

**Musculoskeletal System** Long Bones Short Bones Flat Bones Irregular Bones Articulating Bones Synovial Joints Cartilage Tendons Ligaments  
 Freely Moveable Joints Ball and Socket Hinge Flexion Extension Plantar Flexion Dorsi Flexion Rotation Adduction Abduction **Muscular System**  
 Prime mover (Agonist) Antagonist Antagonistic Pairs Isotonic Muscle Contraction Isometric Muscle Contractions **Cardio-respiratory System**  
 Gaseous Exchange Alveoli Inhale Exhale Diffusion Spirometer Trace Tidal Volume Expiratory Reserve Volume Inspiratory Reserve Volume  
 Residual Volume Vital Capacity Cardiovascular System Oxygenated blood Deoxygenated blood Heart rate Arteries Veins Capillaries Diastole  
 Systole Cardiac Cycle Blood Pressure Vasoconstriction Vasodilation Stroke Volume Cardiac Output **Aerobic Exercise Anaerobic Exercise Intensity**  
 Lactic Acid Excess Post-exercise Oxygen Consumption (EPOC) Delayed Onset Muscle Soreness (DOMS) Fatigue Hypertrophy

## The Structure and Function of the Skeleton

### Four types of Bones:

**Flat** - quite large and protect vital organs  
**Long** - enable gross movements  
**Short** - enable finer, controlled movements  
**Irregular** - specifically shaped to protect

### Articulating Bones:

Bones that meet at a joint to allow movement.  
 E.g. Shoulder: scapula, clavicle, humerus  
 Elbow: humerus, radius, ulna

## Functions of the Skeleton

### Support

For muscles and vital organs. Without support the body would be a mass of soft tissue that was unable to move

### Protection

Of vital organs such as the cranium, a flat bone, protecting the brain. It reduces the chance of injury

### Movement

Occurs at the joints when muscles contract

### Shape & Structure

Maintaining basic form of our body and providing attachment for our muscles

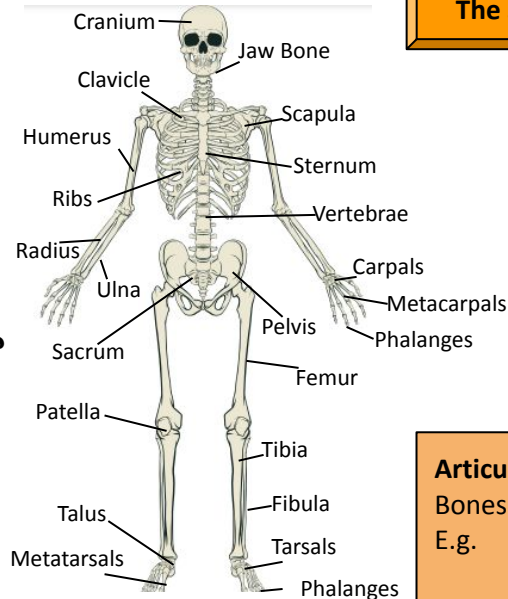
### Blood cell production

Takes place in the bone marrow. Red blood cells, white blood cells and platelets

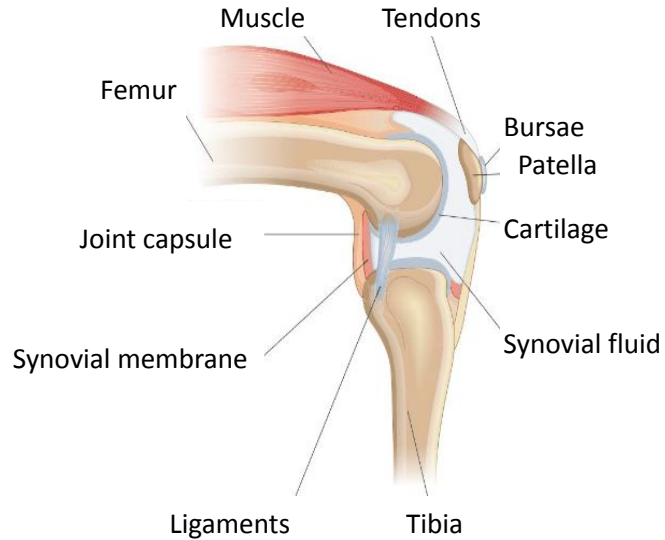
### Storage of Minerals

Essential for major body functions. Links to the general health of an athlete.

## Structure of the Skeleton



Known as freely moveable joints and are the most common type of joint in the human body. Located at the shoulder, elbow, hip, knee and ankle.



