

# **BTEC Level 3 National Diploma** **in Sport and Exercise Science**

## **Unit 2: Functional Anatomy**

### **Body System Content:**

- **A – Anatomical positions, terms and references**
- **B – Anatomy of the cardiovascular system**
- **C – Anatomy of the respiratory system**
- **D – Anatomy of the skeletal system**
- **E – Anatomy of the muscular system**
- **F – Analysis of the skeletal and muscular systems and how they produce movements in sport and exercise**



Name: \_\_\_\_\_

## A1. Anatomical language

**Task 1:** You need to describe and recognise the following anatomical terms which have meaning towards their location of the body.

Term and location	Description
Anterior	
Posterior	
Lateral	
Medial	
Proximal	
Distal	
Superior	
Inferior	
Peripheral	
Superficial	
Deep	
Supine	
Prone	

**This is the 'anatomical position'**



## Revision questions on Anatomical language:

### 1. Which of the following statements describes the 'anatomical position'?

- a) Standing upright, facing forward, arms at side, palms facing the person's side
- b) Standing upright, facing forward, arms at side, palms facing
- c) Standing upright, facing forward, arms at side, palms facing
- d) Standing upright, facing forward, arms at side, palms facing

### 2. Which of the following are correct statements?

- a) The neck is superior to the pelvis
- b) The chest is inferior to the stomach
- c) The hip is superior to the shoulder
- d) The ribs are superior to the chin

### 3. When a person is walking towards you, what view are you seeing them?

### 4. Complete the missing words with either **lateral** or **medial** in the following sentences

- a) The inside of the thigh is \_\_\_\_\_ to the outside of the thigh
- b) The shoulder is \_\_\_\_\_ to the neck.
- c) The knee is \_\_\_\_\_ to the hip

### 5. Complete the missing words either with **distal** or **proximal**.

- a) The hip is \_\_\_\_\_ to the knee
- b) The shoulder is \_\_\_\_\_ to the elbow
- c) The knee is \_\_\_\_\_ to the ankle

### 6. Complete the missing words either with **superior** or **inferior**.

- a) The elbow is \_\_\_\_\_ to the knee
- b) The ankle is \_\_\_\_\_ to the knee
- c) The mouth is \_\_\_\_\_ to the chin

### 7. Identify if a person is supine or prone in the following activities:

- a) Swimming front-crawl
- b) Swimming backstroke
- c) Performing press-ups
- d) Performing sit-ups

## B. Anatomy of the cardiovascular system

**Task 2:** Next to each component of the blood, write down their function.



**Task 3:** Describe the components and function of the lymphatic system

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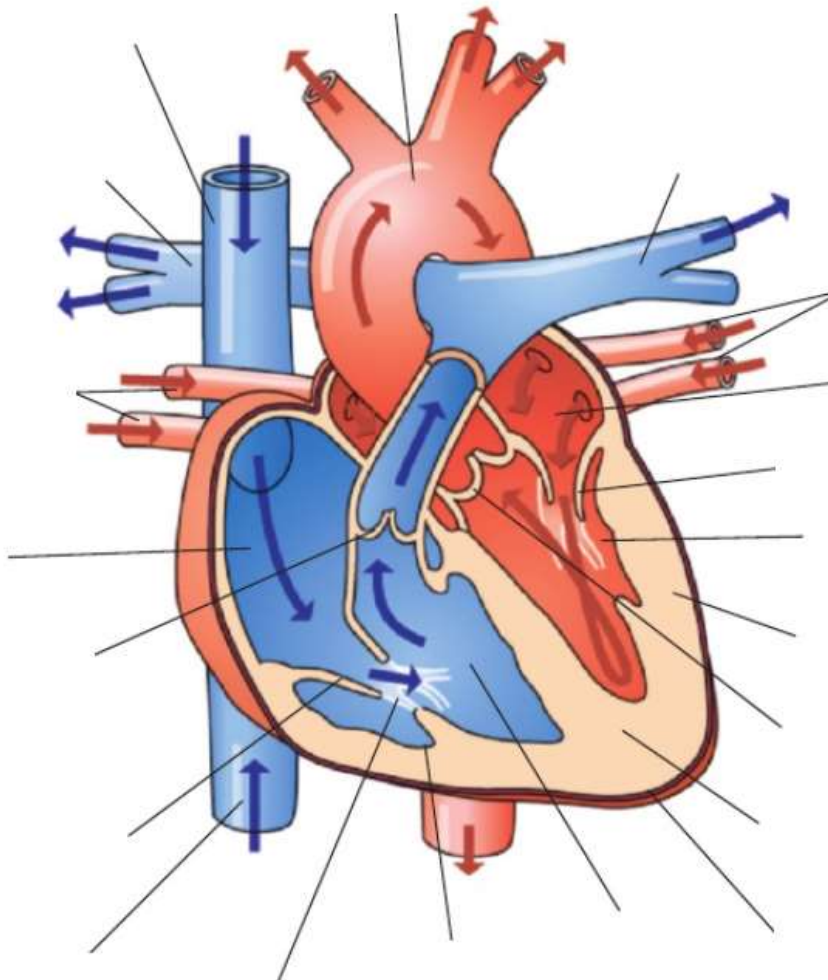
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**Task 4:** Label the diagram of the heart

← = oxygenated blood      ← = deoxygenated blood



Left atrium, left ventricle, right atrium, right ventricle, vena cava (inferior and superior), aorta (inferior and superior), pulmonary artery, pulmonary vein

Bicuspid valve, tricuspid valve, semilunar valves, chordate tendineae, septum, coronary arteries.

