Paper 1: Fitness and the body systems

SKELETON

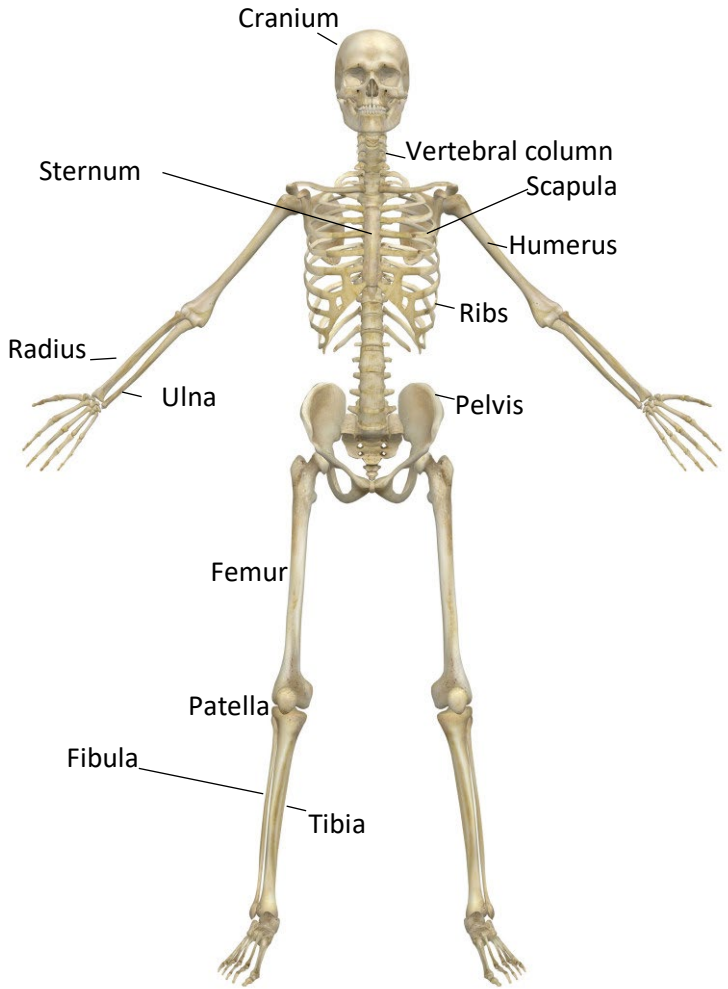
Functions of the skeleton:

Protection – protects vital organs – ribs (heart and lungs) - cranium (brain)
Support/Structure shape – rigid bone frame that gives us our shape. Supports soft tissues like skin and muscle.
Movement – muscles are attached the bones via tendons . Movement happens at joints
Mineral Storage – bones store minerals calcium and phosphorus. Makes bones string.
Blood cell production – blood cells produced in the bone marrow of bones.

Structure of the Vertebral column:

Number of vertebrae:

Cervical -	7
Thoracic -	12
Lumbar -	5
Sacrum -	5
Coccyx -	4



Types of bone

Long bone – are strong and are used by muscles to assist movement. E.g. humerus or femur

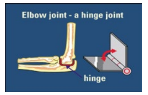
Short bones – support the weight of the body – they are weight bearing. E.g. tarsals in the foot

Irregular bones – Suited to protection and muscle attachment (vertebrae of the spine).

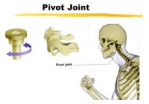
Flat bones – protect vital organs. E.g. ribs

Types of joint

Ball and socket joint – hip and shoulder – allows flexion, extension, abduction, adduction, rotation and circumduction.



Hinge – elbow, knee, ankle – allows flexion and extension.



Pivot joint - neck – allows rotation

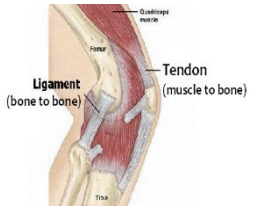
Condyloid – Wrist – flexion and extension, abduction and adduction.

MUSCLES

Connective tissue

Ligaments - Attach bone to bone at a joint. They help to stabilise the joint.

Tendons – Attach muscle to bone. They help create movement.



