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Mike Murray

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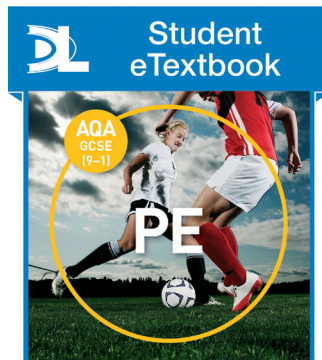
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Chapter 3 Physical training

Chapter objectives

- The relationship between health and fitness
- The components of fitness
- How to evaluate the need for components of fitness in specific physical activities and sport
- Reasons for carrying out fitness tests
- The protocol and procedures which should be followed when carrying out fitness tests
- The limitations of carrying out fitness tests
- How qualitative and quantitative data can be gained and used when fitness testing
- The principles of training and overload and how they can be applied to training programmes
- The varying training types and the advantages and disadvantages of using them
- How training can be structured into seasons
- The reasons for warming up and cooling down

The relationship between health and fitness

The definitions of health and fitness are also covered in Chapter 6 on health, fitness and well-being. This chapter deals with the relationship between health and fitness whereas Chapter 6 looks in detail at the components of health and well-being.

Definitions of health and fitness

Key terms

Health A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

Fitness The ability to meet/cope with the demands of the environment.

Health (as per the World Health Organization's definition: 1948) – 'A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.'

Be aware that 'ill health' refers to being in a state of poor physical, mental and/or social well-being.

Fitness – The ability to meet/cope with the demands of the environment.



▲ To be 'healthy' is to be physically, mentally and socially well.

Looking at these terms, it is important to fully appreciate the relationship between health and fitness. It perhaps seems obvious that if you are in a good state of fitness, you are more likely to be healthy – certainly physically, but also mentally. Developing a good fitness level allows you to cope better with the demands of your daily life and environment and can help to lessen the potential to be affected by illness and disease.

However, it is important to realise that irrespective of how fit you are, there is always the potential to become unwell, i.e. suffer poor health.

The relationship between health and fitness can be summarised in the following points:

- Ill health can negatively affect fitness as the individual may be too unwell to train – thus lowering their fitness.
- Ill health may not affect fitness if the person is still well enough to train.
- Increases in fitness can positively affect health and well-being, e.g. you may be less likely to contract certain illnesses and diseases, you may feel content/happy within yourself and you may have enhanced your social well-being through taking part in activities.
- However, increased fitness cannot prevent you from contracting some illnesses and diseases and subsequently your health may suffer.

N.B. Over training (training too much) can in fact lower your immune system and make you more susceptible to illness and disease!

PRACTICE QUESTION

Which **one** of the following is correct?

A person who trains regularly and has a high level of fitness will:

- definitely not catch any illness or disease
- be less likely to catch some illnesses or diseases
- definitely have good mental health and well-being
- definitely not have any friends or social well-being. (1 mark)

Answer is on page 178.

Study hint

It is a common mistake to suggest that increased fitness definitely improves health.

Check your understanding

Can you define health and fitness and suggest some elements of the relationship between the two?

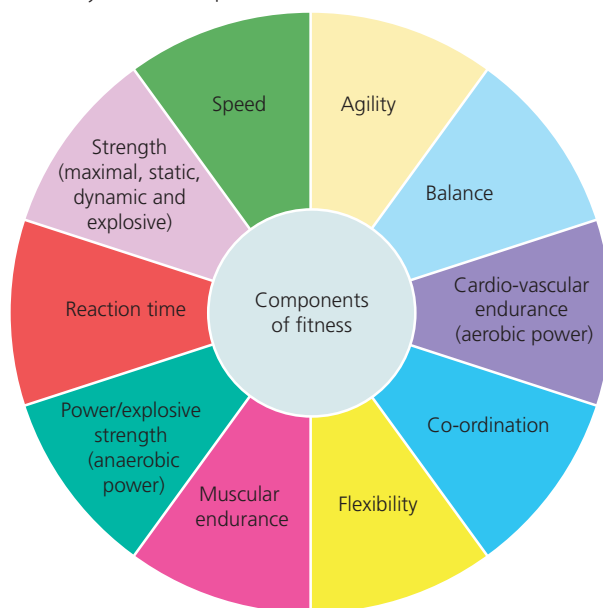
Answers are on page 177.