**Task 5:** Give a brief description of the function of the following blood vessels.

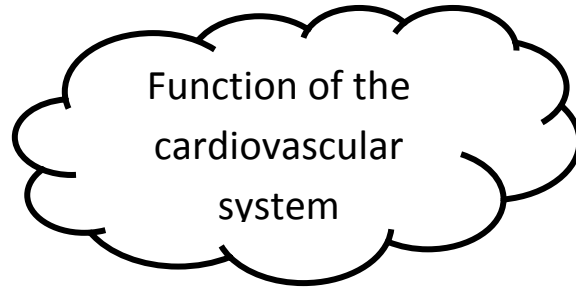
Blood vessel/type	Function
Aorta	
Vena cava	
Pulmonary artery	
Pulmonary vein	
Arteries	
Arterioles	
Veins	
Venuoles	
capillaries	

**Task 6:** Complete the table below to compare the main differences between arteries and veins.

Arteries	Veins

## B2. Function of the cardiovascular system

**Task 7:** Functions of the cardiovascular system; complete mind map



**Task 8:** What are the different responses of the cardiovascular system?

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

What are the different adaptations of the cardiovascular system?

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

## B3. The Cardiac Cycle

**Task 9:** Place the following statements of the cardiac cycle into the correct order.

- A. At the lungs, the blood picks up oxygen (gas exchange)
- B. From the left atrium, blood flows through into the left ventricle.
- C. Blood is pumped through the aorta to deliver oxygen rich blood to the rest of the body.
- D. It goes through the pulmonary arteries to the lungs.
- E. Blood enters the right atrium from the superior and inferior vena cava
- F. Oxygenated blood is now returned to the heart through the pulmonary veins.
- G. From the pulmonary veins, blood flows into the left atrium.
- H. From right atrium, it goes through the tricuspid valve to the right ventricle.

**Order:** \_\_\_\_\_

Now rewrite the order from memory.

**Task 10:** In the table below, explain the 4 part electrical system of your heart that trigger the cardiac cycle.

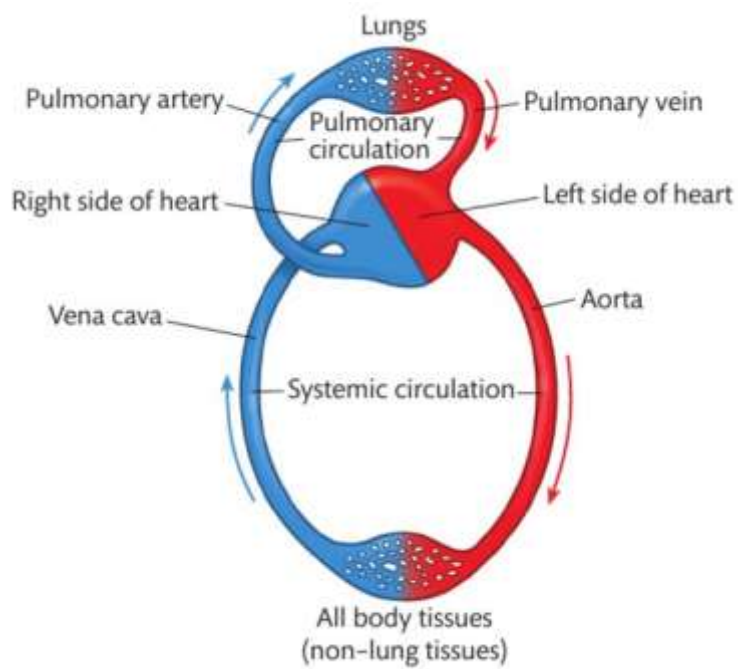
Electrical System	What happens...?
Sinoatrial node (SAN)	
Atrioventricular node (AVN)	
Bundle of His	
Purkinje fibres	



**Revision questions – Cardiovascular system**

Describe the functions of the white blood cells. (3 marks)

Explain how the heart works as a “double pump”.



Describe the differences between arteries and veins. Explain why there are structural differences between arteries and veins. **(4 marks)**

List the main functions of the cardiovascular system.

What is meant by 'cardiac output'? **(1 mark)**

Describe what happens to your cardiac output during exercise. **(2 marks)**

Consider the two components of cardiac output. What are the long-term adaptations affecting your cardiac output due to an exercise programme? **(4 marks)**

Describe the pathway of blood flow from the heart through the major blood vessels to the body and lungs. **(6 marks)**