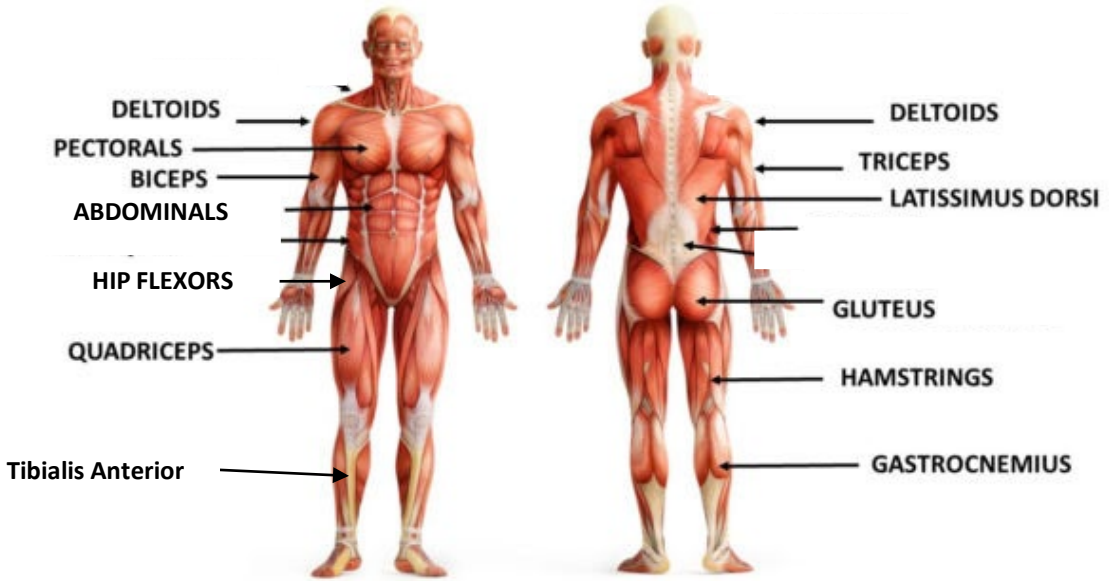
Types of muscle contraction

Isometric – muscle contracts but stays the same length

Isotonic – Muscle changes length. There are two types:

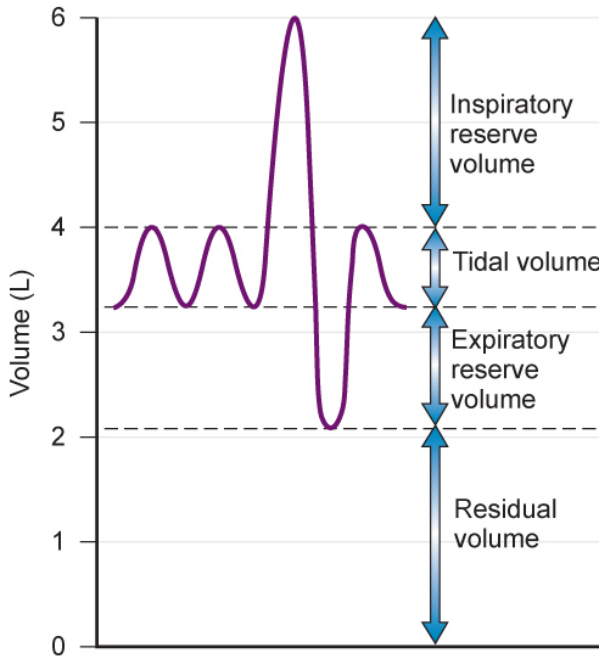
Concentric – the muscles that shortens and pulls.

Eccentric – muscle that lengthens. Helps control the speed of the movement.



Joint	Movement	Agonist (one that starts movement)	Type of contraction	Antagonist	Type of contraction	Bones
Elbow	Flexion	Bicep	Concentric contraction	Tricep	Eccentric contraction	Radius, ulna and humerus
	Extension	Tricep		Bicep		
Knee	Flexion	Hamstring		Quadriceps		Tibia, Fibula and Femur
	Extension	Quadriceps		Hamstring		
Ankle	Plantar-flexion	Gastrocnemius		Tibialis anterior		Tibia, Fibula and Talus
	Dorsi-flexion	Tibialis Anterior		Gastrocnemius		
Hip	Flexion	Hip flexors		Gluteus Maximus		Pelvis and femur
	Extension	Gluteus Maximus		Hip flexors		
Shoulder	Flexion	Front of deltoid		Back of deltoid		Scapula and humerus
	Extension	Back of deltoid		Front of deltoid		
	Abduction	Latissimus dorsi		Middle of deltoid		
	Adduction	Middle of deltoid		Latissimus dorsi		
	Rotation (arm out)	Infraspinatus and teres minor		Subscapularis		
	Rotation (arm in)	Subscapularis		Infraspinatus and teres minor		

The LUNGS



Tidal volume – the amount of air that is breathed in or out in one breath.
Inspiratory reserve volume – is the difference in volume from normal when we breath in as much as we can.
Expiratory reserve volume – the difference in volume after maximum exhalation.
Residual volume – the amount of air left in the lungs after the most forcible exhalation possible.
Vital Capacity – the most air that you can breathe in after breathing out the largest volume of air possible.

Changes in exercise

Tidal volume increases – deeper breaths in and out so the 'peaks' are higher and the 'dip' is lower.
Breathing rate increases – more breaths are taken per minute so the 'peaks' are close together.

Gaseous exchange

Gaseous exchange is the exchange of oxygen and carbon dioxide. It takes place in the alveoli in the lungs.

What makes gaseous exchange effective?

Large surface area of alveoli – there are thousands of alveoli in the lungs and they are round. Each of these factors increases the surface area of the alveoli meaning more exchange can take place at any one time.

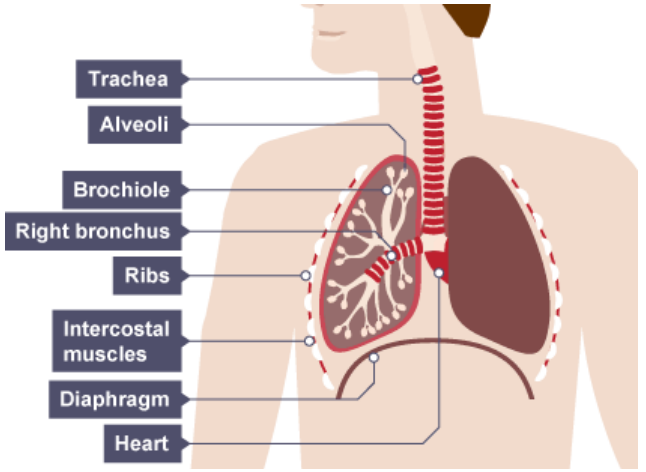
Moist thin walls – Gas can easily pass through the walls the exchange is very quick

Lots of capillaries – Capillaries surround the alveoli to allow exchange to take place as they carry blood.

