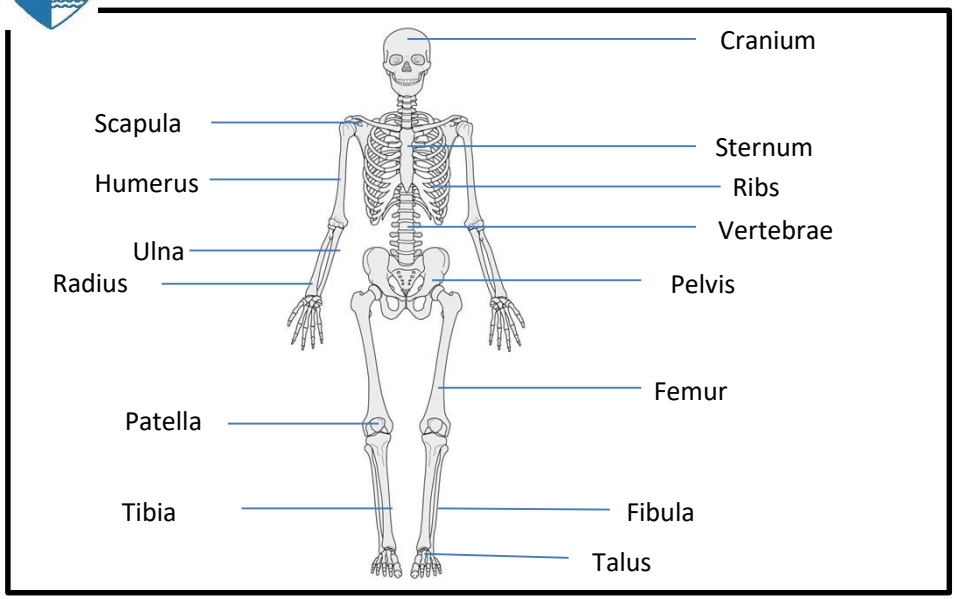
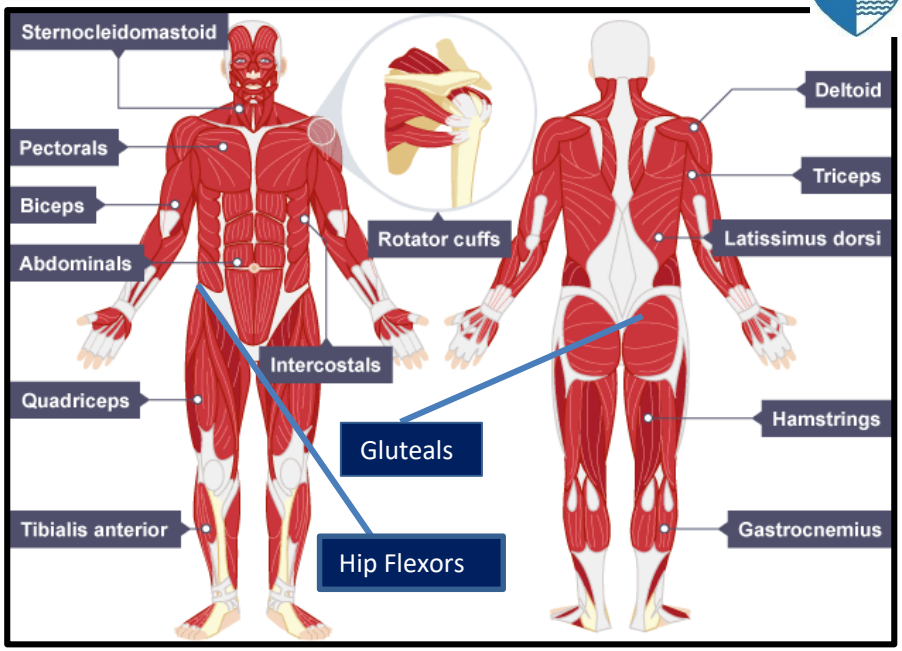
# Musculoskeletal System




## Muscular Contractions

**Isotonic Contractions**

These contractions occur when there is movement of the body. The ends of the muscles move closer together to cause the movement.

**Isometric Contractions**

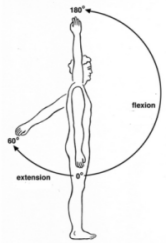
This type of contraction takes place when the body is being held in the same position. The length of the muscle during these contractions stays the same length.

**Isotonic Concentric Contraction** occurs when the muscle shortens e.g. biceps contracting concentrically during the upwards phase of a bicep curl / triceps contracting concentrically during the upwards phase of a press-up

**Isotonic Eccentric Contraction** occurs when the muscle lengthening (antagonist) is under tension. An eccentric contraction provides the control of a movement on the downward phase and it works to resist the force of gravity e.g biceps contracting eccentically when lowering the weight in a bicep curl / triceps contracting eccentically during the downwards phase of a press-up.

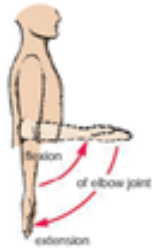
**Flexion and extension at the shoulder**

- The **Deltoid** causes flexion at the shoulder
- The **Latissimus dorsi** causes extension at the shoulder



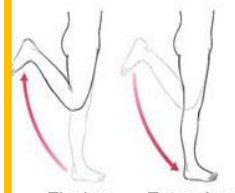

**Flexion and extension at the elbow**

- The **Biceps** cause flexion at the elbow
- The **Triceps** cause extension at the elbow



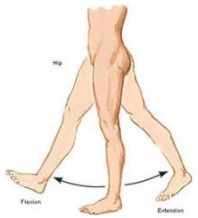

**Flexion and extension at the knee**

- The **Hamstrings** cause flexion at the knee
- The **Quadriceps** cause extension at the knee




**Flexion and extension at the hip**

- The **Hip Flexors** cause flexion at the hip
- The **Gluteals** cause extension at the hip




**Flexion and extension at the ankle**

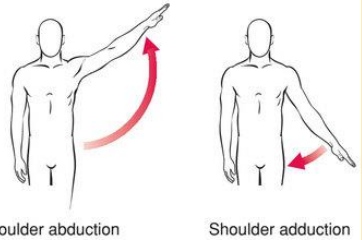
- The **Tibialis Anterior** causes dorsiflexion at the ankle
- The **Gastrocnemius** cause plantar flexion at the ankle


**Rotation of the Shoulder**

- The **Rotator Cuff** causes rotation at the shoulder

**Abduction and Adduction at the shoulder**

- The **deltoid** causes abduction at the shoulder
- The **Pectorals / Latissimus Dorsi** cause adduction at the shoulder