State the function of the bicuspid valve. **(1 mark)**

Describe the nervous control of the cardiac cycle. **(4 marks)**

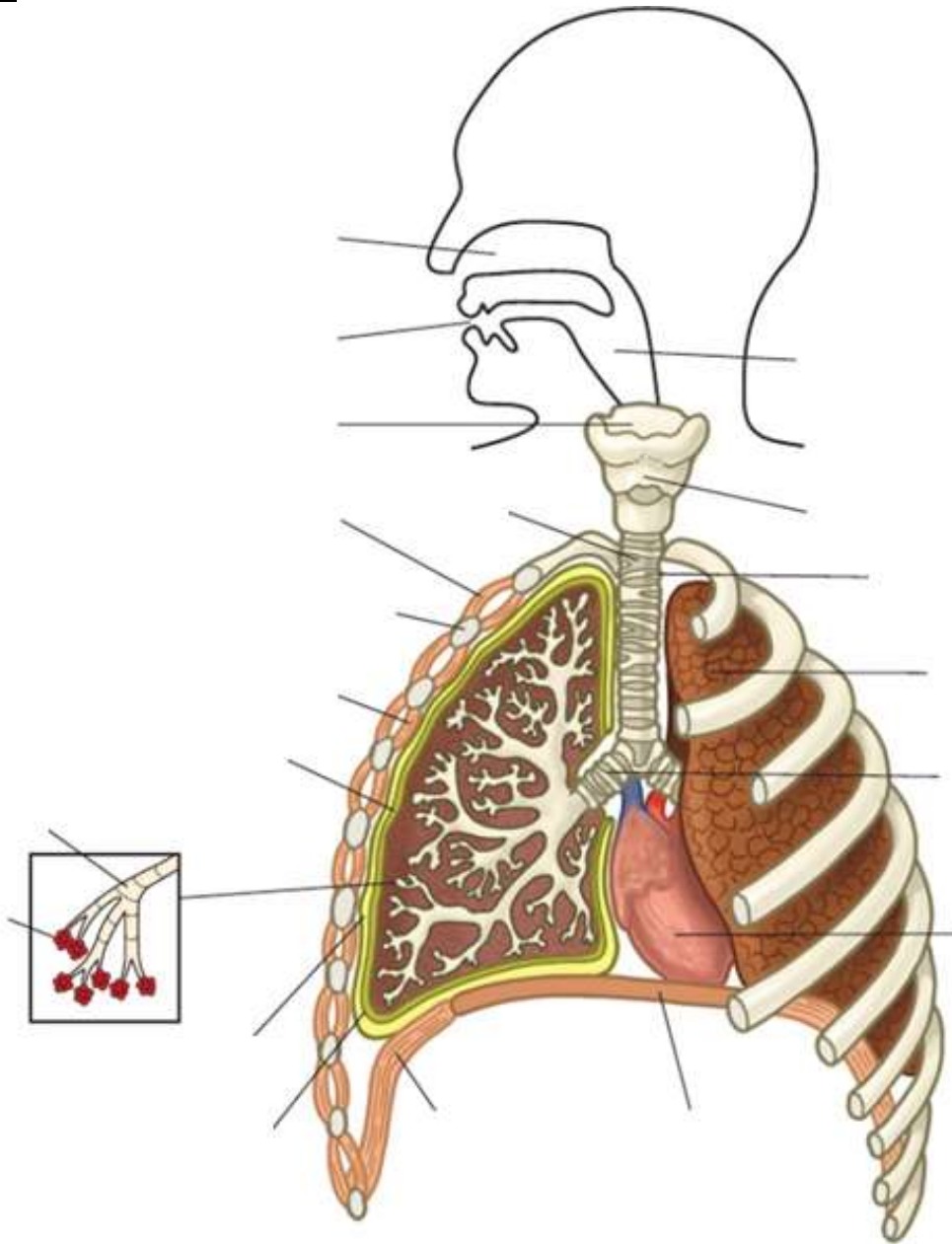
Grace is a basketball player. The table shows Grace's heart rate at rest and then one minute before taking part in regular basketball for over 8 months. In this time Grace's resting heart rate has decreased from 77 to 70 bpm. Explain why Grace's resting heart rate has decreased. **(3 marks)**

Resting heart rate (bpm)	Heart rate one minute before taking part in basketball (bpm)
70	80

Explain the change in Grace's heart rate show in the two columns of the table. **(4 marks)**

**C1. Location, anatomy and function of the respiratory system**

**Task 11:** Label the diagram below using the checklist provided.



		Complete
<b>Structure:</b>	Nasal Cavity	
	Epiglottis	
	Pharynx	
	Larynx	
	Trachea	
	Bronchus	
	Bronchioles	
	Lungs	
	Alveoli	
	Diaphragm	
	Thoracic Cavity	
	Pleura (visceral and parietal)	
	Intercostal Muscles (external and internal)	

**Task 12:** Add the function of each the different components of the respiratory tract to the flowchart below.

Nasal cavity	
Pharynx	
Larynx	
Trachea	
Epiglottis	
Lungs	
Bronchi	
Bronchioles	
Alveoli	
Diaphragm	

## C2. Function of the respiratory system

**Task 13:** Explain the process of inspiration and expiration in the table below.

Phase	What happens...?
Inspiration	
Expiration	

**Task 14:** What are the difference between the **internal** intercostal muscles and **external** intercostal muscles?

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What happens to the intercostal muscles and the diaphragm during exercise? Justify your answer.

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**Task 15:** Define the following respiratory key terms

Tidal volume → \_\_\_\_\_

Residual volume → \_\_\_\_\_

Vital capacity → \_\_\_\_\_

**C3. Control of breathing** – You must understand the **2 ways** in which breathing rate is controlled in response to exercise.

**Task 16:** How is breathing controlled? Explain the neural and chemical processes that occur when we breathe.

Control	What happens...?
Neural	
Chemical	



**Task 17:** Gas exchange is the process by which one type of gas is exchange for another. Explain the process of gas exchange between oxygen and carbon dioxide. Where does it take place? How does it happen?

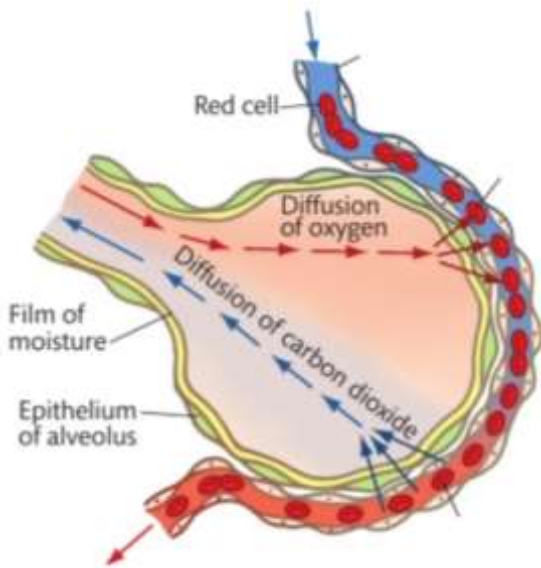
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Identify the percentage of carbon dioxide and oxygen during inspired and expired gases.

Phase	% of Oxygen	% of Carbon dioxide
Inspiration		
Expiration		

**Revision questions respiratory system**

List the journey of air from the mouth to the alveoli.

Define the following respiratory terms

a)

b)

Think about how your breathing changes during exercise. Explain what is happening to each specific lung volume.

The table below shows an athlete's tidal volume as they take part in a game of hockey.  
**(4 marks)**

<b>Tidal volume before taking part in hockey</b>	<b>Tidal volume after 40 minutes of playing hockey</b>
500ml	650ml

Explain why the athlete's tidal volume has changed after 40 minutes of playing hockey.

