1.1 – The structure and functions of the musculo-skeletal system

**Learning objectives**

To be able to describe the functions of the skeleton.
To understand different bone classifications and functioning.
To be able to recognise and label a skeleton.
To be able to define different joint classifications.
To be able to describe and analyse different types of joint movements and how they are used during sporting movements.
To be able to describe the difference between cartilage, tendons and ligaments.
Functions of the skeleton

The skeleton performs many functions in the body:

**Support** – The skeleton supports the muscles.

**Protection** – The skeleton protects delicate parts of the body like the brain.

**Muscle Attachment/Movement** – Muscles are attached to the bones and move them creating levers.

**Blood cell production** – blood cells are made in the bone marrow.
Support

The skeleton acts as a framework.

It gives the body **support**, enabling us to stand.

The bones of the body are held together by **ligaments**.

The skeleton provides a framework for the muscles, which are attached to bones by **tendons**.
Protection

Some of our body parts, such as the brain, are very delicate and need protection.

Bones can protect body parts from impact and injuries.

1. What vital organ does the Cranium protect?
   Answer: 

2. What vital organ does the Rib Cage protect?
   Answer: 
Muscle Attachment/Movement

Muscles are firmly attached to bones forming levers which create sporting movements.
Blood cell production

Long bones and other bones including the ribs, humerus, femur and vertebrae bones, contain **red bone marrow**.

This is where red blood cells are produced which carry oxygen.

**Other functions include:**

- White blood cells to combat illness and disease
- Platelets for clotting and healing.
- Storage of Calcium and Phosphorus
Skeletal System

Without your skeleton you would be a shapeless sack of flesh. The adult skeleton has 206 bones.

How many bones can you name?
Skeletal System Structure

- Cranium
- Sternum
- Humerus
- Radius
- Ulna
- Femur
- Patella (knee cap)
- Tibia
- Fibula
- Clavicle
- Ribs
- Pelvis
Skeletal System Structure

Hand

- Scapula
- Vertebral column
- Carpals
- Metacarpals
- Phalanges

Foot

- Tarsals
- Metatarsals
- Phalanges
The vertebral column

It is made up of irregularly shaped bones called **vertebrae**.

Between each vertebra there is a pad of **cartilage** which allows movement and prevents friction.

The vertebrae protects the **spinal cord**.

The vertebral column is divided into **5 sections**.
Classification of bones

Bones are divided into a number of different categories which have different roles in the body.

1. Long bones

Long bones have a long shaft and are responsible for different types of movement. Sporting actions are created by long bones through levers.

Long bones can be any size; they include the femur, humerus, tibia, fibula, metatarsals, metacarpals and phalanges.
2. Flat bones

Flat bones perform a number of functions.

1. Protection for delicate areas.
   *i.e. the cranium protects the brain.*

2. Provides a broad surface area for muscle attachment.
   *i.e. muscles in the back attach to the pelvis.*
**3. Short bones**

**Short bones** are light, small and very strong. The primary function is to support the weight of the body.

The carpals in the wrist and the tarsals in the foot are examples of short bones.

**How does this aid sportspeople in an event?**

Gymnasts use carpals to support a handstand.
4. Irregular bones

Irregular bones are specially shaped to perform a particular function.

These functions include:
1. Protection
2. Muscle attachment

Examples include the patella and the vertebrae.
DEFINITION:
“A joint is a place where two or more bones meet”.

Joints are responsible for the huge range of movement that the body can produce.

There are several different types of joint classification.
1. **Ball and socket joint** - the rounded end of a bone fits inside a cup-shaped end.

Ball and socket joints allow movement in **all directions**. These are the most mobile joints in the body.

**Examples found in the body**: Shoulders and hips.

**Why are these joints important for sport?**

Most sporting movements require movement by the shoulder and hip joints *e.g. tennis serve*.
Classification of Joints

2. **Hinge joints** - only allow **forwards and backwards** movement like the hinge on a door.

Examples found in the body: The knee and elbow.

**Why are these joints important for sport?**

These joints are extremely powerful and in conjunction with surrounding muscles can produce power and speed, e.g. *Knee drive during a 100m sprint*
Classification of Joints

3. The **Pivot joint** has a ring of bone that fits over a pivoting bone. Pivot joints allow **rotation only**.

**Examples found in the body:** The joint between the **atlas and axis** in the **neck** allows turning and nodding of the head.

**Why are these joints important for sport?**

This joint allows for small movements that assist a larger sporting action  
*e.g. breathing during a swimming stroke*
4. **Condyloid joints** have an oval-shaped bone which fits into a similar shaped bone. They allow small movements in all directions.