▲ Argentinian footballer Jonas Gutierrez had to stop playing football for some time to receive treatment for cancer.

The components of fitness, benefits for sport and how fitness is measured and improved

There are numerous components of fitness; however, for GCSE Physical Education you are required to know, define and understand the following:



Activity

Class debate

'Does an increase in a person's fitness definitely mean that they will be healthier'?



▲ Footballers often change direction quickly (at speed) to outwit opponents.



▲ Maintaining the centre of mass over the base of support in a headstand.

Key terms

Agility The ability to move and change direction quickly (at speed) whilst maintaining control.

Balance Maintaining the centre of mass over the base of support.

✓ Check your understanding

Can you provide reasons/justifications why agility is needed by different sports performers?

Answers are on page 177.

For each of these components of fitness it is important that you can link them to specific sports and skills, justifying why they are needed.

Agility

Agility is simply defined as ‘the ability to move and change direction quickly (at speed) whilst maintaining control’. In summary, agility involves:

- changing direction quickly or at speed
- maintaining control.

Agility combines speed, co-ordination, reaction time and strength and is applicable to most sporting scenarios. However, events like the 100 metres do not require agility as the runner does not change direction. As with all of the components of fitness, you may need to justify why agility is actually needed. It is not enough to simply state ‘you need agility to change direction quickly’. Thus a footballer who does need to change direction quickly does so to outwit another player, or to manoeuvre themselves into a suitable position to pass or shoot. Similarly, it is true that a volleyball player may need to change direction quickly so that they can react to the opposing team’s use of the ball.

Activity

Can you complete the table in order to justify why agility is required in the following sporting examples?

EXAMPLE SPORTING SCENARIO	JUSTIFICATION
Rugby player	Needs to change direction to avoid a tackler or to perform a side-step
Hockey player	
Badminton player	
Dancer	

Answers are on page 182.

Balance

Balance is defined as ‘the maintenance of the centre of mass over the base of support’.

It is important to realise that there are in fact two different types of balance:

- Static balance (balancing whilst still), and
- Dynamic balance (maintaining balance whilst moving).

An example of static balance is when performing a headstand, which is in a held position. An example of dynamic balance is simply when walking, or, more complexly, when a snowboarder aims not to fall over when making his or her downhill descent.

Balance is an essential ingredient in all sports. You get no plaudits in any sport for falling over!

Activity

Gymnastics is an activity where there are many examples of when balance is particularly important. Can you complete the table to justify why balance is needed?

GYMNASTIC EXAMPLE	TYPE OF BALANCE	JUSTIFICATION
Handstand		Position of handstand has to be held whilst maintaining control, e.g. no wobbles
Headstand	Static	
Cartwheel along a beam		Moving along the beam without falling off Maintain control during the jump/rotation/movement
Tumble	Dynamic	

Answers are on page 182.

Cardio-vascular endurance

Cardio-vascular endurance can also be called 'aerobic power'. It is linked closely to stamina, which is being able to exercise whilst delaying the onset of fatigue. The definition of cardio-vascular endurance is 'the ability of the heart and lungs to supply oxygen to the working muscles'.

Cardio-vascular endurance is particularly important for sports performers who:

- perform long, enduring events
- perform using the aerobic energy system (using oxygen).

Thus you can say that cardio-vascular endurance is important for long distance runners, team sports performers, endurance cyclists and rowers (see Chapter 1c).

Marathon runners

Marathon runners run for 26 miles 385 yards. It is a long, gruelling event that requires the athlete to make best use of their aerobic energy system. Their ability to use oxygen is a key ingredient in whether they succeed or not.

Example scenario:

- Athlete A: A marathon runner with good cardio-vascular endurance will be good at supplying oxygen to the working muscles.
- Athlete B: A marathon runner with poor cardio-vascular endurance will be poor at supplying oxygen to the working muscles.
- Summary: Athlete B will tire quickly and will not be able to run as fast as athlete A.