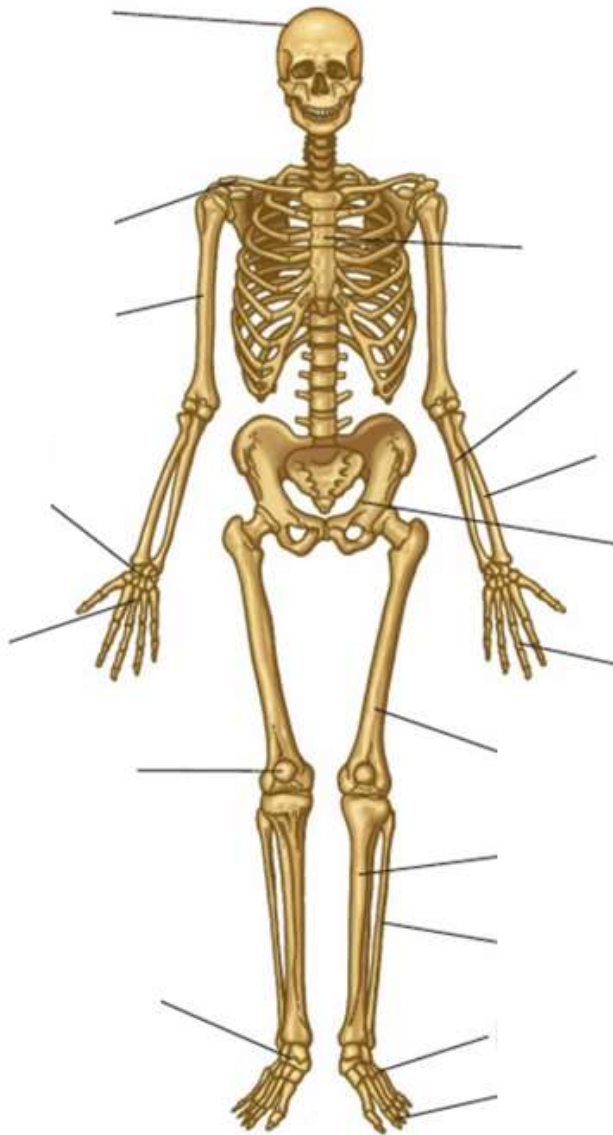
Describe *specifically* how the respiratory system adapts to long term exercise.

Explain the short-term effect of taking part in football on tidal volume. **(3 marks)**

Explain the role of carbon dioxide in the chemical control of breathing during exercise.  
**(3 marks)**

## D3. Location of skeletal bones

**Task 18:** Label the major bones on the diagram below.



		Complete
<b>Major Bones:</b>	Cranium	
	Clavicle	
	Ribs	
	Sternum	
	Scapula	
	Humerus	
	Radius	
	Ulna	
	Carpals	
	Metacarpals	
	Phalanges	
	Pelvis	
	Vertebral Column (cervical, thoracic, lumbar, sacrum, coccyx)	
	Femur	
	Patella	
	Tibia	
	Fibula	
	Tarsals	
	Calcaneus	
	Metatarsals	

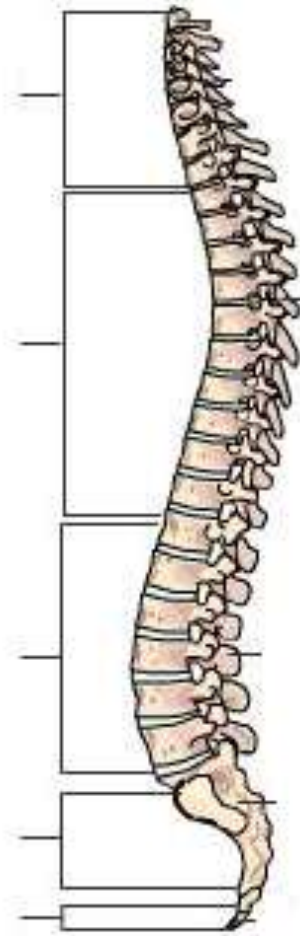
**Task 19:** Complete the table below about the 5 classification of bones:

Type of bone	Characteristics	Examples
1.		
2.		
3.		
4.		
5.		

**Task 20:** Complete the table below about the 2 different types of Skeleton:

Type of skeleton	Function	Bones
1. A _____		
2. A _____		

**Task 21:** Label the different parts of the vertebral column on the diagram below.



**Task 22:** Complete the table below about the 5 different sections of the vertebral column.

Section	Characteristics
1.	
2.	
3.	
4.	
5.	

**Task 23:** In the table below, provide examples and describe the main functions of the 5 different types of bones.

Type of bone	Examples	Function
1.		
2.		
3.		
4.		
5.		

### **D1 and D2. Process of bone growth and remodelling**

**Task 24:** Explain the key terms below in relation to bone growth.

1. Osteocyte activity →

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2. Osteoclasts →

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3. Osteoblasts →

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4. Ossification →

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**What is bone remodelling?**

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**D4 and D5. Ligaments and joints –** you must understand the role of ligaments in the skeletal system

**Task 25:** What is the role of ligaments? Describe the differences between ligaments and tendons.

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Label the key ligaments that are responsible for stabilising and restricting the joints circled.



**Task 26:** Complete the table below about the 3 different *classifications* of joints.

Type of Joint	Characteristics	Examples
1.		
2.		
3.		

**Task 27:** Label the features of the synovial joint on the diagram below.



Add definitions to the key features of a synovial joint below.

Joint capsule → \_\_\_\_\_

Bursa → \_\_\_\_\_

Articular cartilage → \_\_\_\_\_

Synovial membrane → \_\_\_\_\_

Synovial fluid → \_\_\_\_\_

Ligaments → \_\_\_\_\_

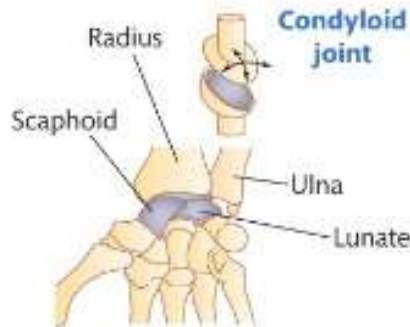
**Task 28:** Complete the table below about the 6 different types of synovial joints.