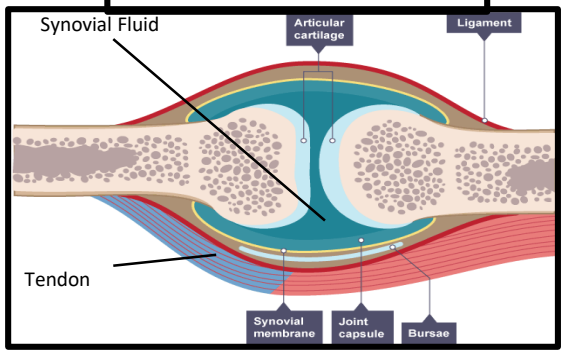
## Function of the Skeleton

- **Support:** the bones are solid and rigid. They keep us upright and hold the rest of the body – the muscles and organs – in place.
- **Movement:** the skeleton helps the body move by providing anchor points for the muscles to pull against.
- **Structural shape and points for attachment:** the skeleton gives us our general shape such as height and build. The skeleton also provides anchorage points for the muscles to attach via tendons, so when muscles contract movement occurs.
- **Protection:** certain parts of the skeleton enclose and protect the body's organs from external forces e.g. the brain is inside the cranium. This function is especially important in activities that involve contact. E.g. rugby, boxing.
- **Production of Blood Cells:** the bone marrow in long bones and ribs produce red and white blood cells.
- **Mineral Storage:** bones store several minerals e.g. calcium, which can be released into the blood when needed.

### Types of Bones

**FLAT BONES:** protect vital organs e.g. cranium protects your brain, ribs protect heart and lungs.
**LONG BONES:** enable gross (large) movements e.g. femur, tibia and fibula in the leg which allow us to run, humerus, radius and ulna in arm which allows us to throw a ball.
**SHORT BONES:** enable fine (small) movements e.g. fingers allowing you to spin a cricket ball.

## Synovial Joints



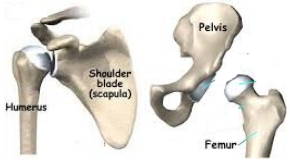

Ligaments
Attaches bone to bone to keep the joint stable eg knee when kicking the ball or restricts movement/prevents movement to stop injury.
Cartilage
Found between bones and prevents friction by stopping the bones from rubbing together.
Synovial Membrane
Secrets synovial fluid.
Synovial Fluid
Is produced by the synovial membrane and helps lubricate the joint.
Joint Capsule
This is lined with synovial membrane. It encloses the joint making sure the cartilage and synovial fluid remain in place.
Bursae
Fluid filled sac providing cushion between bones and tendons. This stops friction at the joint.
Tendons
Attach muscle to bone. When a muscle contracts to move a joint, it is the tendon which pulls on the bone, keeps muscles/bones stable or holds join in place.

### Bones Located at Joints

**Head and Neck =** Cranium and Vertebrae
**Shoulder =** Scapula and Humerus
**Chest =** Ribs and Sternum
**Elbow =** Humerus, Radius, Ulna
**Hip =** Pelvis, Femur

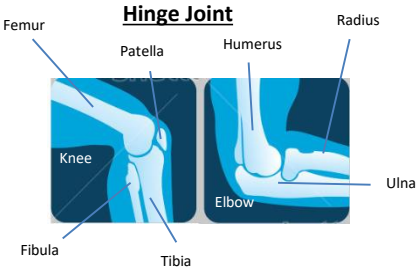
**Knee =** Femur, Tibia, Patella
**Ankle =** Tibia, Fibula, Talus

### Types of Joint
### Ball and Socket Joint




**Location in Body:** Shoulder and Hip
**Type of Movement Allowed by Joint:** Flexion, Extension, Adduction, Abduction, Rotation

### Hinge Joint




**Location in Body:** Knee and Elbow
**Type of Movement Allowed by Joint:** Flexion and Extension

### How do MUSCLES WORK?

Muscles can only PULL they cannot push. This means that they must work in pairs to allow parts of the body to move back and forth. THESE PAIRS ARE CALLED **ANTAGONISTIC PAIRS.**

### Antagonistic Pairs

- A muscle must work in partnership with another muscle to allow movement to occur.
- The muscle that causes the movement (the pulling muscle) is called the **AGONIST** or **PRIME MOVER**. When this muscle contracts in becomes shorter.
- During this time the other muscle within this partnership is relaxing. This muscle is called the **ANTAGONIST** and is lengthening while it relaxes.

EXAMPLES:
When we flex our elbow the bicep is the **agonist** and the tricep is the **antagonist**. However these roles are reversed when the elbow extends ,with the tricep becoming the **agonist** and the bicep becoming the **antagonist**.

When dorsiflexion occurs in our ankle the tibialis anterior is the **agonist** and the gastrocnemius is the **antagonist**. However these roles are reversed when plantar flexion occurs at the ankle, with the gastrocnemius becoming the **agonist** and the tibialis anterior becoming the **antagonist.**

## Antagonistic Pairs

| BICEPS | TRICEPS |
|---|---|
| HAMSTRINGS | QUADRICEPS |
| GASTROCNEMIUS | TIBIALIS ANTERIOR |
| HIP FLEXORS | GLUTEALS |
| DELTOID | LATISSIMUS DORSI |

## Common Misconceptions

**Isotonic contraction** involves **muscles visibly moving/changing length**. When muscles move they work as an antagonistic pair. One muscles contracts (gets shorter), the other relaxes (gets longer).
The muscle that contracts is an **isotonic** concentric contraction
The muscle that relaxes is an **isotonic** eccentric contraction

**Circumduction v Rotation**
**Circumduction** – only happens at the shoulder and hip. Best example = bowling in Cricket or an overarm tennis serve
**Rotation** - This occurs in the hip joint in golf while performing a drive shot or the shoulder joint when playing a topspin forehand in tennis.

Know and **be familiar and secure** with the differences in key terminology

- Names of Bones (14)
- Types of Bone (4)
- Names of Joint (5)
- Types of Joint (2)
- Types of Movement at a Joint (8)
- Names of Muscles (15)
- Antagonistic muscle action
- Muscular contraction (2)

# Cardio-Respiratory System

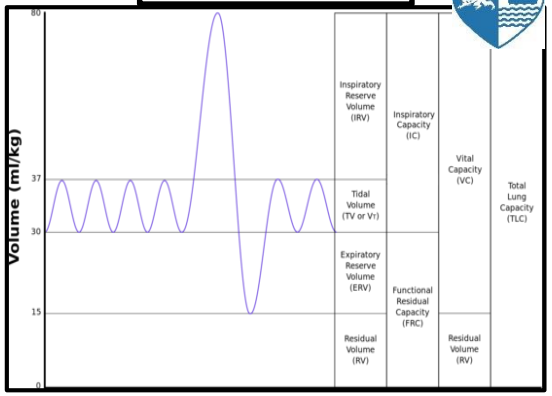
## Key Terms:

1) Respiratory rate - breathes per minute
2) Tidal volume – amount of air inhaled / exhaled per breath
3) Minute Volume= Respiratory Rate x Tidal Volume– amount of air inhaled per minute
4) Residual volume = the volume of air that remains in the lungs after maximal expiration.
5) Expiratory reserve volume (ERV) = the additional air that can be forcibly exhaled after the expiration of a normal tidal volume.
6) Inspiratory reserve volume (IRV) = the additional air that can be forcibly inhaled after the inspiration of a normal tidal volume.