Javelin thrower

As an event, javelin lasts only a few seconds and is explosive/powerful. It does not matter if a javelin thrower can supply oxygen to the working muscles for a long period of time. Thus, cardio-vascular endurance is not required by a javelin thrower.

✓ Check your understanding

Define balance. Name two different types of balance. Explain why balance is needed for certain sporting activities.

Answers are on page 177.

Key term

Cardio-vascular endurance The ability of the heart and lungs to supply oxygen to the working muscles.

Activity

In small groups discuss whether cardio-vascular endurance is needed by a basketball player?

Study hint

It is important that you can justify why/why not cardio-vascular endurance is needed by sports performers.



▲ Distance runners require a good level of cardio-vascular endurance.

✓ Check your understanding

Define cardio-vascular endurance and suggest reasons why it is needed by performers in different sports.

Answers are on page 177.

Key term

Co-ordination The ability to use different (two or more) parts of the body together smoothly and efficiently.

PRACTICE QUESTION

10,000 m in athletics is completed by running round a 400 m track 25 times. Would this require cardio-vascular endurance? Justify your answer. (2 marks)

Answer is on page 178.

Key term

Flexibility The range of movement possible at a joint.

Study hint

If two or more body parts are being used, co-ordination is needed.

✓ Check your understanding

Define co-ordination and suggest reasons why it is needed by performers in different sports.

Answers are on page 177.

Co-ordination

Co-ordination is defined as 'the ability to use different (two or more) parts of the body together smoothly and efficiently'.

In simple terms, it involves effective interaction of body parts, e.g. the eyes and the hands (hand-eye co-ordination). The nervous signals from the brain are timed to ensure effective use of appropriate muscles, e.g. signals are sent to the shoulders, arms and hands to catch a ball.

Some examples of co-ordination being used in sport include:

- hitting a cricket ball with a bat (hand-eye co-ordination)
- kicking a football (foot-eye co-ordination)
- arms and legs when dribbling a basketball (arms-legs co-ordination).

Flexibility

Flexibility is defined as 'the range of movement possible at a joint'. The joints of the body have maximum ranges of movement which differ in relation to the type of joint being used, e.g. a ball and socket joint allows a wider range of movement than a hinge joint (see joints, Chapter 1a). Developing good flexibility is beneficial as it can prevent individuals from sustaining an injury if their body moves out of the normal range of movement.



▲ A gymnast showing incredible flexibility.

Flexibility is required to different extents by different sports people. A gymnast usually needs a good range of movement in many of their joints to create the shapes and moves required in a floor routine, e.g. performing the splits.

Muscular endurance (similar to dynamic strength)

Muscular endurance is the ability of a muscle or muscle group to undergo repeated contractions, avoiding fatigue. The repeated contractions cause a limb to carry out repeated movement. The ability of a muscle/muscle group to move a limb repeatedly is needed for activities such as middle-distance running, rowing or swimming. Swimming strokes are repeated, forceful movements that need to be sustained.



▲ Rowers perform repeated contractions causing their limbs to carry out the strokes required. This involves muscular endurance.

Power/explosive strength (anaerobic power)

Power, also known as explosive strength or anaerobic power is the product of strength and speed, i.e. strength \times speed.

The creation of 'power' is useful in many sporting skills, for example:

- to generate power whilst kicking a football – kicking with strength, moving the leg at speed
- to smash/spike a volleyball with power – hitting with strength, moving the arm at speed
- to release a discus with power – releasing with strength, moving the arm at speed
- to perform a punch with power in boxing – punching with strength, moving the arm at speed.

In all of these examples, strength is exerted at speed to create the power.

✓ Check your understanding

Define flexibility and suggest reasons why it is needed by performers in different sports.

Answers are on page 177.

Key term

Muscular endurance Ability of a muscle or muscle group to undergo repeated contractions avoiding fatigue.

✓ Check your understanding

Define muscular endurance and suggest reasons why it is needed by performers in different sports.

