

Section 4:

Exercise Physiology

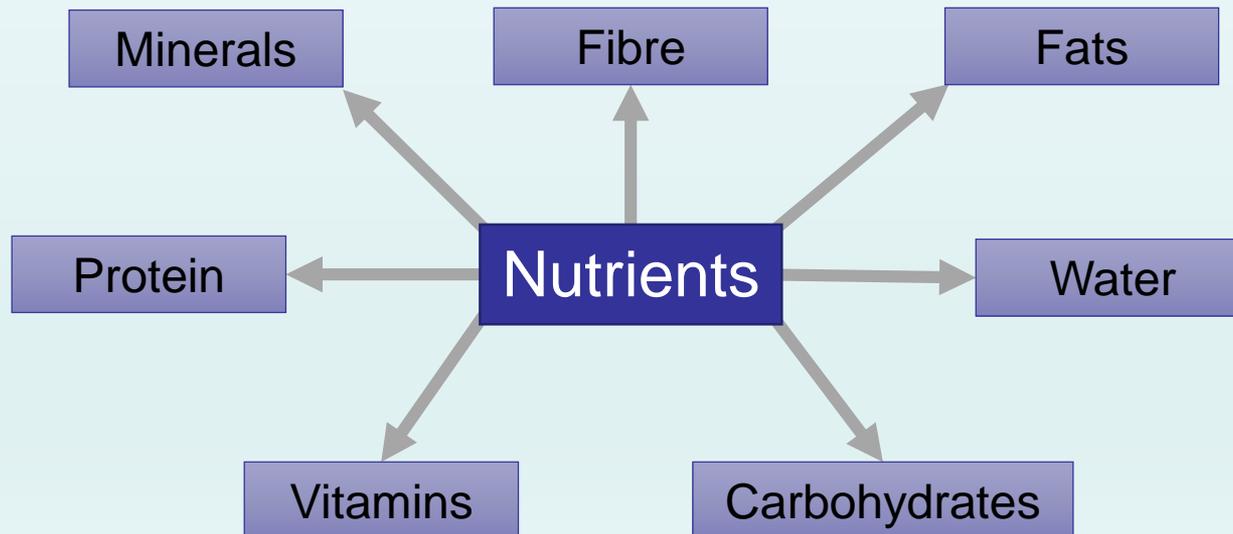
Diet and nutrition and their effect on physical activity and performance

Learning Objectives

1. Identify the seven classes of food as: carbohydrates, fats, proteins, vitamins, minerals, fibre and water.
2. Identify the exercise-related function of each of these types of food.
3. Identify the positive and negative effects of creatine, sodium bicarbonate, caffeine and glycogen loading on the performer.

Diet

- A balanced diet is essential for optimum performance.
- Diet impacts upon health, weight and energy levels.
- There are seven nutrients that should be present in all sports performers diets.



Carbohydrates

Two types:

- Simple - These are found in fruits and easily digested. Also found in processed and anything with refined sugar added.
- Complex – These are found in nearly all plant-based foods, and usually take longer for the body to digest. They are most commonly found in bread, pasta, rice and vegetables.
- Carbohydrates are the main source of energy for the body.
- The main fuel for high intensity, anaerobic work.
- Carbohydrate in food is digested and converted into glucose and enters the bloodstream.
- Glucose is stored in the muscles and liver as glycogen but these stores are limited, so regular refuelling is necessary.
- It is important to consider the 'glycaemic index' and release rate of different carbohydrates.
- Foods with a low glycaemic index cause a slow and sustained release of glucose to the blood. This means blood glucose levels are maintained for longer.
- Foods with a high glycaemic index cause a rapid, short rise in blood glucose but this will be short lived.

Fats

- Saturated fats are found in sweet and savoury foods but most come from animal sources.
- Too much saturated fat leads to excessive weight gain, leading to a lack of flexibility, a lack of stamina and health problems such as coronary heart disease, diabetes and high blood pressure. It also leads to high cholesterol levels.
- Cholesterol is made predominantly in the liver and is carried in the blood as low-density lipoprotein (LDL) and high-density lipoprotein (HDL). Too much LDL can lead to fatty deposits developing in the arteries which can have a negative effect on blood flow. HDL, on the other hand, takes cholesterol away from the parts of the body where it has accumulated to the liver where it is disposed of.
- Trans-fats are a type of unsaturated fats that can be found in meat and dairy products but most are made in industrial process that adds hydrogen to liquid vegetable oils (hydrogenation), which causes the oil to become solid at room temperature. Using artificial trans-fats allows food to have a longer shelf-life. Trans-fats can also lead to high levels of cholesterol can be found in meat and dairy products.
- Replacing saturated and trans-fats with unsaturated fats is important.
- Fat is a major source of energy for low intensity, aerobic work such as jogging.
- Fats cannot be used for high intensity exercise where oxygen is in limited supply as they require oxygen to be broken down.
- Fats are also a carrier for the fat-soluble vitamins A, D, E and K.