**Classification of Joints**

**Examples found in the body:** Found between the carpals and metacarpals in the wrist.

**Why are these joints important for sport?**

These joints are extremely useful when a sport involves gripping a ball.

*e.g. handball throw*
What synovial joints are used in these sporting examples?

Apply it!

What has stuck with you?
What are the 4 functions of the skeletal system?

Explain why we have flat, short, long and irregular bones. Can you give examples of each?

Musculoskeletal system

Highlight on your body as many bones as you can!

Name the 4 joint classifications?

What has stuck with you?
Practice it!

Exam questions

1. List three major types of bones, found in the human skeleton. (3)
   (i) Irregular
   (ii) ______________________
   (iii) ______________________
   (iv) ______________________

2. Except for the femur, provide the names of two other bones in the leg that are classified as long bones. (2)
   a) ______________________
   b) ______________________
Exam questions
3. The humerus is a long bone. Which of the following statements correctly identifies a function of the humerus and its associated advantage to the performer in the statement? (1)

A a hockey player can reach further to hit the ball as the humerus is a long bone
B a footballer can kick the ball harder due to the length of the humerus
C the humerus acts as a lever so a hockey player can apply more force to the ball
D the humerus protects the footballer from injury.
Practice it!

Exam Questions:

4. Name the bones of the upper and lower arm? (3)

5. Name the anatomical name for the following bones (5)
   a) Skull
   b) Knee cap
   c) Collar Bone
   d) Shoulder blade
   e) Wrist
### Practice it!

**Exam Questions:**

6. The following are regions or bones of the vertebral column. Place these regions of the vertebral column in the order they appear after the bones Atlas and Axis.

<table>
<thead>
<tr>
<th>Thoracic</th>
<th>Sacral</th>
<th>Atlas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumbar</td>
<td>Cervical</td>
<td>Axis</td>
</tr>
</tbody>
</table>

Place these regions of the vertebral column in the order they appear after the bones Atlas and Axis.

- Atlas
- Axis
- 1 ..........................................
- 2 ..........................................
- 3 ..........................................
- 4 ..........................................

(4)
Practice it!

Marks Scheme:

1. Short, Long, Flat

2. Tibia, Fibula

3. C

4. Humerus, Radius, Ulna

5. a) Cranium b) Patella c) Clavicle d) Scapula e) Carpals

6. Cervical, Thoracic, Lumbar, Sacral
1.1 – The structure and functions of the musculo-skeletal system

Learning objectives

To understand the three muscle types and their functions

To be able to label the voluntary muscles in our body

To explain the term ‘antagonist pair’ and provide examples

To understand the characteristics of fast and slow twitch muscle fibres
Connective tissues

There are 3 types of connective tissue:

Tendons connect muscles to bones.

Ligaments are tough, elastic fibres that link bones to bones.

Cartilage prevents the ends of bones rubbing together at joints.
Joint Movements

1. Flexion and Extension

**FLEXION** – Decreasing the angle at a joint. *(Bending the joint)*

**EXTENSION** – Increasing the angle at a joint. *(Straightening the joint)*
Joint Movements

2. Abduction and Adduction

Abduction and Adduction is determined from the ‘MIDLINE’ of the body.
Joint Movements

ADDUCTION –
Sideways moving limb towards midline of the body.

ABDUCTION –
Sideways moving limb away from midline of the body

**REMEMBER:** Adduction is to **ADD** towards the midline.

**REMEMBER:** Abduction is to **TAKE AWAY** from the midline.
Joint Movements

3. Rotation/Circumduction

The joint moves in a circular motion. e.g. Service action or bowling action.
Joint Movements

4. Planter-Flexion and Dorsi-Flexion

Planter-flexion – The action of pointing toes away from the body.

Dorsi-flexion – The action of pulling toes towards the body.
Apply it! What has stuck with you?