Answers are on page 177.

Rapid recall

You can simply remember that
power = strength \times speed

Key term

Power The product of strength and speed, i.e. strength \times speed.

✓ Check your understanding

Define power and suggest reasons why it is needed by performers in different sports?

Answers are on page 178.



▲ The reaction time in sprinting is the time between the gun going off and the sprinter starting to initiate a response (starting to run).

Key term

Reaction time The time taken to initiate a response to a stimulus.

Activity

Can you calculate the following using distance divided by time?

If a sprinter runs 100 m in 10 seconds what is the average speed in metres per second?

Answer is on page 182.

Key term

Speed The maximum rate at which an individual is able to perform a movement or cover a distance in a period of time. Distance divided by time.

✓ Check your understanding

Define speed and suggest reasons why it is needed by performers in different sports?

Answers are on page 178.



▲ The point of release when throwing a discus requires strength to be exerted at speed (power).

Reaction time

Reaction time is the time taken to initiate a response to a stimulus – the time taken from the presentation of the stimulus to starting to initiate a response (e.g. gun sounding at start of 100m to starting to move out of the blocks).

(Gun) → time to start reaction → (reaction starts/movement starts)

▲ Reaction time.

Speed

Speed is the maximum rate at which an individual is able to perform a movement or cover a distance in a period of time. It is also defined as 'putting the body parts through actions as quickly as possible'.

Speed can be calculated as 'distance divided by time'.

$$\text{(speed} = \frac{\text{distance}}{\text{time}})$$



▲ Olympic sprinters show amazing speed, performing the 100 m in less than 10 seconds.

Strength

Strength is the ability to overcome a resistance. It relates to the force that can be produced by a muscle or group of muscles. This can be maximal, explosive, static or dynamic:

- Maximal The largest force possible in a single maximal contraction
- Dynamic (see Muscular endurance for similarity)
- Explosive (see Power)
- Static: The ability to hold a body part (limb) in a static position. Muscle length stays the same/maximum force that can be applied to an immovable object.

Maximal strength relates to the absolute maximum force that can be generated in one contraction. This is often tested using a one rep max test (see testing). It can be related to a single punch in boxing.

Dynamic strength relates more to repeated contractions (see muscular endurance).

Explosive strength is also known as power – the product of strength and speed. It can be expressed as $\text{strength} \times \text{speed}$.

Static strength is applicable to scrummaging in rugby. When both teams push with the same force and the scrum is not moving, the muscles involved remain at the same length and force applied is maintained. (See isometric contraction Chapter 1a.)

Key term

Strength The ability to overcome a resistance.



▲ Strength demonstrated to lift a weight.

✓ Check your understanding

Can you define strength and suggest reasons why it is needed by performers in different sports? Answers are on page 178.

Study hint

You may be required to define any of the components of fitness. You may also need to link physical activities and sports to the components of fitness, justifying why they may or may not be needed, e.g. a footballer needs agility because.....

N.B. 'Justify' means to give a reason for your answer.

PRACTICE QUESTIONS

1. Is agility needed by a netball player? Justify your answer. (2 marks)
2. Name a sport that requires participants to have good reaction time. Justify your answer. (2 marks)
3. Which of these components of fitness is not required by a shot putter?

● Power	● Co-ordination
● Flexibility	● Muscular endurance

 (1 mark)
4. What is balance, and, using examples, why is it needed to play team games? (4 marks)
5. What is speed and explain why a netball player may require good speed. (2 marks)
6. In a sport like football, why might strength be needed? (1 mark)
7. Using a sport of your choice, explain why cardio-vascular endurance is not needed. (3 marks)

Answers are on page 178.