**During Exercise the following happens:**

1) Respiratory rate - Increases
2) Tidal volume – increases
3) Minute Volume= increases
4) Residual volume = stays the same.
5) Expiratory reserve volume (ERV) = decreases
6) Inspiratory reserve volume (IRV) = decreases

## Spirometer Trace




## Aerobic Respiration (exercise):

- Energy is created **with** the presence of oxygen.
- Used for **low intensity**, **long duration** activities.
- Very effective method of producing energy. However the process is slow and gradual, much slower than anaerobic.

## Anaerobic Respiration (exercise):

- Energy is created **without** the presence of oxygen.
- This is not an efficient process as it produces 1/20th as much energy as aerobic respiration.
- However the process is three times as quick so energy can be produced for **high intensity** (explosive) activities performed over a **short period of time**.
- After a short period of time performance drops as lactic acid builds up, resulting in oxygen debt.

## Oxygen Debt

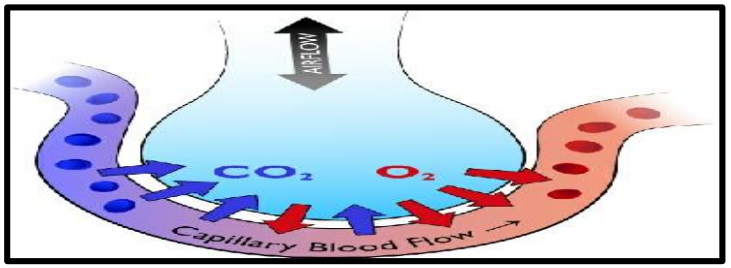
- The amount of oxygen needed to break down the lactic acid within the body.
- Lactic acid is produced due to the body not having enough oxygen to break down the glucose. This means that the glucose is only partially broken down.
- Oxygen is paid back when the performer has stopped working

## Gaseous Exchange

- Takes place at the **Alveoli** through **diffusion**
- Oxygen (high concentration) diffuses through the capillaries into the blood stream (low Oxygen concertation) to be sent to the heart.
- Carbon dioxide (high concentrations) In the capillaries replaces the oxygen (**exchanged**) in the alveoli ( Low carbon dioxide concentration) so that it can be removed from the body.

## Function of Alveoli:

to bring oxygen into the body and remove carbon dioxide.




**Exam Example:**
**1)** As soon as we start to exercise our breathing rate and depth of breathing increases.
(a) Explain **two** reasons why the respiratory system responds in this way when beginning exercise.

1. **Explanation 1:** Increased/more demand for oxygen (1) to supply (working) muscles/because need (more) energy for exercise/removal of lactate/removal of lactic acid (1)

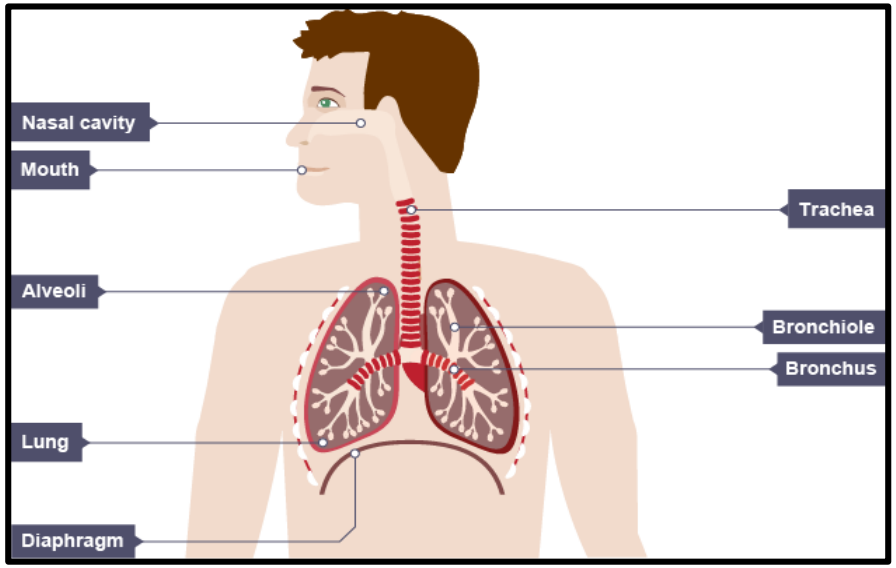
2. **Explanation 2:** More carbon dioxide is produced during exercise **(1)** therefore there is an increased need to remove carbon dioxide **(1)**

## Key features of the Alveoli (help diffusion):

- Alveoli walls are only **one cell thick** and are **moist** – easy to exchange gases
- They are **very small**, however their are **millions** within the lungs – large surface area
- Covered with **huge network of capillaries** – constant blood supply

## The Pathway of Air into the Body

- When we breathe in, air moves through the **mouth and nose**.
- It then travels down the **trachea**. The inner surface of the trachea is covered in tiny hairs called **CILIA**, which catch particles of dust. The trachea is kept open **by RINGS OF CARTILAGE**.
- Near the lungs the trachea divides into two tubes called **bronchi** (one enters left lung and the other the right).
- Once in the lungs the bronchi split into smaller bronchi before dividing into even smaller tubes called **bronchioles.**
- At the end of each bronchiole are openings to the **alveoli.** There are usually several alveoli coming from one bronchiole, forming a little clump that resembles a cluster of grapes.
- At the alveoli gaseous exchange occurs. Capillaries carrying blood surround each alveoli resulting in oxygen being passed into the bloodstream from the alveoli in exchange for carbon dioxide which passes from the blood stream into the alveoli.



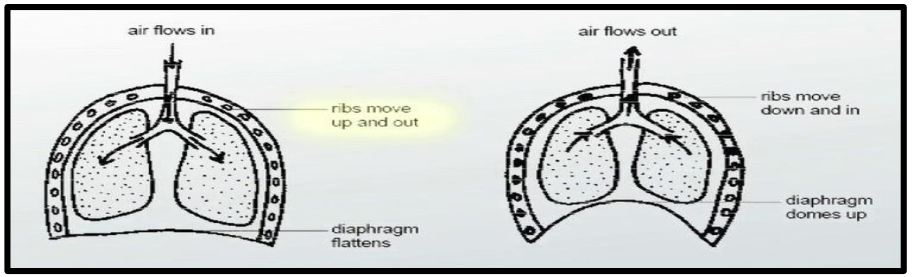

## Inspiration / Expiration

**Inspiration (How we breathe in):**

- The diaphragm contracts and flattens.
- The intercostal muscles contract which causes the rib cage to rise.
- Both these actions cause the chest cavity to increase in size / volume.
- This reduces the pressure in the chest cavity, due to this the air passes from the higher pressure outside of the lungs to the lower pressure inside the lungs.
- This causes the lungs to expand and fill the chest cavity

**Expiration (How we breathe out):**

- The diaphragm relaxes and bulges up, returning to its original dome shape.
- The intercostal muscles also relax causing the ribs cage to lower.
- Both these actions cause the chest cavity to decrease in size / volume.
- The reduction in the size of the chest cavity increases the pressure of the air in the lungs and causes it to be expelled.
- The air passes from the high pressure in the lungs to the low pressure in the bronchi and trachea.