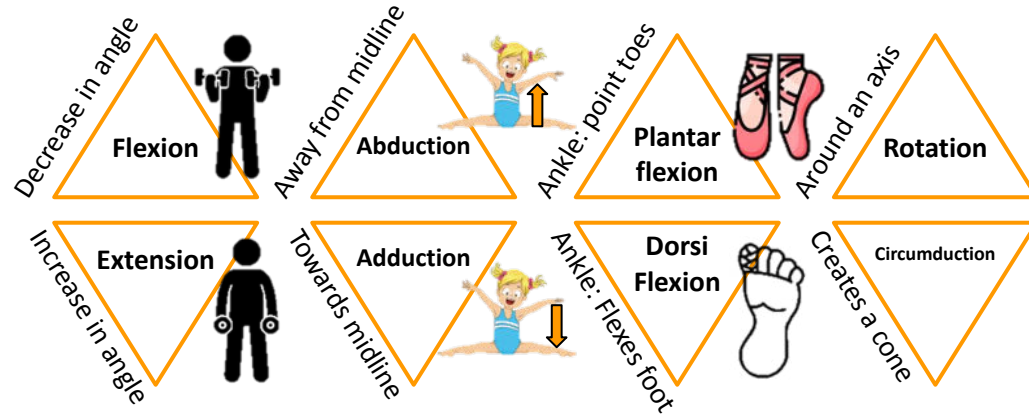
Different types of freely moveable joints allow different types of movement.

**Ball and Socket:** Shoulder and hip. Can move away and towards the body and rotate. The most moveable joint.

**Hinge:** Elbow, knee and ankle. Only move in one direction, towards and away from each other

### Structure and Function of the Muscular System

## Joint Action and Movements



## The Muscular System

**Major Muscle Groups that operate at the following joints:**

**Shoulder:** Deltoid, trapezius, pectorals, latissimus dorsi, biceps, triceps, rotator cuff

**Elbow:** Biceps, triceps

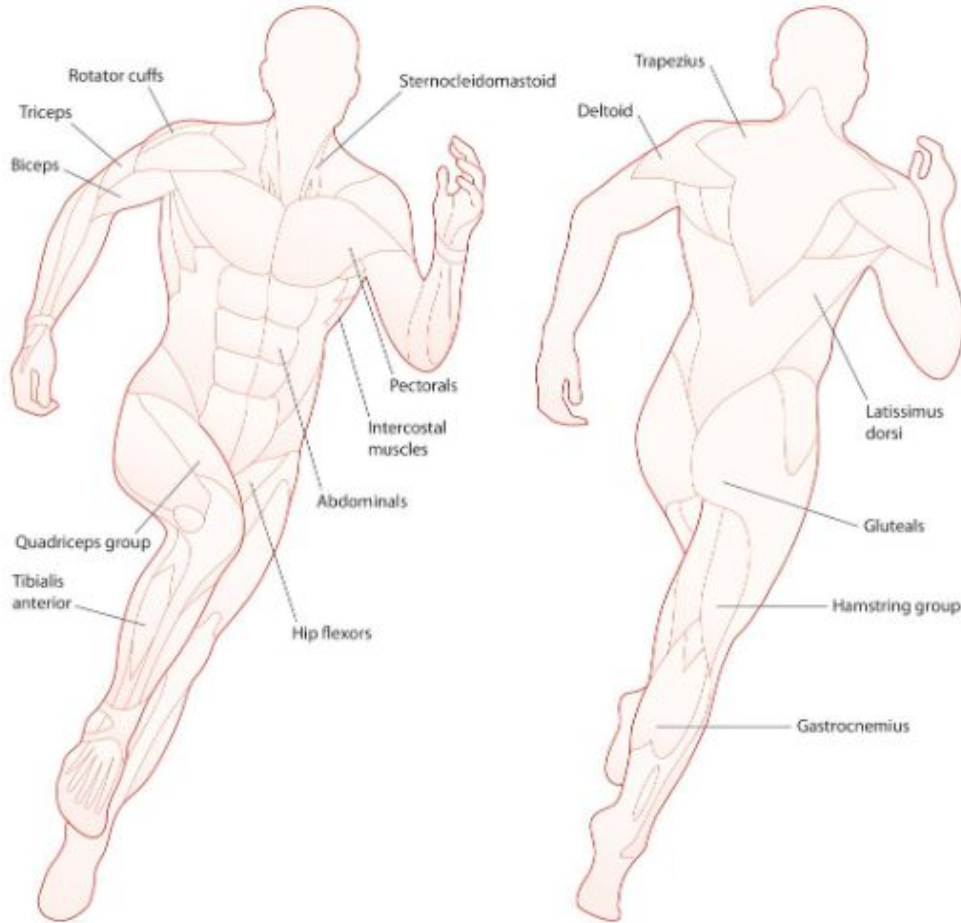
**Hip:** Gluteals, hip flexors

**Knee:** Quadriceps group, hamstring group

**Ankle:** Tibialis anterior, gastrocnemius



## The Muscular System



## Muscles and Movement

### Prime Mover (Agonist)

Muscles can only pull, not push. Arranged in pairs on either side of the joints. One muscle contracts whilst the other relaxes. The muscle that contracts is the agonist, the one that relaxes is the antagonist.