Reasons for carrying out fitness tests

It is often beneficial to test how proficient an individual is in a range of, or in specific components of, fitness. In simple terms, the main reasons for carrying out fitness tests can be summarised as:

- To identify strengths and/or weaknesses in a performance. Are there reasons for performing well or not so well? For example, perhaps your dribbling in a hockey match was poor because of a lack of speed?
- To inform your training requirements. As a result of initial tests, what components did you score poorly in and therefore may need to improve?
- To show a starting level of fitness. By testing at the start of a training programme, you can work out what level you are starting at. This links in well with the next point.
- To monitor improvement. Have the components of fitness you needed to improve actually improved over a period of time?
- To gauge the success of a training programme. If you have been training specific components of fitness you may test how well it has gone by undertaking fitness tests.
- To compare against norms of the group/national averages. You can compare results with your peers or, for an informed appraisal, some tests have national averages that you can compare your scores to.
- To motivate/set goals. Having knowledge that you will be doing fitness tests may well motivate an individual to try harder or to train in advance of the test so as to score well. It could also be that an individual is set a specific goal to achieve in the tests, thus providing them with motivation (drive).
- To provide variety in a training programme. Training programmes can be boring and lack variety. Carrying out tests either randomly or on a planned basis may well provide the variety required to keep individuals enthusiastic and motivated.



▲ Fitness testing can show you your strengths and weaknesses, what you need to improve and provide you with a starting point upon which to improve.

Fitness tests

The following fitness tests allow you to gain knowledge of:

- suitable tests for components of fitness
- what equipment is required
- what the protocol for each test is
- what the average is/national averages are for each test.

Activity

Why not try the tests out and compare your scores to the national averages/ratings provided? Please note that you should complete a thorough warm up (see page 76) prior to attempting any of the following tests.

No test should be completed without the permission and/or supervision of a teacher/responsible adult.

Agility test – Illinois agility test

The test involves the following protocol:

- Equipment: 8 cones, a measuring tape and a stopwatch.
- The cones should be arranged in a 10 m x 5 m rectangle with 4 cones down the middle – see below.

Rapid recall

The word **TEST** can be used to remember reasons for carrying out fitness tests.

- T** Training programme – can inform you what needs to be trained
- E** Evaluate strengths and weaknesses
- S** Set goals – goals can be set, e.g. to achieve a specific score in a test
- T** Tedium – to provide variety and avoid tedium/boredom in training

Activity

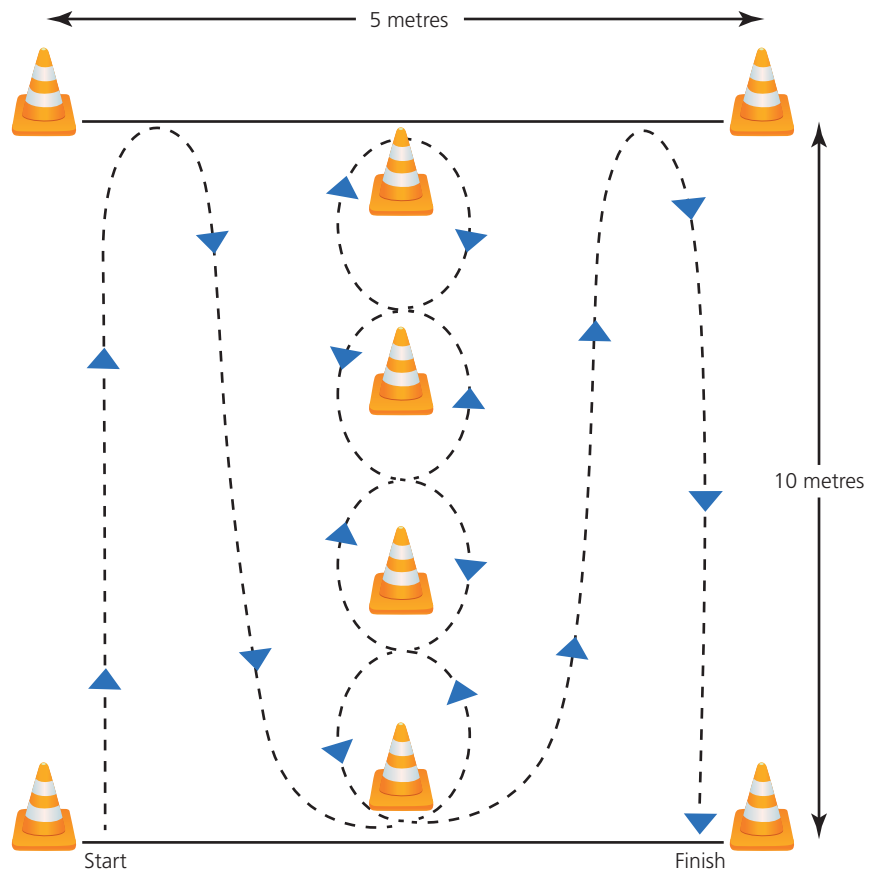
In small groups, discuss what fitness tests you have completed. Did anyone learn anything from the results?