**Additional muscles used during inspiration and expiration during exercise:**

**During inspiration:**
When exercising the **PECTORALS** and **STERNOCLEIDOMASTOID** muscles contract assisting the performer inhale air. These allow the chest cavity to further increase in size (have a larger volume) so more air can enter the lungs.

**During expiration:**
When exercising the **ABDOMINAL** muscles contract assisting the performer exhale air. They help force air out of the lungs faster and so speed up expiration.

## Common Misconceptions

**Oxygen Debt** – This occurs after high intense exercise. The body (muscles) has worked anaerobically (without oxygen). The muscles can only do his for a short period of time. Lactic acid builds up. Oxygen debt therefore, is the amount of oxygen needed by the muscles to remove the lactic acid, when the performer is at a lower exercise intensity.

**Spirometer** – be able to accurately label a graph – knowing what each wave is. The commonly tested parts are **Vital Capacity** and **Tidal Volume**. Know the definitions of all of them

# Effects of Exercise

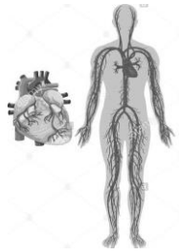
## Immediate Effects of Exercise on the Body

## (During Exercise)

### Respiratory System

| Changes | Effect |
|---|---|
| • Increased Breathing Rate<br>• Increased Tidal Volume<br>• Increased Minute Volume  | More air can be breathed in per breathe (tidal volume) and per minute (minute volume = tidal volume x respiratory rate).<br><br>This means more oxygen can be passed into the blood stream and taken to the heart AND more carbon dioxide can be breathed out. |

### Circulatory System

| Changes | Effect |
|---|---|
| • Increased Heart Rate (100 – 150BPM)<br>• Increased Stroke Volume<br>• Increased Cardiac Output  | More blood carrying oxygen is sent to your working muscles so that more energy can be produced.<br><br>ALSO due to more energy being produced, more carbon dioxide will be produced which needs to be taken back to the lungs so that it can be removed from the body. |

### Muscular System

- Muscles create HEAT when they contract.
- Performer sweats to help cool them down. -
- Performers look red as blood flows closer to the skin (vasodilation)

## Short Term Effects of Exercise on the Body

## (24 – 36 hours after exercise)

Fatigue: 

-A day after strenuous exercise muscles often feel heavy and tired.

Nausea: 

- People can feel sick due to over exerting themselves during an activity.

Dizziness and lightheadedness: 

- People can feel dizzy and light headed due to low blood sugar levels.

Delayed onset muscle sorene 

- Pain or stiffness in muscles a day or two after exercise.

- Caused by tiny tears in muscle fibres leading to swelling. Muscles are supposed to tear; they repair stronger which is the main benefit of training. DOMS is not cramp – cramp is a painful contraction of muscle caused by fatigue, often linked to dehydration and loss of minerals due to sweating.

## Long Term Effects of Exercise on the Body

## (Months and Years of exercising)

### Changes in Body Structure

- Reduced body weight – fat stores are used to create energy (fat is burnt off)
- Increased size of muscle (Muscular Hypertrophy) – muscles get bigger and stronger



### Musculoskeletal System

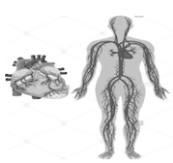
- Increase in muscular strength – weight training (anaerobic)
- Increase in muscular endurance – circuit training (repeated actions)
- Increase in flexibility – due to repeated movements at a joint and the increased levels of synovial fluid within the joints.
- Tendons and ligaments get stronger – stabilise the joint

### Other Components of Fitness

- Increase in speed – rapid anaerobic movements
- Increase in cardiovascular endurance – continued aerobic movements which cause capillarisation around muscles and alveoli, increase in strength of diaphragm, intercostal muscles or sternomastocleidoid which then creates a larger chest cavity so more alveoli can be used.

### Cardiorespiratory System

- Increase in Stroke Volume – larger heart (Hypertrophy)
- Heart rate can be increased for a longer period of time
- Resting heart rate is reduced - Bradycardia



## Common Misconceptions

When referring to immediate and long term changes in the body in the Cardio-respiratory system, the following equation is helpful to remember

**CO = HR x SV**

Cardiac Output = Heart Rate x Stroke Volume

So,
if **Heart Rate** increases, **cardiac output** must increase too.
If **Stroke Volume** increases, **cardiac output** must increase too.

If a long term change to the cardio-respiratory system is a decreased **resting heart rate**, **stroke volume** must increase. This is because the heart is pumping more blood per beat at rest, therefore it doesn't need to work as hard (beat as many times) to send the blood round the body.

= Fulcrum
(acts as a pivot usually joints in the body)

= Load
(Usually involves weight to be moved)

= Effort
(force applied to move resistance created by muscles)