What movements occur during these actions?
<table>
<thead>
<tr>
<th>Cyclist</th>
<th>Footballer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FLEXION</strong> – at the <strong>RIGHT</strong> knee joint</td>
<td><strong>EXTENSION</strong> – at the knee joints</td>
</tr>
<tr>
<td><strong>EXTENSION</strong> - at the <strong>LEFT</strong> knee joint</td>
<td><strong>FLEXION</strong> – at the <strong>HIP JOINT</strong> of right leg</td>
</tr>
<tr>
<td><strong>FLEXION</strong> – at the <strong>RIGHT</strong> hip joint as the leg raises</td>
<td><strong>ADDUCTION</strong> – at the hip joint as the left leg is moving towards the central line of the body</td>
</tr>
<tr>
<td><strong>FLEXION</strong> – Slight Flexion at the elbows</td>
<td><strong>ADDUCTION</strong> – Left arm</td>
</tr>
<tr>
<td><strong>FLEXION</strong> – Torso (body is bent forwards)</td>
<td><strong>FLEXION</strong> – at left elbow</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Swimmer - Start</th>
<th>Butterfly Stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ADDUCTION</strong> – of the arms</td>
<td><strong>ROTATION</strong> – at the <strong>shoulder joint</strong></td>
</tr>
<tr>
<td><strong>EXTENSION</strong> – at the knee joints</td>
<td><strong>EXTENSION</strong> – at <strong>elbow joints</strong></td>
</tr>
<tr>
<td><strong>EXTENSION</strong> – at the elbows</td>
<td><strong>ABDUCTION</strong> – of the <strong>arms</strong></td>
</tr>
</tbody>
</table>
Label as many joint movements as you can see.

i.e. flexion at the knee
Classification and Characteristics of Muscles

Muscles are used in everyday life all the time. Sportspeople are reliant on the power of muscles to compete.

What do you know about muscles already?
Muscles are involved in every movement in your body.

Muscle is a special type of tissue made up of fibres that contract (shorten) and relax (lengthen).

There are three types of muscle fibre.
Classification and Characteristics of Muscles

1. Voluntary Muscles
These are attached to bones and they work whenever we want them to. e.g. Biceps & Triceps. These muscles are under our conscious control.
2. Involuntary muscle
These are found on the walls of the internal organs and they contract in waves.

Food travels through the digestive system and blood through the blood vessels in this way.

It works without you consciously controlling it, or even being aware of it.
3. Cardiac muscle

This is a special type of muscle that forms the walls of the heart chambers.

It is a type of *involuntary* muscle, as it contracts without conscious thought or effort.

It works non-stop without ever tiring. When it contracts it pumps blood out of the heart and around the body.
All three types of muscle are important in physical activity:

- **Voluntary muscles** enable movement throughout the body.

- **Involuntary muscles** are essential in maintaining healthy body systems.

- **Cardiac muscle** is vital in sport because it makes the heart pump. Fitness training will strengthen cardiac muscle making the heart more efficient at pumping blood around the body.
Voluntary Muscles

- Pectorals
- Bicep
- External Obliques
- Abdominals
- Hip Flexors
- Quadriceps
- Tibialis Anterior
- Triceps
- Deltoid
- Latissimus Dorsi
- Gluteus Maximus
- Hamstring
- Gastrocnemius
Voluntary Muscles

What happens when muscles contract?

Muscles shorten when they contract and lengthen when they relax.
Voluntary Muscles

When you contract your **QUADRICEP** what is the effect on the limb?

When you contract your **HAMSTRING** what is the effect on the limb?

When you contract your **DELTOID** what is the effect on the limb?
Now complete the grid below. What happens when each muscle contracts?

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Main Action(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Deltoid</td>
</tr>
<tr>
<td>2</td>
<td>Biceps</td>
</tr>
<tr>
<td>3</td>
<td>Abdominals</td>
</tr>
<tr>
<td>4</td>
<td>Quadriceps</td>
</tr>
<tr>
<td>5</td>
<td>Pectorals</td>
</tr>
<tr>
<td>6</td>
<td>Latissimus Dorsi</td>
</tr>
<tr>
<td>7</td>
<td>External Obliques</td>
</tr>
<tr>
<td>8</td>
<td>Triceps</td>
</tr>
<tr>
<td>9</td>
<td>Gulteus Maximus</td>
</tr>
<tr>
<td>10</td>
<td>Hamstring</td>
</tr>
<tr>
<td>11</td>
<td>Taibialis Anterior</td>
</tr>
<tr>
<td>12</td>
<td>Gastrocnemius</td>
</tr>
<tr>
<td>13</td>
<td>Hip Flexors</td>
</tr>
<tr>
<td>Muscle</td>
<td>Main Action(s)</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1 Deltoid</td>
<td>Raises arm sideways at the shoulder (abduction)</td>
</tr>
<tr>
<td>2 Biceps</td>
<td>Bends arm at the elbow (Flexion)</td>
</tr>
<tr>
<td>3 Abdominals</td>
<td>Flexes trunk so you can bend forward</td>
</tr>
<tr>
<td>4 Quadriceps</td>
<td>Straighten leg at the knee (extension)</td>
</tr>
<tr>
<td>5 Pectorals</td>
<td>Draws arm across chest</td>
</tr>
<tr>
<td>6 Latissimus Dorsi</td>
<td>Pulls arms backwards towards back</td>
</tr>
<tr>
<td>7 External Obiliques</td>
<td>Allows twisting and turning of the torso</td>
</tr>
<tr>
<td>8 Triceps</td>
<td>Straightens arm at the elbow joint (extension)</td>
</tr>
<tr>
<td>9 Gulteus Maximus</td>
<td>Pull leg back at hip.</td>
</tr>
<tr>
<td>10 Hamstring</td>
<td>Bends leg at the knee. (flexion)</td>
</tr>
<tr>
<td>11 Taibialis Anterior</td>
<td>Flexes the ankle joint so you can pull toes towards the body</td>
</tr>
<tr>
<td>12 Gastrocnemius</td>
<td>Extends the ankle joint so you can stand on tiptoes</td>
</tr>
<tr>
<td>13 Hip Flexors</td>
<td>Pulls upper leg towards the chest</td>
</tr>
</tbody>
</table>
Muscles are arranged in **antagonistic pairs**.