For example:

- Did you score particularly well/poorly in a specific test?
- Is there a component of fitness that you would benefit from training to improve?
- Has anyone completed a test more than once in the last three years? Have they improved or got worse, and why?

Study hint

You may need to suggest the 'protocol' to carrying out fitness tests. This means: what do you actually do to carry out the test? Remember to use the correct units when describing a test, for example, one rep max in kilograms (kg).



- Performer starts face down on the floor.
- The test involves running round the cones as fast as possible (it is a maximal test).
- It is timed in seconds, and
- It can be compared to the ratings below.

▼ Illinois agility test ratings.

RATING	MALES	FEMALES
Excellent	< 15.2	< 17.0
Above average	16.1–15.2	17.9–17.0
Average	18.1–16.2	21.7–18.0
Below average	18.3–19.2	23.0–21.8
Poor	> 19.3	> 23.0

Source: Davis, B. et al. (2000) *Physical Education and the Study of Sport*

Balance test – the ‘stork balance’ test

This test involves the following protocol:

- Equipment: a stopwatch is required.
- The individual starts balanced on two flat feet.
- Hands are placed on the hips.

- One leg is lifted so that the toes of the lifted leg touch the inside of the knee of the planted leg.
- The timekeeper tells the individual to raise the heel on the planted leg (and the stopwatch should start).
- The individual balances on one leg for as long as possible until they lose balance or have to move the toes attached to the inside of the knee.
- The time is recorded in minutes/seconds.
- The test can be repeated and scores are compared to the ratings below.

RATING	MALES	FEMALES
Excellent	< 50	< 30
Above average	41–50	23–30
Average	31–40	16–22
Below average	20–30	10–15
Poor	> 20	> 10

Source: Johnson and Nelson (1979) *Practical Measurements for Evaluation in Physical Education*

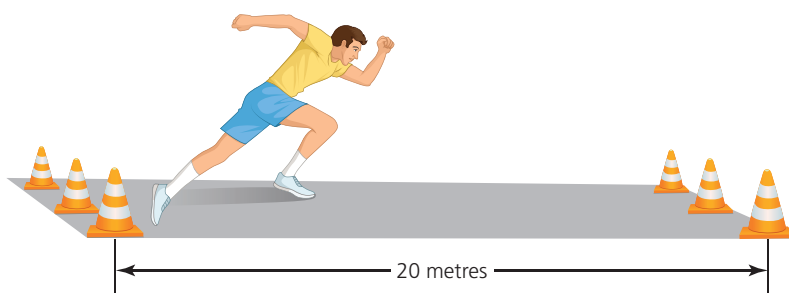


▲ Stork balance test.

Cardio-vascular endurance (aerobic power) test – multi-stage fitness test

The test involves the following protocol:

- Equipment: cones, tape measure (20 m or more), tape/CD with test, sheet to record score.
- It is run over a distance of 20 m, i.e. cones/line 20 m apart.
- It is progressive, i.e. it progressively gets harder.
- Individual runs 20 m in time with 'bleeps'.
- The time between bleeps gets shorter as the level increases.



- The individual keeps running until they cannot keep up with the bleeps (maximal test) – N.B. If you do not get to the line in time, the individual is usually given one or two more attempts to 'catch up' with the timing of the bleeps.
- The score is recorded as a level and bleep, e.g. level 8 bleep 4, and compared to the ratings below. The score can provide a prediction of an individual's VO₂ max (the maximum amount of oxygen that can be consumed per minute).

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