Large blood supply – More blood means there is more opportunity for gaseous exchange.

Movement of gas from a high to a low concentration - gases move down the concentration gradient – so carbon dioxide is force out and oxygen is forced in.

Short distance for diffusion – happens quickly



Delivery of oxygen

Oxygen is transported from the heart to the working muscles via the blood.
Red blood cells contain haemoglobin. Oxygen combines to this substance to form oxyhaemoglobin.
Carbon dioxide can also be carried by haemoglobin.

Mechanics of breathing

Inhaling – breathing in

- The external intercostal muscles contract – moving the ribcage up and out
- The diaphragm contracts – flattening.

These two movement increase the thoracic cavity forcing air into the lungs.
In exercise lungs can expand more as pectorals and sternocleidomastoid contract – increasing volume further.

Exhaling – breathing out

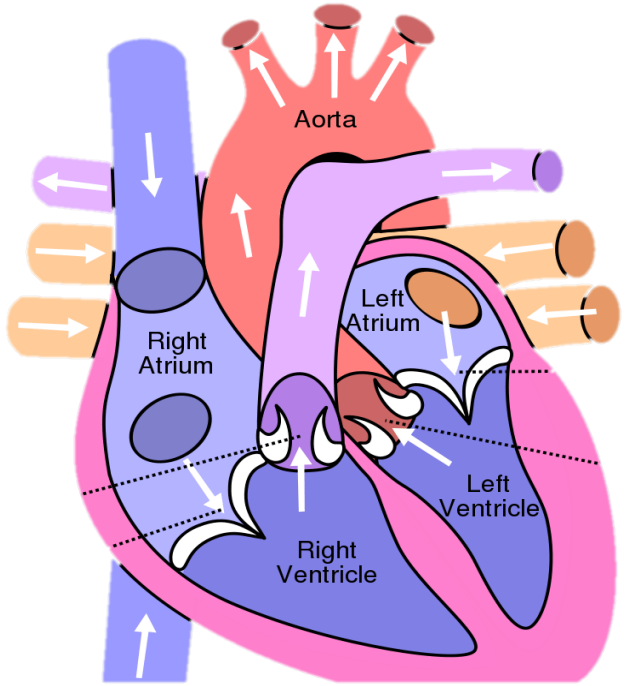
- External intercostal muscle relax – moving rib cage in and down (internal intercostals contract)
- Diaphragm relaxes – moves into dome shape.

These two movement decrease the thoracic cavity forcing air out of the lungs.
Rib cage can be pulled down quicker in exercise by abdominals forcing air out quicker.

HEART

Heart rate – The number of times the heart beats per minute.
Stoke volume - The volume of blood pumped with each heart beat by each ventricle of the heart .
Cardiac output – the volume of blood pumped by each ventricle in the heart per minute.

Cardiac output = Heart rate x Stroke volume

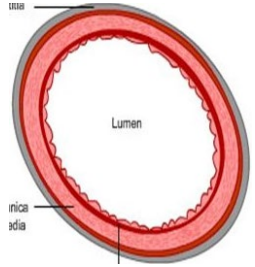


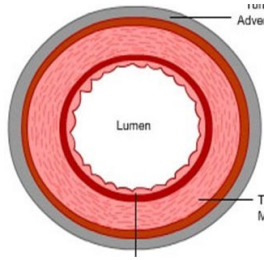
Cardiac cycle and the pathway of blood

Pathway of blood
- Deoxygenated blood into the right atrium
- Then forced into the right ventricle
- Transported to the lungs via the pulmonary artery
- Blood is oxygenised via gaseous exchange
- Blood transported back to the hear via the pulmonary vein.
- Blood re-enters the heart in to the left atrium.
- Moves into the left ventricle.
- Oxygenated blood is ejected and transported to the body via the aorta.

Cardiac cycle
Diastole/diastolic the ventricles are relaxed and are filling with blood from the atrium.
Systole/systolic – the ventricles contract pumping blood out of the heart.

Redistribution of blood flow (vascular shunt mechanism)
Changes in exercise
- Arteries widen to stop blood pressure getting to high in exercise.
- Arteries supplying working muscles vasodilate to increase blood supply to the muscle.
- Arteries supplying inactive organs vasoconstrict to restrict the amount of blood being delivered.
- The amount this occurs depends on the intensity of exercise.





Capillaries
- Carry blood through the body to exchange gases and nutrients
- Very thin walls so substances can easily pass through.
- Narrow so a lot of them can fit into the body, meaning the have a large surface area.
- Blood flows through them slowly to increase time for exchanges to take place.

Veins
- Carry blood towards the heart.
- Have valves to prevent the back flow of blood.
- Carry deoxygenated blood (except pulmonary vein).
- Carry blood at low pressure, so have thinner walls and less muscle. They have a large lumen.
- Muscle in the wall means the artery can widen (vasodilation) or narrow (vasocontriction) to control blood flow.

Arteries
- Carry blood away from the heart
- Blood is oxygenated (except pulmonary artery)
- Thick muscular walls as blood is travelling at a high pressure.
- Muscle in the wall means the artery can widen (vasodilation) or narrow (vasocontriction) to control blood flow.

AEROBIC AND ANAEROBIC EXERCISE

Aerobic exercise

Aerobic respiration occurs in the presence of oxygen.
The oxygen is used to release energy from glucose.