As one muscle contracts (shortens) its partner relaxes (lengthens). *E.g.* Bicep and Tricep.

The fixed or non-moving end is known as the **origin**.

The **insertion** is known as the moving end.
Antagonistic muscle action

Can you think of another antagonists pair in the body?
Antagonistic muscle action

Gastrocnemius and Tibialis Anterior acting at the ankle joint

Hamstring and Quadricep acting at the knee joint.

Hip Flexors and Gluteus Maximus acting at the hip joint.
Muscle fibre types

Muscle twitch fibres occur in different proportions in different people.

This proportion is mainly to do with the genes you inherit but can be altered by training.
Muscle fibre types

How can athletes do this?

What do you know about muscle fibres already?
Muscle fibre types

There are two main types of muscle fibres:

1. SLOW TWITCH MUSCLE FIBRES – Small in size. These fibres take a relatively long time to contract.

- Have a good oxygen supply and is why they are deep red in colour.
- They contract slowly, but can work for **long periods**.
Muscle fibre types

2. FAST TWITCH MUSCLE FIBRES - Large in size. These fibres contract quickly and powerfully.

- Fast twitch fibres are paler in colour and have limited oxygen supply.
- They contract quickly and powerfully, but tire easily.
肌纤维类型

平均人具有：

60% 缓慢收缩纤维
40% 快速收缩纤维

精英耐力运动员具有高比例的慢收缩纤维。

精英爆发力运动员具有高比例的快速收缩肌肉纤维。
What are the 3 classification of muscle types?

What has stuck with you?

Explain what is meant by an antagonistic pair and an example in the body?

Musculo-skeletal system

Highlight and name as many muscle as you can!

Explain the difference between fast and slow twitch muscle fibres.
Apply it! What has stuck with you?

Will each of the athletes below require mostly fast twitch or slow twitch muscle fibres and why?
Practice it!

Exam questions
1. Figure 4 shows a high board diver in flight. Complete the following statements about the diver.

(i) The high diver has ................................................................. his legs at the knee and folded his body by ........................................ at the ................................................................. joint to allow him to bend forward. (3)

(ii) The diver’s arms are ................................................................. at the elbow. The muscle that contracts to bring about this movement is the.................................................................. (2)
Practice it!

Exam questions
1. Figure 4 shows a high board diver in flight. Complete the following statements about the diver.

iii) Movement occurs at the joints. The hip and shoulder provide the greatest range of movement in the body. What type of joint are the hip and shoulder?

.................................................................................................................................................. (1)
Exam questions

2. Figure 5 is a diagram of a joint.

i) What is the name and type of joint shown in Figure 5?  (2)
Joint name ...........................................
Joint type ...........................................

(ii) Name the bones of the joint labelled A, B and C in Figure 5. (3)
A .....................................................
B .....................................................
C .....................................................
Practice it!

Exam question

3. Using examples to illustrate your answer, describe the differences between slow and fast twitch muscle fibres. (4)

4. What percentage of fast twitch and slow twitch muscle fibres would a midfield football player need and why? (3)
Practice it!

Marks Scheme:

1. i) Extended/extension, Flexing/flexion, Hip
   ii) Flexed, Bicep
   iii) Ball and Socket

2. i) Knee, Hinge
   ii) Femur, Patella, Tibia

3. Endurance event – slow twitch fibres (Marathon runner) Better oxygen content/delivery therefore allows athletes to continue to work without tiring. Power event – fast twitch fibres (100m Sprinter) Not as dense oxygen supply but powerful contraction possible.

4. 70%/30% - slow/fast twitch fibres. Position requires endurance to cover all areas of the pitch both attack and defence. Powerful sprints required at times to make runs and track attacking players.