# Levers

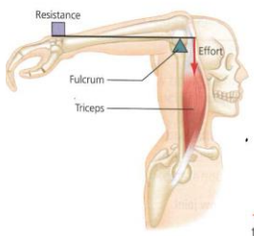
**Remember: 1,2,3 – F,L,E**

## 1st Class Lever

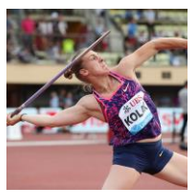

1st Class = Elbow Extension

**Examples**

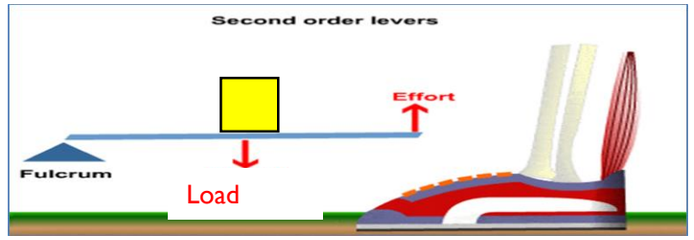
Football Throw in




Javelin Throw



## 2nd Class Lever



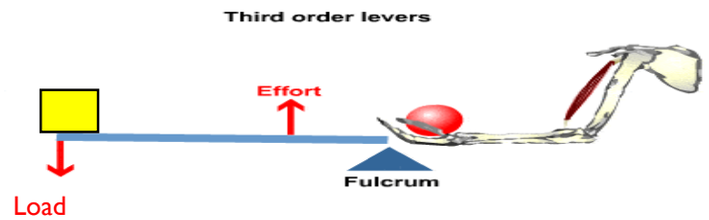

2nd Class = The ankle

**Examples**

Long Jump Take off


Sprint Start

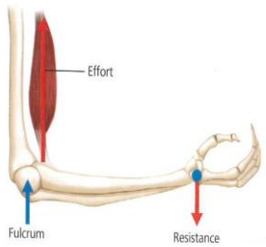
## 3rd Class Lever




3rd Class = All other examples

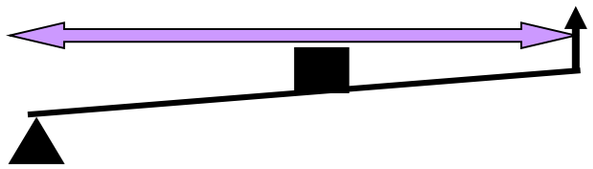
**Examples**

Bicep Curl




Squat

Effort Arm
The part of the lever between the **FULCRUM** and the **EFFORT**



**Mechanical Advantage = Effort arm ÷ Resistance Arm**

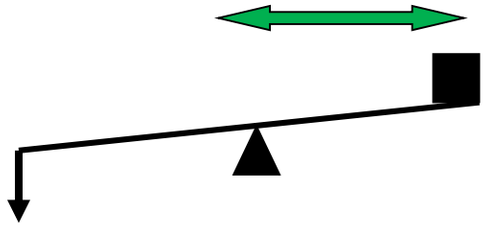
If the **effort arm** is longer than the **resistance arm**:

1. It gives the advantage of being able to move a heavier weight.

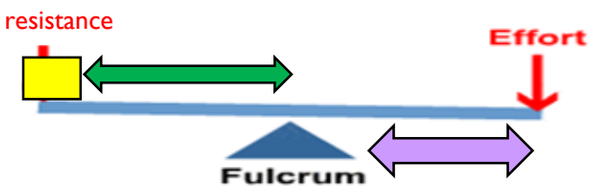
If the **resistance** arm is longer than the **effort** arm:

1. The greater the speed of movement
2. The wider the range of movement

Resistance Arm
The part of the lever between the **FULCRUM** and the **RESISTANCE**

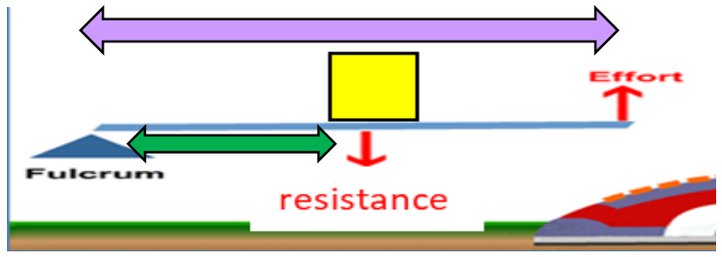


**Mechanical Advantage of 1st Class Lever**




*Resistance arm longer than effort arm*

**Mechanical Advantage of 2nd Class Lever**




*Effort arm longer than resistance arm*

**Mechanical Advantage of 3rd Class Lever**

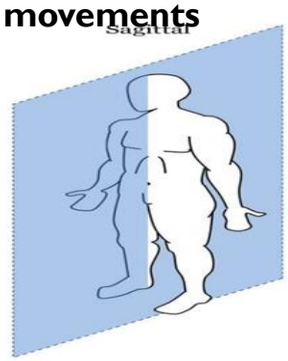

*Resistance arm longer than effort arm*

# Planes and Axes

## Planes of Movement

****PLANES LINK TO MOVEMENTS****

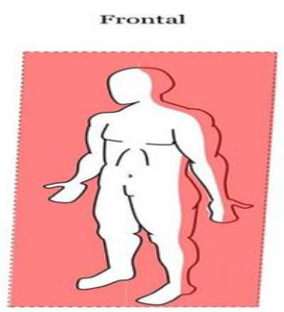
**Sagittal – Forward and backwards movements**
**Frontal – side to side movements**
**Transverse – Rotation or turning movements**




### Sagittal Plane

Through the body from front to back, dividing the body into left and right halves

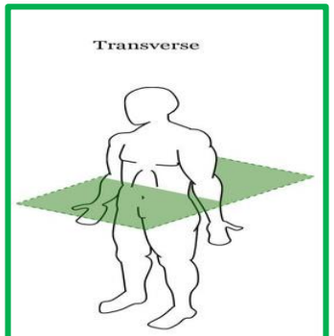
Remember –
**Sagittal = Side to Side**




### Frontal Plane

Through the body from left to right, dividing the body into front and back halves

**Remember –**
**Front and back**



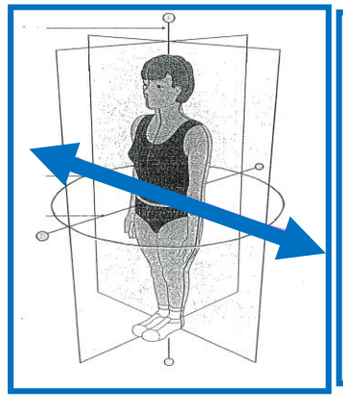

### Transverse Plane

Cuts through the hips to divide the body into top and bottom.

**Remember –**
**Top and bottom**

## Axes of Rotation

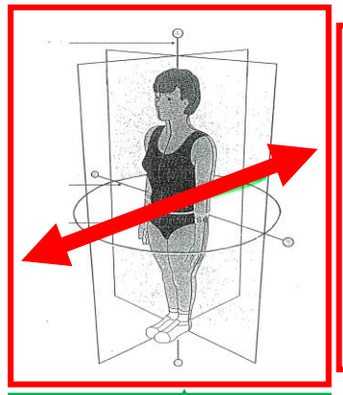
****AXIS IS A STRAIGHT LINE AN OBJECTS ROTATES AROUND****



### Transverse Axis

Passes horizontally through the body from left to right.

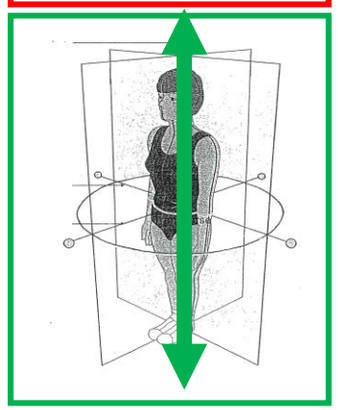
**Remember –**
**Transverse = Table Tennis**



### Sagittal Axis

Passes horizontally through the body from back to front

**Remember –**
**Sagittal = Stomach**



### Longitudinal Axis

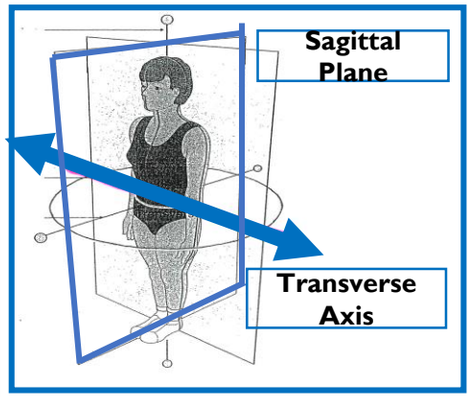
Passes vertically through the body from top to bottom.