Glucose + Oxygen ⟶ Carbon Dioxide + Water + Energy

This happens when the body is able to meet the demands of the exercise – e.g. marathon. The body is able to get the oxygen to muscles in time.

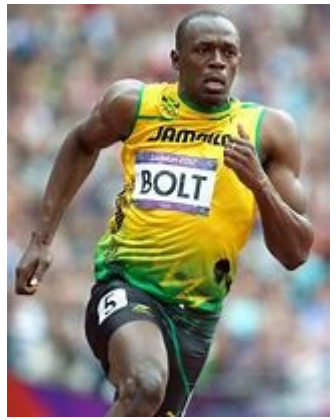
Anaerobic exercise

Anaerobic respiration occurs in the absence of oxygen.

Glucose ➡ **Lactic Acid + (little) Energy**

This happens when the body is not able to meet the demands of the exercise – e.g. sprinting.
The body isn't able to get the oxygen to muscles in time.

Can only do this for a short period of time as lactic acid builds up and causes fatigue in the muscles.



Excess post-exercise oxygen consumption (EPOC) or Oxygen debt.

EPOC – The amount of oxygen the body needs to take in following a period of exercise to remove lactic acid and recover.

How it happens - when we begin exercise the body is not able to perform aerobic respiration straight away to meet the demands of the exercise. The body therefore performs anaerobic respiration, producing lactic acid. In order to convert lactic acid back to pyruvate (a non-harmful substance) the body needs oxygen. Therefore after exercise we take in extra oxygen by maintaining an increased breathing rate to ensure all body systems are ready to be used again, and any harmful substances are removed.

The aerobic training zone is 60-80% of maximum heart rate.

The anaerobic training zone is 80-90% of maximum heart rate.

EFFECTS OF EXERCISE

Short-term effects

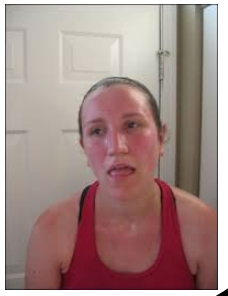
These are the things that occur during exercise.

You will become hot/sweaty and may have red skin. This is due to the body trying to cool down.

Lactic acid starts to build in the muscles.

Increase in depth and frequency of breathing – this will deliver more oxygen to the working muscles to allow them to continue to work.

Increase in heart rate – this will increase the blood flow to the muscles and therefore more oxygen will be delivered to the working muscles. There will also be an increase in stroke volume.

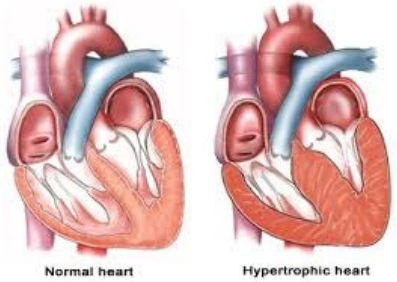


Long-term

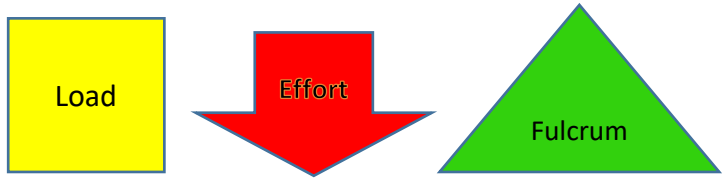
These are the effects that may after months-years of exercising.

- Change in body shape
- Improvement in specific components of fitness including:
  - Muscular endurance
  - Speed
  - Suppleness
  - Cardiovascular endurance

- Increase in the size of the heart (hypertrophy)
- Lower resting heart rate (bradycardia)
- Increased bone density
- Muscle hypertrophy
- Larger lung capacity
- Lower blood pressure

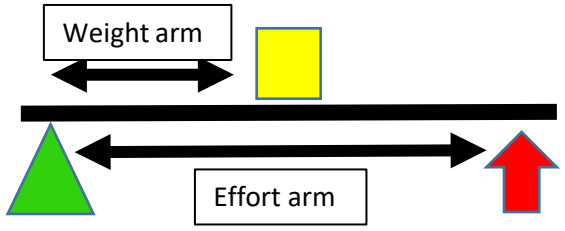


LEVER SYSTEMS

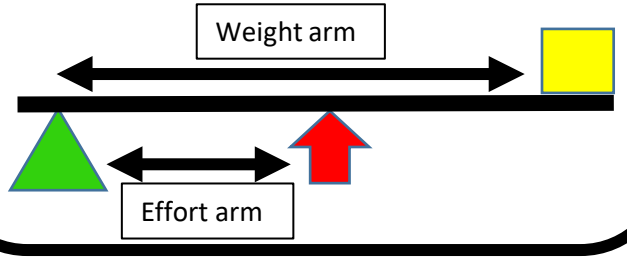


Fulcrum – Joint where movement happens
Effort – force applied by muscle
Load – what is being lifted (resistance)

Mechanical advantage
When the effort arm is longer than the weight arm.
Second class levers have this
Mechanical advantage = effort arm ÷ weight arm



Mechanical disadvantage
When the effort arm is shorter than the weight arm.
Third class levers have this
Large effort for a small load, but it is done quickly through a large range of movement.