This is called an **antagonistic muscle pair**

### Antagonist

#### Obvious pairs include:

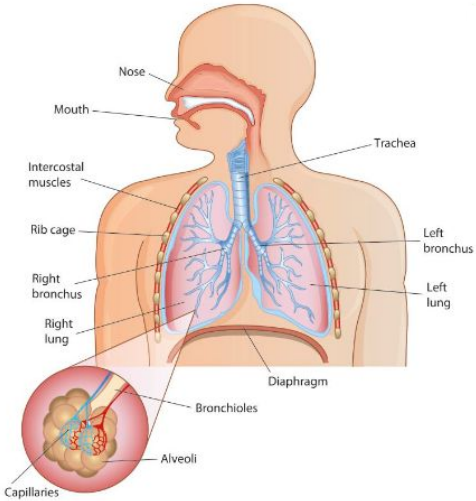
Biceps and triceps  
 Hip flexors and gluteals  
 Hamstring group and quadricep group  
 Tibialis anterior and gastrocnemius

Muscles contract in two different ways: isotonically and isometrically

**Isotonic:** When the muscle changes length when it contracts, resulting in limb movement. Concentric (muscle shortens) or eccentric (muscle lengthens)

**Isometric:** When the muscles stay the same length. No actual movement of either the limb or the joint because the muscles are working to keep the joint stationary

## The Structure and Function of the Cardio-respiratory System



## The Respiratory System

# Anatomy & Physiology

Made up of the circulatory system (heart, blood vessels and blood) and the respiratory system (the lungs and airways)

1.

Oxygen that has been breathed in passes through the alveoli and into the red blood cells in the capillaries

*Gaseous Exchange*

2.

In the capillaries, the oxygen combines with **haemoglobin** to form **oxyhaemoglobin**

4.

The carbon dioxide in the capillaries passes through the alveoli and is breathed out

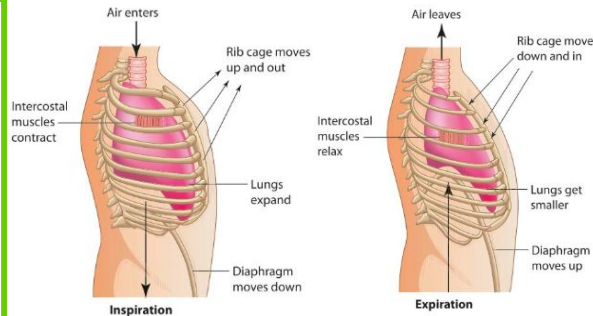
3.

At the same time haemoglobin carries carbon dioxide from the body to the capillaries

## The Mechanics of Breathing

### Inhalation:

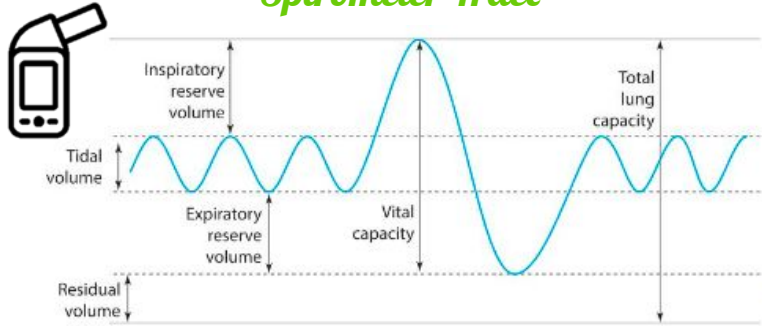
- Chest cavity changes shape and size
- Diaphragm flattens and moves downwards
- Intercostal muscles contract, raising the ribs up and pushing out the sternum
- Chest cavity is then larger
- Reduces air pressure, causing air to be sucked in



### Exhalation:

- Diaphragm becomes dome shaped
- Intercostal muscles relax, lowering the ribs and dropping the sternum
- Chest cavity is then smaller
- Increases air pressure, causing air to be pushed out