Proteins

- These are a combination of many chemicals called amino acids and are important for muscle growth and repair and to make enzymes, hormones and haemoglobin.
- Proteins are a minor source of energy and tend to be used more by power athletes who have a greater need to repair and develop muscle tissue.
- Generally proteins tend to provide more energy when glycogen stores are low. Meat, fish, eggs and dairy products are good sources of protein.

Vitamins

Vitamins are essential nutrients that your body needs in small amounts in order to work properly.

There are two types of vitamins:

Fat soluble – A, D, E and K.

- These vitamins are found predominantly in fatty foods and animal products such as milk, dairy foods, vegetable oils, eggs, liver and oily fish. The body stores fat-soluble vitamins in the liver and fatty tissues for use at a later date.

Water soluble vitamins – the B vitamins and vitamin C.

- These are found in a variety of foods such as fruit, vegetables and dairy products. They are not stored in the body so they need to be taken daily. Excessive consumption will not have any beneficial effects as any additional amounts will be excreted through urine.

Vitamin	Source	Exercise-related function
C (ascorbic acid)	Green vegetables and fruit	<ul style="list-style-type: none"> Protects cells and keeps them healthy. Helps in the maintenance of bones, teeth, gums and connective tissue such as ligaments
D	Most vitamin D is made by our body under the skin when it is exposed to sunlight. To a lesser extent it can come from oily fish and dairy produce	<ul style="list-style-type: none"> Has a role in the absorption of calcium, which keeps bones and teeth healthy
B1 (thiamin)	Yeast, egg, liver, wholegrain bread, nuts, red meat and cereals	<ul style="list-style-type: none"> Works with other B group vitamins to help break down and release energy from food Keeps the nervous system healthy
B2 (riboflavin)	Dairy products, liver, vegetables, eggs, cereals, fruit	<ul style="list-style-type: none"> Works with other B group vitamins to help break down and release energy from food. Keeps the skin, eyes and nervous system healthy
B6	Meat, fish, eggs, bread, vegetables, cereals	<ul style="list-style-type: none"> Helps form haemoglobin Helps the body to use and store energy from protein and carbohydrate in food
B12 (folate)	Red meat, dairy products and fish	<ul style="list-style-type: none"> Makes red blood cells and keeps the nervous system healthy Releases energy from food

Minerals

Minerals assist in bodily functions; calcium, for example, is important for strong bones and teeth and iron helps form haemoglobin, which will enhance the transport of oxygen and therefore improve stamina levels. Minerals tend to be dissolved by the body as ions and are called electrolytes. Two of the functions they have are to facilitate the transmission of the nerve impulses and enable effective muscle contraction, both of which are important during exercise. Good sources of minerals are meat, fish, eggs, dairy products, cereals, vegetables, fruit and nuts.

Mineral	Exercise related function
Calcium	Strong bones and teeth Efficient nerve and muscle function
Sodium	Regulation of fluid in the body Too much can lead to high blood pressure, heart attack and stroke
Water	Formation of haemoglobin in RBCs Improved oxygen carrying capacity in the blood A lack of iron can lead to anaemia

Fibre

Good sources of fibre are wholemeal bread, pasta, potatoes, nuts, seeds, fruit, vegetables and pulses. Fibre is important during exercise as it can slow down the time it takes the body to break down food, which results in a slower, more sustained release of energy. Dietary fibre causes bulk in the small intestine, helping to prevent constipation and aiding digestion.

Water

Water is extremely important in the human body. It constitutes up to 60 per cent of a person's body weight and is essential for good health. It transports nutrients, hormones and waste products around the body. It is the main component of many cells and plays an important part in regulating body temperature. When you take part in exercise, energy is required and some of that energy is released as heat. Water will keep you from overheating. The evaporation of sweat helps to cool you down, but this means water is lost during the cooling process. Once the body starts to lose water during exercise, dehydration can happen. As a result of this, the following can happen:

- Blood viscosity increases, reducing blood flow to working muscles and the skin.
- Reduced sweating to prevent water loss, which results in an increase in core temperature.
- Muscle fatigue and headaches.
- Reduction in the exchange of waste products/transportation of nutrients.
- Increased heart rate resulting in a lower cardiac output.
- Decreased performance/decreased reaction time/decreased decision making.

