - Which muscle is contracting?
   - What type of contraction is it performing?

2. Now perform the upward phase of a squat
   - What is happening at the knee joint?
   - Which muscle is contracting?
   - What type of contraction is it performing?

3. Try to hold the squat in the downward phase
   - Which muscle feels as if it is contracting
   - What type of contraction is it performing?

	Action	Agonist	Type of contraction
1			
2			
3			

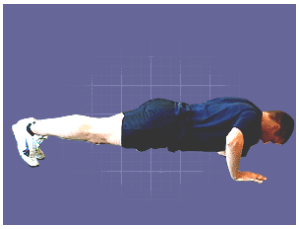
[CHECK]

1. Weightlifters will follow a strength training programme to ensure that they perform their best in a competition. The picture below shows a weightlifter performing a squat. Using the picture, identify the joint action, main agonist and the type of muscle contraction occurring at the hip and knee joints as the weightlifter performs the downward phase (5 marks)

	Hip	**Knee**
Joint action		
Main agonist		
Type of muscle contraction		

2. The picture below shows a gymnast performing a press-up during a fitness session:

A B



(i) Using this picture name the main agonist and antagonist acting on the elbow as the gymnast moves from the position A to position B. (2 marks)

Agonist = ……

Antagonist = …….

(ii) Name the type of muscle contraction that occurs in the main agonist at:

Position A while the gymnast is stationary

As the gymnast moves from position A down to position B (2 marks)

Revision Notes

What do I need to know:	Y/N
Identify the type of joint and articulating bones for the ankle, knee, hip, elbow and shoulder	
Identify the following joint actions: flexion, extension, hyper extension, plantarflexion and dorsiflexion, abduction, adduction, horizontal abduction and horizontal adduction   	
Identify which plane and axis these joint actions occur in	
State the main agonists and antagonists for the actions occurring at these joints	
Explain the types of muscle contraction: isotonic (concentric, eccentric) and isometric	