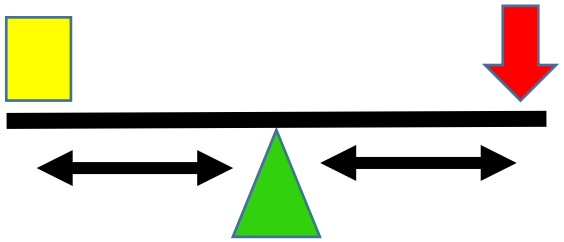


How to remember:

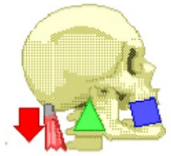
Letter represents the middle component in that particular class of lever.

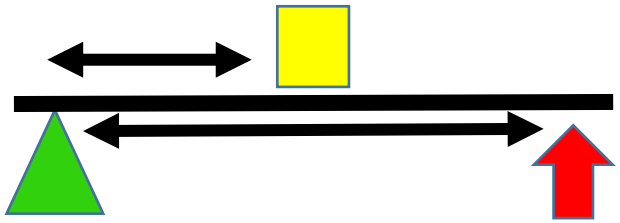
1 2 3

F L E



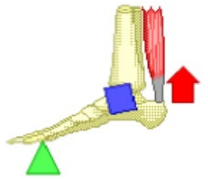
Fulcrum located in between the effort and the load.

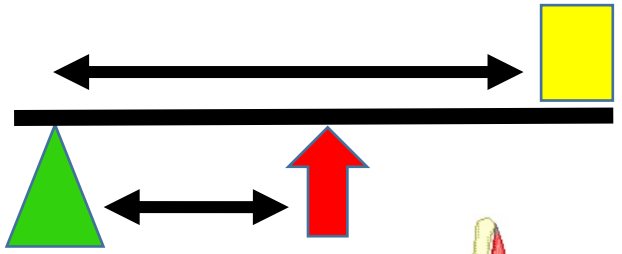




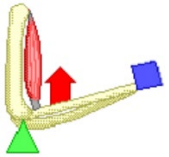
Load is located in between the fulcrum and effort.

Plantar-flexion and dorsiflexion at the ankle.



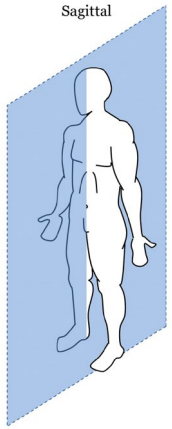


Effort is located in the middle of the fulcrum and the load.



Flexion and extension at the shoulder, hip and knee.
Flexion at the elbow.

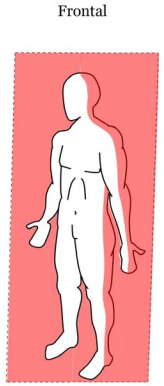
PLANES AND AXIS



Sagittal plane – divides left and right.

Movement here is up and down movements of flexion and extension.

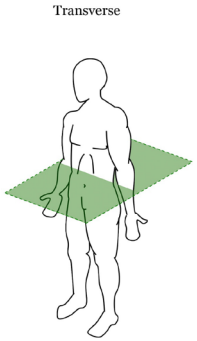
E.g. running action



Frontal plane – divides front and back

Movement here is abduction and adduction.

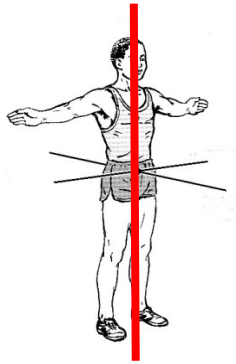
e.g. Cartwheel



Transverse plane – divides upper and lower halves of the body.

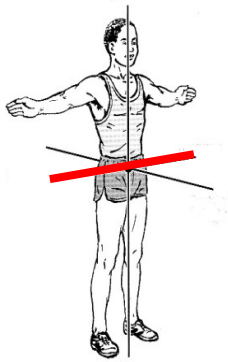
Movement here is rotational.

e.g. hip rotation in a golf swing.



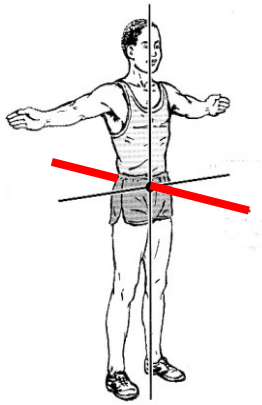
Vertical axis – runs through the body from the top to the bottom.

E.g. pirouette or a 360 degree rotation.



Frontal axis – runs through the body from left to right.

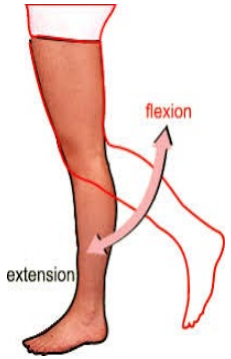
e.g. somersault or forward roll



Sagittal axis – horizontal from the back to the front of the body.

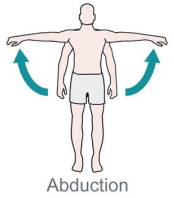
e.g. cartwheel

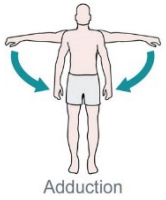
TYPES OF MOVEMENT



Flexion
Decreasing the angle at a joint.
Extension
Increasing the angle at a joint.

Occurs at the knee, elbow, hip and shoulder.



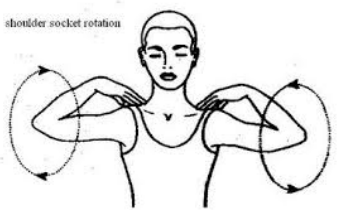


Abduction
Moving a limb away from the midline of the body.
Adduction
Moving a limb towards the midline of the body.