Type of Joint	Example	Movement Allowed
1.		
2.		
3.		
4.		
5.		
6.		

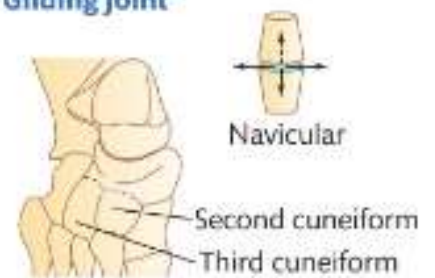
**Ball and socket joint**



**Condyloid joint**



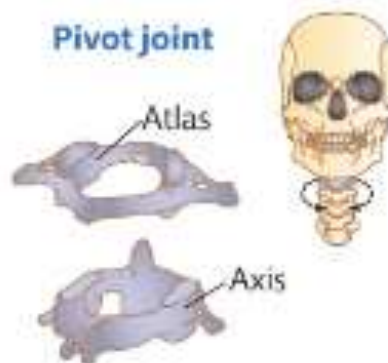
**Gliding joint**



**Hinge joint**



**Pivot joint**



**Saddle joint**



## D6. Function of the skeletal system

**Task 29:** In the table below, identify and explain the 6 functions of the skeleton.

Function	Explanation/Example
1.	
2.	
3.	
4.	
5.	

**\*Types of movement allowed at each joint will be covered in E5.**

**Task 30:** Explain how the additional factors below are affected by the skeletal system and exercise?

<b>Arthritis</b>	
<b>Osteoporosis</b>	
<b>Age</b>	

**Revision Questions → Bones, joints and adaptations to the skeletal system**

1. Connor has returned to playing football after a 5 year break from sport. He needs to improve his fitness so takes part in a 3 month fitness training programme. He joined a gym and was given the following weekly training programme:

Monday – 20 minutes continuous running

Tuesday – weight training (upper body)

Thursday – 15 minutes continuous rowing and 15 minutes continuous cycling

Friday – weight training (lower body) Saturday – 20 minutes continuous running

Explain how this fitness training programme would increase the strength of Connor’s bones.

2. Identify the location of each of the types of synovial joints?

- A) Condyloid
- B) Pivot
- C) Hinge
- D) Gliding
- E) Saddle
- F) Ball and socket



3. Think about your warm-up before exercise. What happens to your body and why? Research and draw up a list of the changes that occur in the skeletal system and explain why they happen during exercise. **(4 marks)**

4. Explain why weight bearing exercises will prevent osteoporosis from getting worse **(3 marks)**



5. Analyse how the axial and appendicular skeleton allows the ranges of movement necessary at the shoulder, trunk and wrist for the athlete to adopt the position shown compared to the anatomical standing position. (12 marks)

6. Analyse how movement at the synovial joints in the upper skeleton allows a tennis player to serve the ball as shown in the picture. (6 marks)



7. What are the main functions of the skeleton? Why are these important in sport and exercise?

8. Describe the process of bone remodelling.

9. What are the different responses of the skeletal system to exercise?

- 1. \_\_\_\_\_
- 2. \_\_\_\_\_
- 3. \_\_\_\_\_
- 4. \_\_\_\_\_

10. What are the different adaptations of the skeletal system?

- 1. \_\_\_\_\_
- 2. \_\_\_\_\_
- 3. \_\_\_\_\_
- 4. \_\_\_\_\_



## E. The anatomy of the muscular System

**Task 31:** Complete tasks below

What are the main functions of the muscular system?

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

Complete the table below about the 3 different types of muscle.

Type of Muscle	Characteristics	Examples
1.		
2.		
3.		

What is the difference between voluntary and involuntary muscles?