## Spirometer Trace



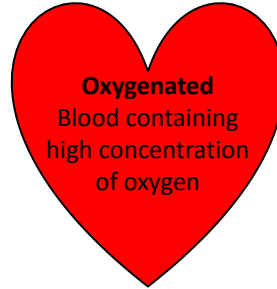
**Tidal Volume:** The normal amount of air inhaled or exhaled per breath. Tidal volume increases with exercise

**Expiratory Reserve Volume:** The amount of air that can be forced out after TV. ERV decreases during exercise

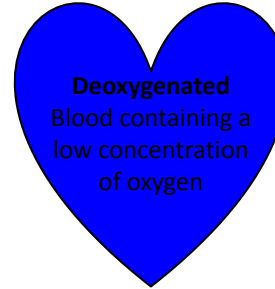
**Inspiratory Reserve Volume:** The amount of air that can be forced in after TV. IRV decreases during exercise

**Residual Volume:** The amount of air that remains in the lungs after maximal expiration. There is no change during exercise

**Vital Capacity:** The largest volume of air that can be forcibly expired after the deepest possible inspiration



**Oxygenated**  
Blood containing a high concentration of oxygen



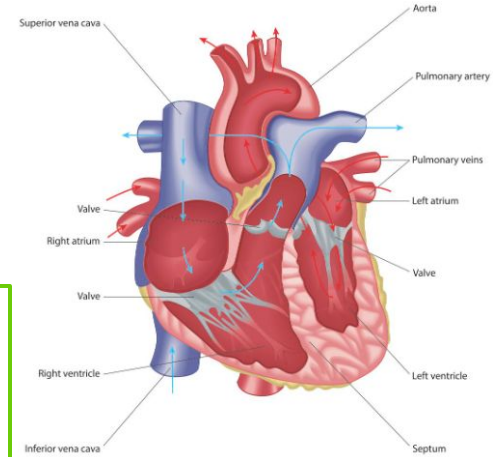
**Deoxygenated**  
Blood containing a low concentration of oxygen

### Blood Vessels

**Arteries** - Thick, muscular walls. Carry oxygenated blood away from the heart quickly and under pressure (except the pulmonary artery - deoxygenated blood to the lungs)

**Veins** - Thinner walls but larger internal diameter. Lower pressure of blood. Carry deoxygenated blood to the heart (except pulmonary vein - oxygenated blood to the heart)

**Capillaries** - Microscopic blood vessels that link arteries to veins. One cell thick to allow gaseous exchange to occur



The pathway of blood is shown with the arrows

### Cardiac Cycle

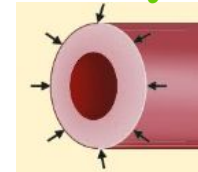
**Diastole** - Chambers of the heart relax and fill with blood

**Systole** - Chambers contract and empty and blood is ejected from the heart

### Redistribution of Blood during Exercise

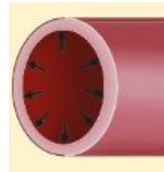
#### Vasoconstriction

The narrowing of the internal diameter of a blood vessel to restrict the volume of blood travelling through it



#### Vasodilation

The widening of the internal diameter of a blood vessel to increase the volume of blood travelling through it



$$\text{Cardiac Output (Q)} = \text{Stroke Volume (SV)} \times \text{Heart Rate (HR)}$$

**Cardiac Output**

The volume of blood ejected from the heart in one minute

**Stroke Volume**

The volume of blood pumped out of the heart by each ventricle during one contraction