Occurs at the hip and shoulder.

Rotation
Circular movement at a joint.

Occurs at the shoulder and hip.



Plantar Flexion
Pointing the toes downwards
Dorsiflexion
Backward bending of the foot (towards the leg)

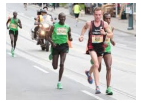
Occurs at the ankle.

Movements you need to know:

- Elbow action in push ups/ throw in
- Shoulder action in cricket bowl
- Hip, knee and ankle in running
- Hip, knee and ankle in kicking
- Hip, knee and ankle in standing vertical jump
- Hip, knee and ankle in squats

HEALTH-RELATED COMPONENTS OF FITNESS AND FITNESS TESTS

Cardiovascular Fitness



Definition
This is the ability of the heart and lungs to supply oxygen to the working muscles, enabling your body to exercise for long periods of time.

Tests – Harvard step test or 12 minute Cooper run

Strength

Definition
The amount of force that a muscle can exert against a resistance.

Test – Muscular strength
Hand grip dynamometer – measures grip strength. Grip as hard as you can for 5 seconds and record the score.

Muscular endurance

Definition
The ability to use voluntary muscles many times without getting tired.

Test – 1 MINUTE SIT UP/PRESS UP tests:

Flexibility

Definition
he range of movement possible at a joint.

Or, the range of motion of your joints.

Test - Sit and reach
Legs are straight out with the feet flat on the box. Reach as far forward as you can recording the result in centimetres.

Speed

Definition
This is the maximum rate in which an individual is able to perform a movement or cover a distance in a period of time.

Test
30 metre sprint test – run the 30m as fast as you can and record time in seconds.

What you need to know:

- Definitions of components
- Test for component
- The equipment needed for the test
- How the test is measured (e.g. levels, cms, seconds)
- Who would need this component of fitness

Reasons for fitness testing:

- Identify strengths and weaknesses
- Monitor improvement
- Show fitness levels
- Inform training
- compare to others and averages
- Motivate and set goals

Limitations to testing:

- Not sport specific
- Don't replicate movement of activity
- Don't replicate competitive conditions of sport
- Measurements and reliability are questionable
- Must be carried out correctly to increase reliability

SKILL-RELATED COMPONENTS OF FITNESS AND FITNESS TESTS

Power

Definition
This is the ability to undertake strength performances quickly.
Strength x Speed

Test - Vertical Jump test
Mark the highest point that you can reach on the wall while standing. Jump and mark the wall at the highest point of jump. Measure the distance between the two marks.

Co-ordination

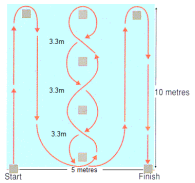
Definition
The ability to move two or more body parts together under control, smoothly and accurately.

Reaction time

Definition
The amount of time between the presentation of a stimulus and the onset of a movement.

Agility

Definition
The ability to control the movement of the whole body and change position or direction quickly.
Test - Illinois agility run
Start lying face down. Complete the course as quickly as you can gaining the shortest possible time.



Balance

Definition
This is being able to keep the body stable whilst at rest or in motion (when on the move).
Test -Stork test
Stand on the one leg with the other touching your knee and your hands on your hops. Raise your heel so you are on your toes. Hold this position for as long as possible.

What you need to know:

- Definitions of components
- Test for component
- The equipment needed for the test
- How the test is measured (e.g. levels, cms, seconds)
- Who would need this component of fitness

Reasons for fitness testing:

- Identify strengths and weaknesses
- Monitor improvement
- Show fitness levels
- Inform training
- compare to others and averages
- Motivate and set goals

Limitations to testing:

- Not sport specific
- Don't replicate movement of activity
- Don't replicate competitive conditions of sport
- Measurements and reliability are questionable
- Must be carried out correctly to increase reliability

PRINCIPLES OF TRAINING

Specificity

Matching the training to the needs of the sporting activity/individual and the components of fitness to be developed.

Reversibility
Fitness levels drop due to lack or training/injury

Tedium
Ensuring the training doesn't get boring

Progressive overload
Gradual increases in exercise (overload) to cause a greater than normal stress to the body for training adaptations to take place.
Done via **FITT.**

FITT Principles
Frequency – number of times one trains
Intensity – how hard you train
Time – how long your train for
Type – What exercises and methods of training you should use.

TRAINING ZONES AND METHODS OF TRAINING

Training zones:
Aerobic target zone – 60-80% of your maximum HR

Anaerobic target zones – 80-90% of your maximum HR.

Calculations
Maximum HR = 220 – age
Aerobic target zone = maximum HR x 0.6 (lower)
= maximum HR x 0.8 (higher)
Anaerobic target zone = maximum HR x 0.8 (lower)
= maximum HR x 0.9 (higher

Continuous training
Training that involves activity without rest intervals targeting the aerobic training zone.
This training involves exercising at a steady, regular pace (eg. jogging). It lasts for at least 20 minutes and is ***aerobic.***
e.g. running, walking, cycling, swimming and r

Advantages - Highly effective for long distance athletes and needs only a small amount of equipment.
Disadvantages - It can be very boring. It doesn't improve anaerobic fitness

Interval training
Interval training is *'training that incorporates periods of high intensity exercise and rest'*. An example of interval training would be sprinting for 25m and walking back to the start. it is a high intensity activity followed by a low intensity activity.

Advantages Quick and easy to set up. Can mix aerobic and anaerobic exercise to replicate team games.
Disadvantages - It can be boring. It can be hard to keep going when you get fatigued.