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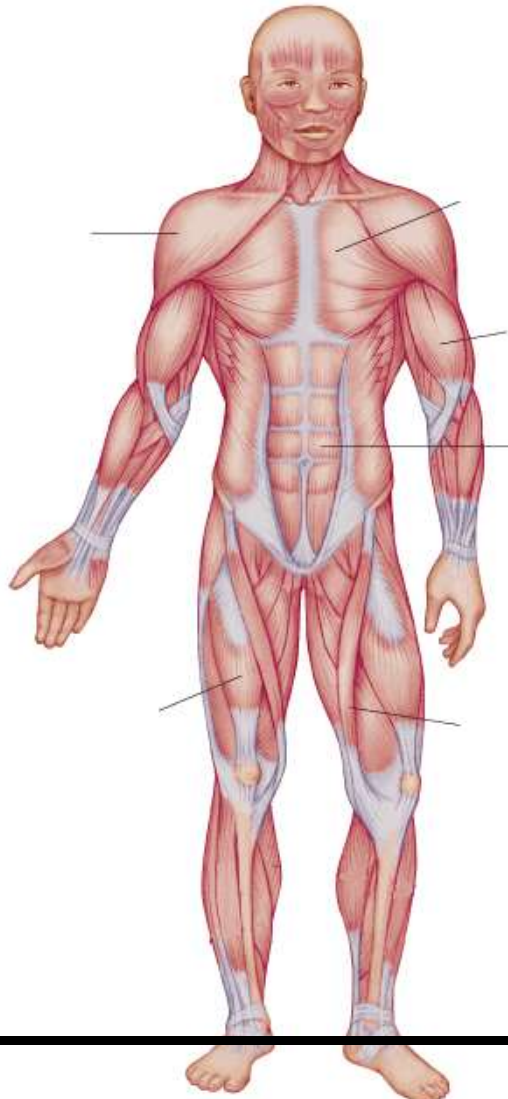
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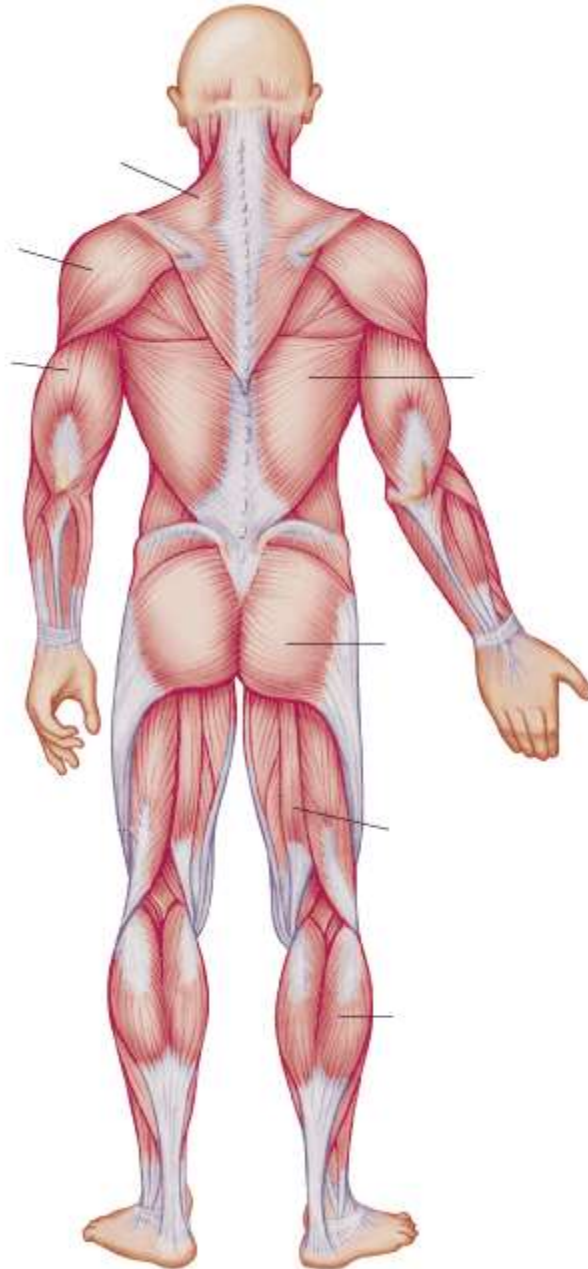
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## E3. Location of skeletal muscles

**Task 32:** Label the two diagrams on the following pages using the checklist below.

		Complete
<b>Major Skeletal Muscles:</b>	Deltoids (posterior, anterior and medial)	
	Shoulder rotators	
	Biceps and triceps brachii	
	Wrist Flexors	
	Wrist Extensors	
	Forearm Supinators	
	Forearm Pronators	
	Pectorals	
	Rectus Abdominals	
	Obliques	
	Transverse abdominals	
	Quadriceps (rectus femoris, vastus medialis, vastus lateralis, vastus intermedius)	
	Iliopsoas	
	Tibialis Anterior	
	Erector Spinae	
	Trapezius	
	Rhomboids	
	Latissimus Dorsi	
	Gluteals (gluteus maximus, medius and minimus)	
	Hamstrings	
Gastrocnemius		
Soleus		





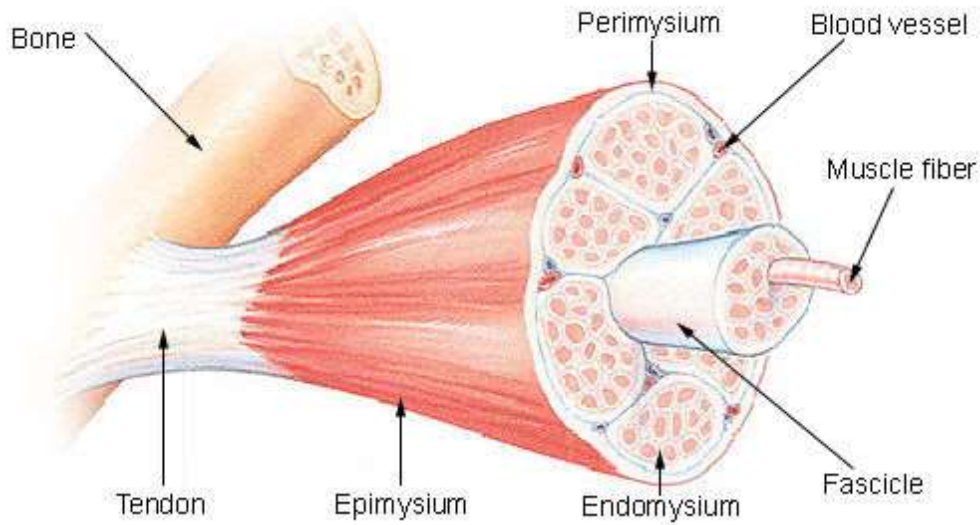
**Task 33:** Complete the table below about the 3 different muscle fibres and the all or none law.

Fibre Type	Characteristics	Sporting Examples
Type I		
Type IIa		
Type IIx		

**All or None Law**

Below are the parts to a skeletal muscle that you need to be aware of.

**Structure of a Skeletal Muscle**



**E2. Neuromuscular process of muscle contractions**

**Task 34:** Complete the table below about the 3 different types of muscle contraction.

Type of Contraction	Characteristics	Examples
1.		
2.		
3.		