**Remember –**
**LONG ways through the body**

## Link between Planes and Axes

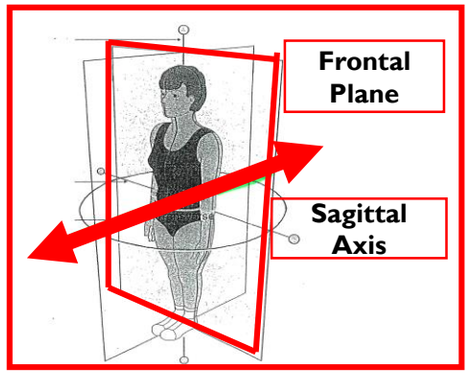
**Planes and Axes go together to allow for certain sporting movements to take place**

****The same plane and Axis will ALWAYS go together****



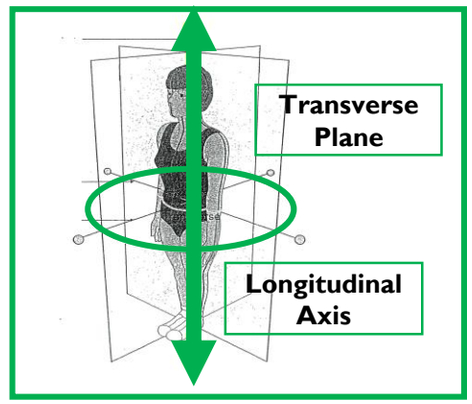

**Sporting**

**Running**
**Somersaults**
**cep Curl**




**Sporting**

**Star Jumps**
**Cartwheels**
**Side bends**




**Sporting examples:**

**Discus Throw**
**Twists**
**Ice skating spin**

**Misconceptions:**

- Planes and Axis DO NOT match up to the same named alternative. For example; sagittal axis matches up with frontal plane (NOT SAGITAL PLANE).
- Movement occurs AROUND an axis and ALONG the plane.
- When drawing a lever system; the fulcrum is always BELOW the lever arm; the load is always ABOVE the lever arm and the effort always lifts the load in an upwards direction.
- Drawings of levers MUST be labeled in order to receive any marks for them.

# Components of Fitness and Fitness Testing

**Health:**
State of complete mental, physical and social wellbeing and not merely the absence of disease or infirmity

**Fitness:**
Ability to meet the demands of the environment

**Relationship between health and fitness:**

- Ill health can negatively affect fitness as the individual may be too unwell to train.
- Increases in fitness can positively affect health and well-being e.g. you may be less likely to get ill, you may feel better about yourself; **HOWEVER**, an increase in fitness cannot prevent illness.

## Components of Fitness:

1) **Cardiovascular endurance:** the ability of the heart and lungs to supply oxygen to the working muscles.
2) **Agility:** The ability to move and change direction quickly (at speed) whilst maintaining control.
3) **Balance:** maintaining the centre of mass over the base of support.
4) **Co-ordination:** the ability to use different (two or more) parts of the body together smoothly and efficiently.
5) **Flexibility:** the range of movement possible at a joint.
6) **Muscular endurance:** Ability of a muscle or muscle group to undergo repeated contractions avoiding fatigue.
7) **Power / Explosive strength:** the product of strength and speed (strength x speed).
8) **Reaction Time:** the time taken to initiate a response to a stimulus.
9) **Speed:** the maximum rate at which an individual is able to perform a movement or cover a distance in a period of time (speed = distance divided by time)
10) **Strength:** the ability to overcome a resistance
    a) **Maximal** – the largest force possible in a single maximal contraction
    b) **Dynamic** – repeated contractions
    c) **Explosive** – (see POWER)
    d) **Static** – the ability to hold a body part in a static position.

**When asked to explain remember to give specific sporting examples:**

- Power is needed in football to kick the ball harder when shooting so it is more difficult for the goalkeeper to save.
- A gymnast uses power gain height when jumping. This will give them more time to complete the move.
- Cardiovascular fitness is important in hockey as each game lasts a long time therefore they need to be able to transport oxygen around the body effectively for the duration of the match. This will help them maintain the quality of performance throughout game.

## Reasons for Fitness Testing:

- To identify strengths and weaknesses, this allows them to work on weaknesses
- To allow you to plan your training
- To show a starting level of fitness
- To monitor improvement
- To monitor the success of a training programme
- To compare against normative data
- To motivate and set goals

## Limitations with Fitness Testing:

- Tests are often not sports specific (give an example)
- They do not replicate the movements in a sport
- They don't replicate the high pressure environment of sporting activities/non competitive
- Some are not reliable
- Some are maximal which means the performer is required to try their best
- Protocols MUST be followed or else the tests are invalid

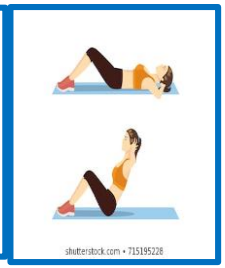
# Fitness Tests

**Maximal Strength test = one rep max:**
lift weight once using the correct technique, if completed attempt a heavier weight until heaviest weight is discovered, take 1 rep max weight and divide it by body weight, compare to national averages.

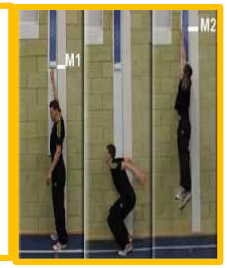
**Co-ordination = wall toss test:**
tennis ball starts in one hand, stand 2m from wall, on 'GO' the performer works for 30 seconds, performer throws ball against wall and catches it with opposite hand, if ball is dropped the time continues, compare to national averages.

**Flexibility = sit and reach test:**
Remove shoes, sit on floor with feet flat against sit and reach board, performers legs must be straight, performer pushes forward slider as far as possible, score is recorded in centimetres, compare to national averages.

**Muscular endurance = abdominal curl conditioning test:**
Performer lies on mat in a sit-up position, partner holds ankles, performer sits up on bleep and down on bleep (staying in time), the test gets progressively harder as bleeps get faster, score is how many sit ups you did, compare to national averages

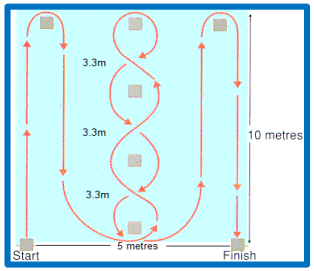



**Power / Explosive strength = vertical jump test**:
With flat feet, stand and push the wall ruler with fingertips as high as possible, apply chalk to finger tips, from a standing position jump as high as possible marking the ruler with chalk, record height jumped, compare to national averages.