Static stretching
Training that is the gradual stretch of a muscle. It is where muscles are held in positions for around 30 seconds to increase flexibility.

Active - you use your own muscles to hold the stretch position.

Passive - you use someone else or a piece of equipment to help you hold the stretch.

Circuit training
Circuit training is *'a series of exercises performed at stations that focus on different muscle groups'*. Each exercise is called a station and should work a different area of the body to avoid fatigue. Circuit training can develop many components and can be specific to sports by using skill stations.

Advantages – Match training to specific needs and components of fitness. Variety within training.
Disadvantages – Takes a lot of time to set up and can require lots of space and equipment.

Fartlek training
"A method of training where the speed, intensity and terrain are constantly changing."

"It is a combination of fast and slow running for an extended period of time."
This training involves exercising at different speeds/intensities. For example 1 lap jogging, 1 lap sprinting, 1 lap running.
Due to the different speeds it is both ***aerobic*** and ***anaerobic.*** It can also be completed over different terrains (hills/roads etc.).

Advantages Good for sports that require changes in speed. Easily adaptable to suit different fitness levels.
Disadvantages It's easy to skip the harder parts. Difficult to know how hard someone is trying.

TRAINING ZONES AND METHODS OF TRAINING

Weight training
Weight training is *'a method of training that uses free weights or resistance machines'.* Weight training can help someone to increase strength (high weights x low reps – 70% of one rep max 3 sets of 4-8 reps) and muscular endurance (low weights x high reps – below 70% of one). It can also help participants to recover from injury.

Advantages - Can be adapted to suit different sports. Can target muscle groups to strengthen.
Disadvantages - Can cause muscle soreness.
Can cause injury if the incorrect technique is used.

Plyometric training
Plyometrics is a *'a method of training that uses jumping, hopping and bounding to increase power'*. Plyometrics exercises involve rapid and repeated stretching and contracting of the muscles. Plyometics increases the speed at which the muscles can contract and therefore also affects power. This can involve jumping on and off of boxes.
Advantages – only form of training that directly improves your power
Disadvantages - Demanding on the muscles so can cause injury.

High altitude training:
Training done at higher than sea level. At a higher altitude pressure is lower, so there is less oxygen in each breath. The body therefore produce more red blood cells, meaning more oxygen can be delivered to the muscles improving cardiovascular and muscular endurance.
Advantages – Improve cardiovascular and muscular endurance
Disadvantages - effects only last for a short time. Can be very expensive. May get altitude sickness and lose training time.
.

SEASONAL TRAINING

Preseason

Preparation – performer makes sure they are ready for season.

Focus on general fitness and developing specific components of fitness and skills.

Competition/playing season

Peak – should be at peak of their fitness and ability.

Maintain current fitness and continue to develop skill.

Too much training may cause fatigue.

Post-season

Transition - performer needs to rest and relax to allow their body to recover.

Light aerobic training is done to maintain general fitness

PREVENTING INJURY DURING/ BEFORE/AFTER TRAINING

Warm up - Complete all stages of a warm up prior to exercise to minimise the chance of injury.
Avoid overtraining –make sure that you don't push the body to far e.g. use the correct weight.
Appropriate clothing and footwear – make sure you are not wearing anything that could get caught. Use protective equipment and make sure footwear is suitable.

Hydration – drink plenty of water during and post exercise to replenish stores.
Stretches – Avoid pushing muscles to far (overstretching) or bouncing.
Technique – Make sure this is done correctly so that muscles are not injured.
Appropriate rest – leave enough time for your body to repair and rebuild muscles after exercise.

WARM UP AND COOL DOWN

Components of a warm up

Pulse raiser – Light exercise that increases your heart rate. Done to increase oxygen flow to muscles, increase body temperature and warm up muscles.
Stretching and mobility – increases the flexibility (therefore range of movement) at a joint. Focus on the muscles and movements you will use.
Skill based practice/ familiarisation – a practice that is related to sport or activity. Helps muscles prepare, but also mental preparation for performance. It gets you in the zone.

Benefits of a warm up

ROM – Increased range of movement at joints and therefore more flexible
Psychological preparation – gets performer in the zone so they can focus on performance.
Practice of movements – activates muscle memory and gets performer prepared to perform
Prevents injury - the body is prepared for exercise.
Body temperature – Raises warming up muscles ready for exercise.

Example warm up

Footballer

Pulse raiser – jog around the pitch for 5minutes.

Stretching/mobility – leg swings, arm swings, hip circles, open and close the gate, Frankenstein walks, walking lunges

Skill based practice – pass and move, shooting drill, corner practice.

Components of a cool down

Pulse lower – this is a gentle exercise to keep the heart and lungs working harder than usual. The intensity of the exercise should gradually be reduced.

Stretching – Should be static or PNF. This is done to increase mobility gains.

Benefits of a cool down

Allows the body to recover - gradually decreases breathing rate and heart rate to resting state. Prevents things such as blood pooling.

Removal of waste products – Cooling down helps the body get rid of waste products such as CO_2 and lactic acid

Prevent DOMS – removal of lactic acid prevents the delayed onset of muscle soreness.