Nutrients - Key Questions

Area of Assessment 1

1. Identify the simplest form of carbohydrate (1 mark).
2. Identify the role of fat within the diet (1 mark).
3. Identify the simplest form of protein (1 mark).
4. Identify the role of protein in the diet (1 mark).
5. Identify two vitamins and describe the role of these within the diet (1 mark).
6. Identify two minerals and describe the role of these within the diet (1 mark).

Area of Assessment 1-2

1. Explain the role of fibre within the diet (4 marks).
2. Explain the role of water within the diet (4 marks).
3. Explain the effects of dehydration on a performer (4 marks).

Area of Assessment 1-3

1. Analyse the dietary requirements of a marathon runner (8 marks).

Dietary Supplements

Glycogen Loading

- The bodies preferred fuel for endurance sport is glycogen.
- Glycogen stores become depleted after 90-120 minutes of exercise.
- This results in fatigue – ‘hitting the wall’
- In order to replenish glycogen an athlete needs a diet rich in carbohydrates.
- Research suggests that athletes need to consume 6-10 grams of carbohydrate per Kg of bodyweight.

- Glycogen loading = Manipulating the diet to maximise aerobic performance.
- 6 days before completion:
 - Eat a high protein diet for three days and exercise at a high intensity to burn off existing carbohydrate stores.
 - This is followed by 3 days of a diet high in carbohydrates and some light training.
 - Theory suggests that stores can increase by double.

- New research suggest that replenishing carbohydrate stores during the first 20-minute window after exercise can enhance performance.
- In the 20 minutes post exercise, the body is more likely to restore lost glycogen.

- Increased glycogen stores.
- Delayed fatigue.
- Increased endurance capacity.

- During loading:
 - Water retention / bloating.
 - Heavy legs.
 - Digestion problems.
 - Weight increase.
- During depletion:
 - Irritability.
 - Disrupted training schedule.

Tip:

Some athletes drink chocolate milkshake after performance. This means that they consume a 3:1 to 4:1 ratio of carbohydrates to protein. This combination helps the body to resynthesize muscle glycogen more efficient. Liquids are also absorbed must faster than solids.

Dietary Supplements

Creatine monohydrate

- More commonly known as 'creatine'.
- Increased phosphocreatine (PC) stores in muscles.
- PC is used to fuel the ATP-PC system.

- Increasing PC stores will allow the ATP-PC system to last for longer.
- Increased PC can also allow for improved recovery.
- Athletes in explosive events are most likely to gain benefits.
- E.g. sprints, jumps and throws.
- Also, may increase muscle mass.

- Possible side effects include:
 - Dehydration
 - Diarrhoea
 - Water retention / Bloating
 - Muscle cramps
 - Slight liver damage.
- There is mixed evidence as to the benefits.

Key terms:

ATP-PC system

- The energy system that provides quick bursts of energy (5-8 seconds) and is used for high intensity exercise.

Dietary Supplements

Sodium Bicarbonate

- Also known as 'soda loading'.
- Athletes drink a sodium bicarbonate solution.
- Performers benefit who use their lactic acid system.
- E.g. 100-400 metres (Swimming, rowing, running).

- Reduces acidity in the muscle cells.
- Delays fatigue.
- Increases the buffering capacity of the blood.

- Possible side affects include:
 - Vomiting,
 - Cramping.
 - Diarrhoea.
 - Bloating.

Key term:

Buffering

- Lessening the impact of lactic acid. Helping to delay fatigue. Also helping to maintain the bloods pH value.

Dietary Supplements

Caffeine

- Stimulant.
- Found in coffee, tea, cola and chocolate.

- Increased mental alertness.
- Reduced effects of fatigue.
- Increases the body use of fats / saves glycogen.
- Improved decision making and reaction time.
- May benefit endurance athletes.

- Loss of fine control.
- Against the rules in large quantities in most sports.
- Possible side affects:
 - Dehydration.
 - Insomnia.
 - Muscle cramps.
 - Stomach cramps.
 - Vomiting.
 - Irregular heart beat.
 - Diarrhoea.

Key terms:

Diuretic

- An increased production of urine.

Insomnia

- An inability to sleep

Irregular

- Not even or balanced

Supplements - Key Questions

Area of Assessment 1-2

1. Discuss the role and effectiveness of Creatine supplements (3 marks)
2. Discuss the role and effectiveness of Caffeine supplements (3 marks)
3. Discuss the role and effectiveness of Bicarbonate of Soda supplements (3 marks)
4. Some runners may use Glycogen Loading as part of their preparation. Describe what you understand by this term and suggest why would a runner may need to do this (4 marks)

Area of Assessment 1-3

Analyse the potential use of dietary supplementation for a middle distance runner (8 marks)