**Reaction time = ruler drop test:**
Place thumb and index finger together of dominant hand, partner holds metre ruler above, without warning partner drops ruler, individual being tested must catch the ruler, measure in 'cm', compare to national averages

**Agility = Illinois agility run:**
Cones arranged in 10m x 5 m rectangle with 4 cones down the middle, performer starts face down, performer runs round the cones as fast as possible, performer is timed, compare results to national averages.

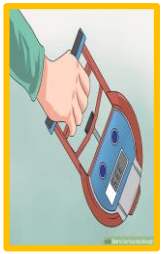



**Balance = Stork Balance Test:**
start balanced on 2 feet, hands placed on hip, one leg lifted so that the toes of the lifted leg touch the inside of the planted leg, timekeeper tells the individual to raise the heel on the planted leg and starts the stopwatch, individual balances for as long as possible, timer stops clock when the individual loses their balance, compare to national averages.

**Cardiovascular endurance = multi-stage fitness test:**
Cones set out 20m apart, test gets progressively harder, individual runs 20m in time with 'bleeps', time between bleeps gets shorter as levels increase, performer runs for as long as possible, score recorded as a level when performer finishes e.g. level 8 bleep 4, compare to national averages.

**Speed = 30m speed test:**
Set up two cones 30m apart, use a flying start, individual is timed running as fast as they can for 30m, compare to national averages.

**Strength = handgrip dynamometer test:**
hold dynamometer in dominate hand, bend elbow at 90 degrees and place against body, squeeze with maximum effort, record best score, compare to national averages.



**Misconceptions:**

- Health and fitness are separate components. People can be healthy but not fit, while some others could be fit but not healthy.
- Sports are not exclusive to one component of fitness. There may be more than one appropriate component of fitness for the sport but you should always look to prioritise them in order of importance.
- Fitness tests provide some good baseline data however they aren't always relevant to sport. (For example, a vertical jump is an effective way of measuring a boxers power).
- Fitness tests MUST be done accurately and the athlete MUST try their hardest in order for them to have any value.

**Training Zones:**

- Aerobic Training Zone = 60 – 80% of maximum heart rate
- Anaerobic training Zone – 80 – 90% of maximum heart rate
- Maximum heart rate = 220 – age

# Types of Training, Principles of Training and Parts of a Training Session

**Types of Training:**

1) **Interval** = Training that involves set periods of work followed by set periods of rest. It usually involves periods of intense exercise followed by periods of rest so that the performer can recover. The intensity of interval training can be altered to suit the individual by altering the time working and / or the time resting.

2) **High Intensity Interval Training(HIIT)** = Short bursts of extreme effort with even shorter rest periods. A 2 : 1 work ratio is often used e.g. 30 seconds work, 15 seconds rest. During HIIT training the performer will be working anaerobically so it will develop their ability to withstand the build up of lactic acid.

3) **Continuous** = Exercising for a sustained period of time without rest. It improves cardiovascular fitness. Sometimes referred to as 'steady state' training. The performer normally trains at a low to moderate intensity but for an extended period of time 20 minutes +. During continuous training the performer will be working aerobically so it will develop their ability to get oxygen into the body and create energy.

4) **Fartlek** = Also known as 'speed play', this type of training involves performers varying their speed / intensity. It can involve different speeds (walk, jog, sprint) or running at different terrains (uphill, down hill, on sand). Altering the intensity allows the performer to use both their aerobic and anaerobic energy systems.

5) **Circuit** = A series of exercises performed one after the other with a rest in between. Each circuit involves different activities called 'stations'. Stations are often set out to work all of a performers body (arms, core, legs). In circuit training performers often work for a set amount of time and then have a set rest period e.g. work 30 seconds, rest 30 seconds. Progressing these sessions is easy as the performer can increase the work time or decrease the rest time.

6) **Weight** = Involves the lifting of weights / resistance to develop muscular strength or endurance. The beauty of weight training is that it can focus on specific muscles / muscles groups so that sessions can be designed to suit an individual's needs. This type of training involves REPS (completing one lift of a weight) and SETS ( the completion of a number of reps). To develop strength / power performers must lift heavy weights but for a low number of reps. To develop strength / power performers should lift above 70% of their one rep max for 4 – 8 reps. To develop muscular endurance performers must lift lighter weights but for a higher number of reps. To develop muscular endurance performers should lift below 70% of their one rep max for 12 – 15 reps.

7) **Plyometric** = Is a type of training that is used to increase power (strength x speed). It typically takes the form of bounding, hopping or jumping. The aim of plyometrics is to use your body weight and gravity to stress the muscles involved. This type of training involves the muscles working eccentrically (lengthening) when landing (often quadriceps) which helps them store elastic energy. This energy is released when the performer pushes up , working their muscles concentrically (shortening) e.g. jumping (hamstrings).

8) **Static Stretching** = Stretching to the limit and holding the stretch isometrically.

## Advantages and Disadvantages of HIIT

Advantages:

1) It burns body fat and calories quickly.
2) It can be altered easily to suit the individual.
3) It can be completed relatively quickly.
4) It can improve the anaerobic and aerobic energy systems.

Disadvantages:

1) Extreme work can lead to injury.
2) High levels of motivation are needed to complete the work.
3) It can lead to dizziness and feelings of nausea.

## Advantages and Disadvantages of Weight Training

Advantages:

1) It can be easily adapted for different fitness aims.
2) It is relevant to all sports.
3) It is relatively straightforward to carry out.
4) Strength gains can occur.

Disadvantages:

1) Heavy weights can increase blood pressure.
2) Injury can occur if weights are too heavy or lifted incorrect technique is used.
3) Calculating one rep max requires high levels of motivation.

## Advantages and Disadvantages of Static Stretching

Advantages:

1) It increases flexibility.
2) It can be done by virtually everyone.
3) It can be done anywhere (does not need a lot of space).
4) It is relatively safe.

Disadvantages:

1) It can be time consuming to stretch the whole body.
2) It can get boring and repetitive.
3) Some muscles are easier to stretch than others.
4) Over-stretching can cause injury

## Advantages and Disadvantages of Circuit Training

Advantages:

1) Exercises chosen can be simple to complex.
2) The circuit can be manipulated to train different things e.g. repeated contraction of a muscle / muscle group to train muscular endurance
3) It can be varied to suit fitness level / age etc.
4) It is easy to monitor and alter – progressive overload can be applied by altering the work / rest ratio.

Disadvantages:

1) An appropriate amount of space is required.
2) It may require specialist equipment e.g. a medicine ball, benches, agility ladders.
3) It is difficult to gauge an appropriate work / rest ratio at the start

## Advantages and Disadvantages of Continuous Training

Advantages:

1) It can be done with little or no equipment e.g. simply go for a run.
2) It improves aerobic fitness
3) Running can be done virtually anywhere
4) It is simple to do – keep doing the same movement over and over.