## E4. Antagonistic muscle pairs

**Task 35:** Explain the following terms, providing examples for each:

Antagonistic pairs → \_\_\_\_\_

Agonist → \_\_\_\_\_

Antagonist → \_\_\_\_\_

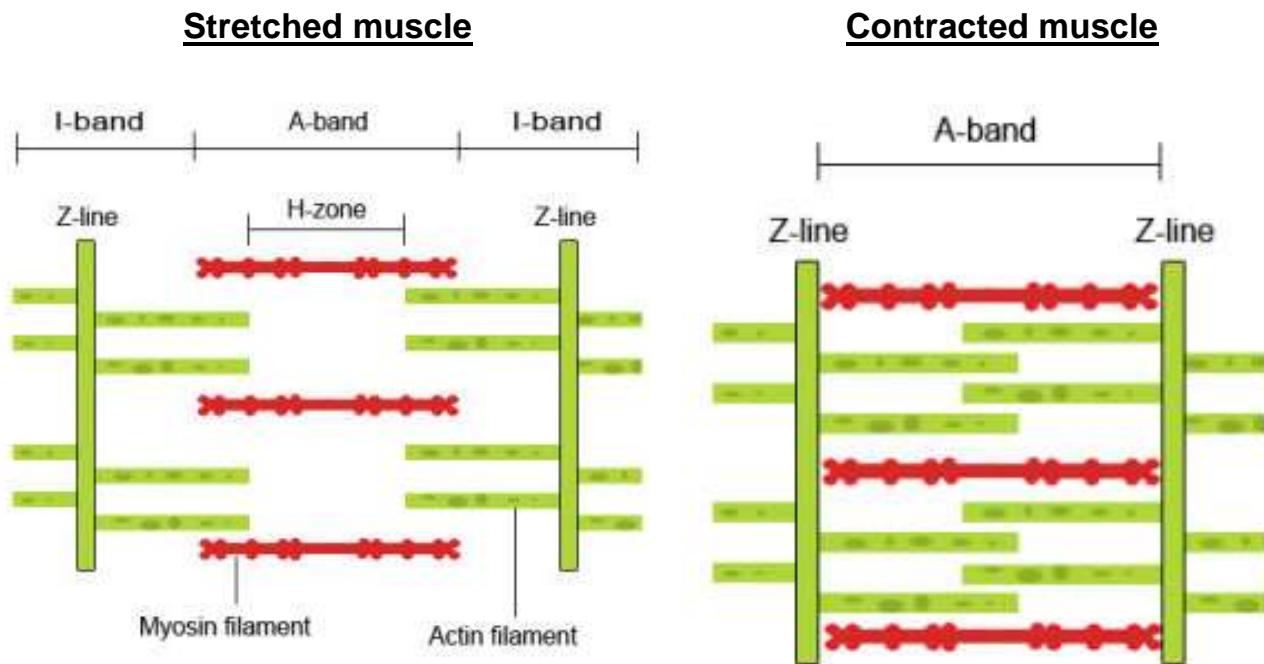
Synergist → \_\_\_\_\_

Fixator muscle → \_\_\_\_\_

- If each of the muscles below were the agonist muscles, list their antagonist.
- Then add the synergist being the muscle that stabilises muscle movement.

<b>Agonist</b>	<b>Antagonist</b>	<b>Synergist</b>
1. Biceps brachii		
2. Trapezius/Rhomboids		
3. Tibialis anterior		
4. Quadriceps		
5. Rectus abdominals		
6. Wrist flexor		
7. Deltoids		
8. Gluteus maximus		

**Task 36: Sliding filament theory** – this has lots of different elements to get to grips with in order to understand how muscles actually move.



**Myofibril:** A cylindrical organelle running the length of the muscle fibre, containing Actin and Myosin filaments.

**Sarcomere:** The functional unit of the Myofibril, divided into I, A and H bands.

**Actin:** A thin, contractile protein filament, containing 'active' or 'binding' sites.

**Myosin:** A thick, contractile protein filament, with protrusions (sticks out) known as Myosin Heads.

**Tropomyosin:** An actin-binding protein which regulates muscle contraction.

**Troponin:** A complex of three proteins, attached to Tropomyosin.

**Task 36:** Complete the missing words in the gaps below.

Calcium ions	<input type="checkbox"/>	Cross bridges	<input type="checkbox"/>	tropomyosin	<input type="checkbox"/>
Myofibril	<input type="checkbox"/>	H zone	<input type="checkbox"/>	ATP	<input type="checkbox"/>
Sarcomere	<input type="checkbox"/>	A band	<input type="checkbox"/>	ATPase	<input type="checkbox"/>
Actin	<input type="checkbox"/>	I band	<input type="checkbox"/>	Muscle fibre	<input type="checkbox"/>
Myosin	<input type="checkbox"/>	Troponin	<input type="checkbox"/>	Muscle contractions	<input type="checkbox"/>

At a very basic level each muscle fibre is made up of smaller fibres called myofibrils. These contain even smaller structures called actin and \_\_\_\_\_ filaments. These filaments slide in and out between each other to form muscle contractions.

The diagram above shows part a myofibril called a \_\_\_\_\_. This is the smallest unit of skeletal muscle that can contract. Sarcomeres repeat themselves over and over along the length of the \_\_\_\_\_.

\_\_\_\_\_ and myosin are what give skeletal muscles their striped appearance, with dark and light bands. The dark bands are called \_\_\_\_\_. The light bands are called \_\_\_\_\_. In the centre of each I band is a line called the \_\_\_\_\_ that divides the myofibril into smaller units called sarcomeres.

A nervous impulse arrives at the neuromuscular junction, which causes \_\_\_\_\_ (Ca+) to be released. The Calcium ions bind to Troponin, changing it to \_\_\_\_\_. The Myosin filaments can now attach to the Actin, forming a \_\_\_\_\_.

The breakdown of \_\_\_\_\_ releases energy which enables the Myosin to pull the Actin filaments inwards and so the muscle shortens. This occurs along the entire length of every myofibril in the \_\_\_\_\_.

To ensure that this process stops, calcium is actively pumped back into the sarcoplasm.

When there is no more calcium present, no calcium binds to \_\_\_\_\_. This would cause tropomyosin to again bind to actin preventing myosin binding to the actin. This means that there is no more sliding of the myosin along the actin and no more \_\_\_\_\_.