**Heart Rate**

The number of times your heart beats in one minute

*Aerobic Exercise*

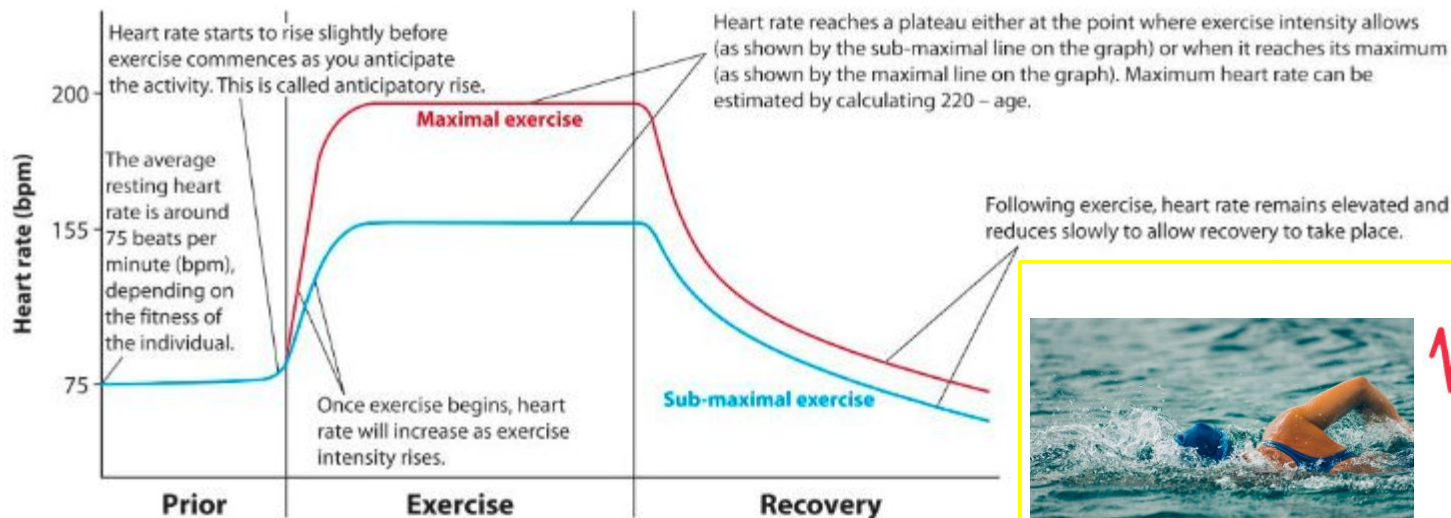
Takes place in the **presence** of oxygen. When exercise is over a long period of time, not too fast and is steady, the heart can supply all the oxygen the working muscles need



Glucose + Oxygen → Energy + Carbon Dioxide + Water

People working aerobically can work for a long period of time at a low to moderate intensity

The effects of exercise on Heart Rate (HR):



Le Tour de France



Virgin LONDON MARATHON

## Anaerobic Exercise

Takes place in the **absence** of oxygen. When exercise is short in duration and at high intensity, the heart and lungs cannot supply enough blood and, therefore, oxygen to the working muscles

Glucose → Energy + Lactic Acid

People working anaerobically can work for short periods of time, for a maximum of approximately 60 seconds



### EXCESS POST-EXERCISE OXYGEN CONSUMPTION (EPOC)

- The amount of oxygen needed to recover after anaerobic exercise
- Characterised by an increased breathing rate and deeper breathing
- EPOC replenishes the body with oxygen and enables the body to convert the lactic acid produced during anaerobic exercise into glucose, carbon dioxide and water

## The Recovery Process

### Cool Down

- Instead of just stopping at the end of a physical activity, end the session gradually
- Some light exercise and gentle stretching
- Reduce the intensity of exercise to maintain an elevated breathing rate
- Ensure quick blood flow to the muscles
- Helps convert lactic acid into glucose, carbon dioxide and water



### Ice Baths or Massage

- Help prevent Delayed Onset Muscle Soreness (DOMS)
- Massage increases blood flow to the sore area, speeding up the healing process

### Manipulation of Diet

- Drinking water to rehydrate and replace lost fluids
- Carbohydrate loading for endurance athletes to boost their performance and limit the length and severity of their recovery period
- Consuming protein after training provides nutrients needed to heal tears quickly



## Immediate Effects of Exercise

|                                                                                               |                                                                                                          |
|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| Heart rate will increase, as your heart works harder to deliver oxygen to the working muscles | Begin to feel hotter as your body temperature increases                                                  |
| Start to sweat and your skin will redden, especially on your face                             | Breathing will become deeper and more frequent, as your body delivers more oxygen to the working muscles |

FURTHER  
READING

## The Effects of Exercise



## Short-term Effects of Exercise

|                                                         |                              |
|---------------------------------------------------------|------------------------------|
| Feel tired, possibly very fatigued                      | Muscles will ache a little   |
| Feel nauseous                                           | Feel light-headed            |
| May experience DOMS if your exercise was high intensity | May experience muscle cramps |



## Long-term Effects of Exercise

|                                                                                                   |                                                                                                         |
|---------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| Body will change shape. Helps keep body weight down                                               | Will see improvements in specific CoF. Exactly which CoF improve will depend on the exercise you do     |
| Your stamina - ability to exercise for longer - will improve                                      | Muscles will increase in size and produce greater strength. This is called <b>hypertrophy</b>           |
| Heart will increase in size. This is called <b>cardiac hypertrophy</b> . Cardiac output increases | Resting heart rate will become lower. <b>Bradycardia</b> is the name given to a slow resting heart rate |