Disadvantages:

1) It can be boring / tedious.
2) It can cause injury due to repetitive contractions.
3) It can be time consuming.
4) It does not always match the demands of the sport e.g. in basketball the players do not run at one speed continuously

**Specific Training Techniques (High Altitude Training)**

- High altitude training is carried out by elite performers.
- Involves carrying out training at a high altitude, 2000m or more above sea level.
- The idea behind this training method is that there is less oxygen in the air at high altitude. This makes training very difficult as the body finds it harder to carry oxygen to the working muscles.
- As a result, the body compensates by making more red blood cells to carry what oxygen there is in the air.
- Therefore by the end of training the body has more red blood cells. This means when the athlete returns to sea level they will have more red blood cells to carry more oxygen to the working muscles.

**Benefits**

- Endurance athletes can sustain exercise at a higher intensity for a longer period of time.

**Issues**

- It can be very difficult to complete.
- Some athletes suffer from altitude sickness – a feeling of nausea.
- The benefits are lost quite quickly once the athlete returns to sea level.

## Safety Principles When Training

- The training type and intensity used should match the training purpose.
- A warm-up and cool down should be completed prior to and after training.
- Over training should be avoided e.g. use of appropriate weights.
- Appropriate clothing and footwear should be worn which protect / support and allow movement.
- Taping / bracing should be used as necessary to protect and support areas of weakness.
- Hydration should be maintained with fluid intake.
- Stretches should not be overstretched or bounce.
- Technique used should be correct e.g. weight lifting technique.
- Appropriate rest should be given in between sessions to allow for recovery.
- Spotters should be used when weight training if heavy weights are being attempted.

## The Three Training Seasons

**Pre-season (Preparation)**

The aim is to improve general and aerobic fitness. It should also focus on specific fitness needs of the performer so they are ready for the competition / season.

**Competition season (Peak / Playing season)**

The aim is to maintain fitness levels. The performer should be at peak fitness and will aim to maintain this. They will focus on specific skills that are needed in their activity.

**Post-season (Transition)**

The aim is to rest and recover from the season / competition. Performers should continue to do some light aerobic training so that fitness levels do not drop to far.

## Principles of Training (S.P.O.R.T):

**S = Specificity**

Training should be specific to the needs of an individual and demands of the sport that they take part in.

e.g. Sprinters would use interval training as it has short rest periods and they work anaerobically compared to the long distance runners who would use continuous training as they need to work aerobically for longer periods of time. This would mean each type of performer is improving a relevant aspect of fitness for their activity.

**PO = Progressive Overload**

Working harder than normal whilst gradually and sensibly increasing the intensity of training.

e.g. Needed for any improvement to be made e.g. drop in resting heart rate
Starting at 5KG and increasing to 6KG once 5KG becomes too easy. In this way the muscles adapt to the new work loads increasing the strength of the individual.

**R = Reversibility**

If an individual stops or decreases their training level, then fitness and performance are likely to drop.

**T = Tedium**

Tedium refers to boredom. Training should be altered and varied to prevent an individual from getting bored and demotivated.

### Principles of Overload (F.I.T.T) :

Works with the principle of PROGRESSIVE OVERLOAD.

| | |
|---|---|
| **F = Frequency –** | refers to how often someone trains. As fitness increases a performer can start to train more often. |
| **I = Intensity -** | refers to how hard a performer trains e.g. how fast they run, how heavy the weight is that they can lift. As fitness increases, the intensity should be suitably increased. |
| **T = Time -** | refers to how long you train for. As fitness increases, the length of time spent training may well increase. |
| **T = Type -** | refers to the type of training used e,g, HIIT. The training type must remain suitable to gain the specific fitness benefits that are required. |

## Warming Up

A good warm-up should include:

- Pulse raiser – gradually raising heart rate in preparation for exercise.
- Stretching – stretch al relevant muscles involved in the activity.
- Skill Based Practices – Perform skills that allows the performer to familiarise themselves to the activity they are taking part in e.g. passing a football / netball.
- Mental Preparation – Starting to get focused, using techniques to control arousal e.g. mental imagery.

The benefits of a good warm-up are as follows:

1. Body temperature will increase ready for exercise.
2. Stretching will increase the range of movement possible.
3. There will be a gradual (not over demanding) increase in effort towards 'competition pace', i.e. you gradually work up to the intensity required for the game/event.
4. You will be focused and psychologically prepared.
5. Movement skills that will be used have been practised before starting the game/match/event.
6. There will be less chance of suffering injury.
7. There will be an increase in the amount of oxygen being carried to the working muscles – helping with the production of energy.

## Justifications of Training Methods

- Training should involve vital component s for the sport. (specificity)
- Training should try and **mimic** many of the specific movements required in a sport. (specificity + type)
- Performing activities that can easily be included within training session to complement other (named) training types, eg continuous training, agility etc
- If no / little equipment is required, methods (e.g. plyometrics) can easily be integrated into session.
- Using methods that can be specifically designed / altered for a specific sporting session, e.g. jumping to reach a ball in basketball, sprinting away from a defender in football.
- How many people can perform the session? If methods can be completed by large groups it would be better for games sports eg whole squads
- Is there space to perform the training method / activity? Fartlek, interval and continuous can be completed on a rugby pitch or in a sports hall as it requires no specific equipment.

## Cool Down

An effective cool down should include:

- An activity to maintain an elevated breathing and heart rate, e.g. walk, jog.
- A gradual reduction in intensity, e.g. jog to light-jog to walk.
- Stretching of all main muscles used in the activity.

The benefits of a good cool down are as follows:

1) It allows the body to start to recover after exercising.
2) It helps with the removal of lactic acid, carbon dioxide and waste products.
3) It can help to prevent the delayed onset of muscle soreness, sometimes referred to as DOMS.

## Misconceptions:

- Methods of training, should always be made specific to each sportsperson. For example, a long distance cyclist training programme should consist of a majority of exercise on a bike.

- Fartlek trainingg and interval training aren't the same. Interval training consists of HIGH INTENSITY exercise with rest periods. Fartlek training consists of continuous exercise but at different intensities.

- Methods of training are performed in order to improve specific components of fitness.
  Interval Training : Speed
  Continuous Training : Cardiovascular Endurance
  Fartlek Training : Cardiovascular Endurance of Games players or Muscular Endurance
  Weight Training : Muscular strength or Muscular endurance
  Plyometric Training : Power
  Static Stretching : Flexibility
  Circuit Training : Circuits can be easily adapted to suit most components of fitness as long as the stations follow the correct procedures.

- ALL aspects of S.P.O.R.T need to be followed when designing a good training session.
- F.I.T.T only relates to ensuring that progressive overload is achieved.

- Training seasons are specific to individual sports so are therefore not the same for all sports.