## E5. Types of movement

**Task 37:** Describe the types of movement and physical examples of their movement

Type of movement	Description	Physical example
Abduction		
Adduction		
Rotation		
Circumduction		
Pronation		
Supination		
Elevation		
Depression		
Protraction		
Retraction		

Flexion and extension need to be understood in slightly more detail.

Horizontal flexion	
Hip flexion	
Shoulder flexion	
Plantar flexion	
Dorsi flexion	

Horizontal extension	
Hip extension	
Shoulder extension	
Hyperextension	

**Task 38:** On the diagram below, label the major muscles and explain what type of muscle contractions are happening.





**Task 39:** What are the different responses of the muscular system?

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

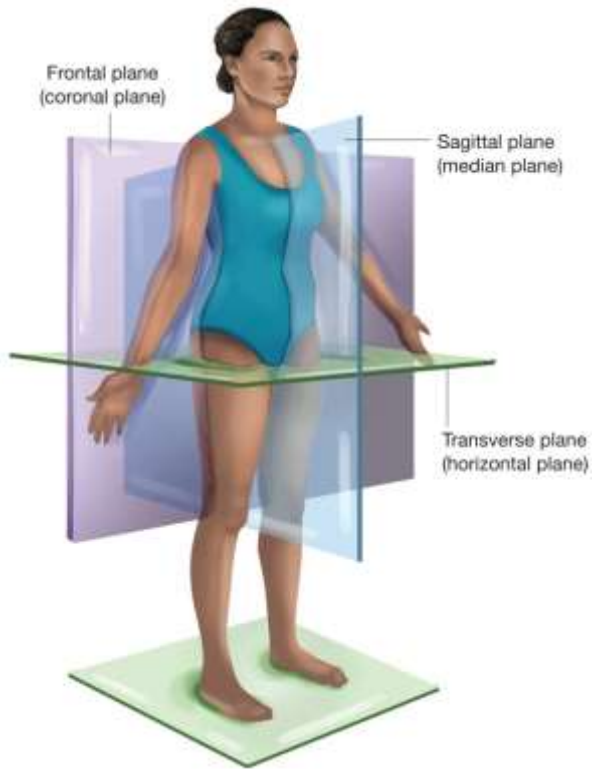
What are the different adaptations of the muscular system?

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

**Task 40:** Explain how the additional factors below are affected by the muscular system and exercise?

<b>Age</b>	
<b>Cramp</b>	

## E6. Planes of movement



**Task 41:** Give a description of the 3 planes of the body. To look at the direction of movement and can divide the body up into imaginary sections or 'planes' to understand where movement comes from.

Sagittal plane → \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Transverse plane → \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Frontal plane Transverse plane → \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

To understand the planes fully link the types of movement that are possible via each plane

- |            |                      |
|------------|----------------------|
| Sagittal   | Abduction related    |
|            | Adduction related    |
| Transverse | Flexion related      |
|            | Extension related    |
| Frontal    | Rotational movements |

**Revision Questions → Muscular System**

What are the different muscle types?

Explain the importance of the different types of muscle fibre in certain sports.

Where are the following skeletal muscles located?

- a) Obliques -
- b) Sternocleidomastoid -
- c) Rhomboids -
- d) Soleus -
- e) Erector Spinae -

Ben is a high jump athlete and Harry is a 1500m runner. They will recruit different skeletal muscle fibre types to complete their sports. Explain why different muscle fibre types would be recruited when taking part in the high jump and 1500m.

Think of a press-up. Which muscles are working as antagonistic pairs in the shoulder? Which muscle would be the synergist?

What type of contraction are taking place for each phase of a press-up at the shoulder joint?

What aspects of the warm-up are used to prevent muscle injury? Why is a warm-up before exercise important to your muscles?

What long-term adaptations occur in your muscles when you exercise?

Consider the different muscle fibre types and list the exercises that could be used specifically to train them.

Nancy is a netball player. She uses weighted lunges as part of her training as shown. Explain how the use of weighted lunges will improve Nancy's performance in netball. **(3 marks)**



Two days after Nancy's training session she experiences delayed onset of muscle soreness (DOMS). Describe why Nancy's training may cause DOMS. **(1 mark)**

The second picture shows Nancy training on a resistance machine. Explain how Nancy's muscles work as antagonistic pairs for each phase of the movement. **(4 marks)**



The accepted theory to explain muscle contraction is the sliding filament theory. Analyse, using the sliding filament theory, the process of muscle contraction.

## **F. Analysis of the skeletal and muscular systems and how they produce movements in sport and exercise**

**F1. Phases of sport and exercise movement** – Learners must understand the application of both systems using anatomical language in each phase of movement (we have already covered this).

**Task 42:** Describe each phase of movement

Preparation:

Execution:

Follow through:

**F2. Interrelationship o the skeletal and muscular systems in**

**movement analysis** – learners must understand how the two systems work together in each phase of movement.

**Task 43:** Identify where on the body the following sections lie for movement analysis

- a) Upper body
- b) Trunk
- c) Lower body



**Task 44:** Recap the following key terms

Role of antagonistic pairs: \_\_\_\_\_  
\_\_\_\_\_

Synergist muscles: \_\_\_\_\_  
\_\_\_\_\_

Fixator muscles: \_\_\_\_\_  
\_\_\_\_\_

Concentric contraction: \_\_\_\_\_  
\_\_\_\_\_



Eccentric contraction: \_\_\_\_\_  
\_\_\_\_\_

Isotonic contraction: \_\_\_\_\_  
\_\_\_\_\_

Isometric contraction: \_\_\_\_\_  
\_\_\_\_\_

Isokinetic contraction: \_\_\_\_\_  
\_\_\_\_\_

**Task 45:** Movement efficiency

What is meant by a kinetic chain?

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\_\_\_\_\_  
\_\_\_\_\_

What are the advantages of kinetic chain exercises?

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\_\_\_\_\_  
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