Example cool down

Pulse lower – slow jog around the pitch into a walk

Stretches – hamstring stretch, toe raisers (gastrocnemius stretch), quadriceps stretch (heel pulled towards the bum)

USE OF DATA

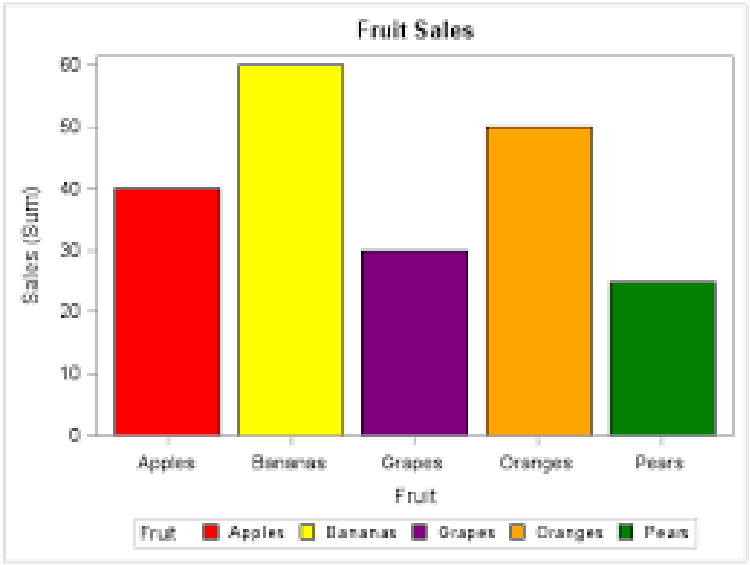
Types of data

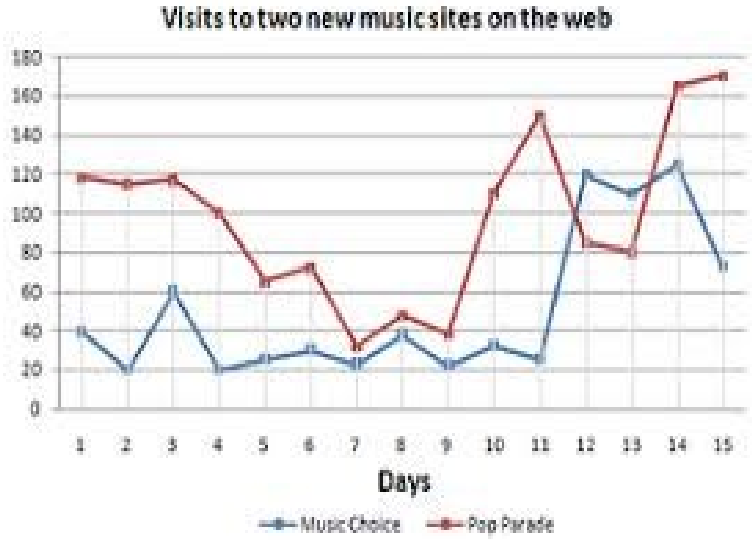
Quantitative data

- Measures something – done in numbers
- Can be collected through questionnaires or surveys.
- Things such as the time taken to finish a race or scores gained in a fitness test.
- Data can be presented in tables and graphs.

Qualitative data –

- Describes something – will be in words.
- Can be collected through interview or observation.





You need to be able to plot a bar chart and a line graph from given data.

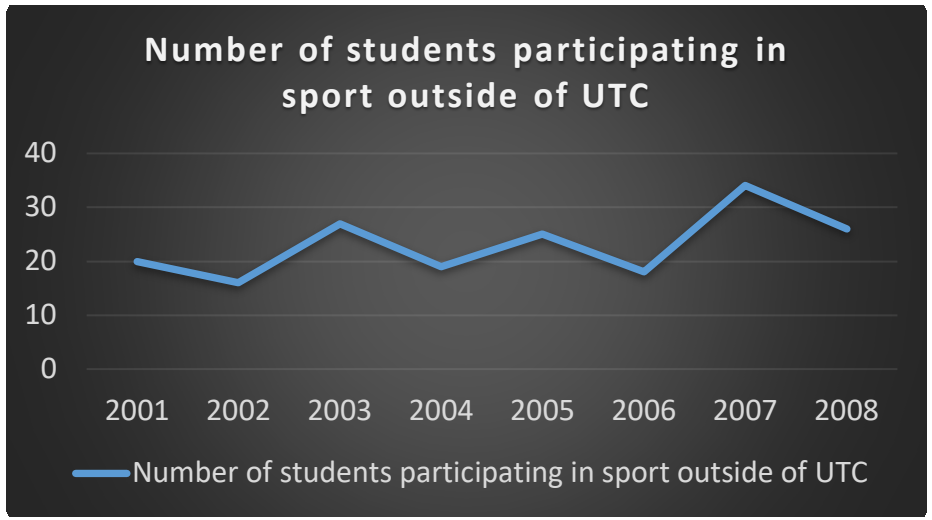
- X axis (one on the bottom) – should be the thing that is controlled such as the day/week or year you took the measurement.
- Y axis (one up the side) – is the thing you are measuring such as time or score achieved.
- Axis should be numbered with the small scale possible for the results.
- Ensure that you label the axis with titles.

Year	2010	2011	2012	2013	2014	2015
No. of yellow cards	6	7	10	11	8	9

Tables

You need to be able to present data that is given into a table.

Highlight in column one what the data is that you are measuring. In each row you should then present the data you have collected that represents each row.



Analysing graphs

You need to be able to analyse tables, bar charts, line graphs and pie charts, and discuss the data that is presented.

E.g. in the graph presented to the left you could discuss how the number of participants increased rapidly from 2006 to 2007, but saw a slight decrease again by 2008.

There has been a slight increase from 2001 with 20 students to 2008 with 28 students participating in sport.