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Creating VCE Success

Physical Education
Teach Yourself Series
Topic 1:Energy Systems – Food Fuels (Unit 3)

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Food Fuels

As it appears in Unit 3

The human body requires energy for all basic body functions and for movements that we choose to complete. These include processes such as breathing, digesting, sleeping, running to class and playing sport. In a physical activity context, this energy is used to create muscular contractions that move our skeleton. This energy is the end product of the food that we consume as part of our normal daily diet.

The chemical compound used to create energy for muscular movement is called Adenosine Triphosphate (ATP). The breakdown of ATPreleases energy for all movements, both voluntary, such as those used when playing sport and involuntary, such as blinking and breathing.

ATP is created as a result of a person's diet via the energy systems that create ATP. All food and liquids consumed contain nutrients that are essential to normal bodily functions such as growth, repair and creation of energy. The three essential **foodfuels** contained in a healthy diet are **CARBOHYDRATE, FATS** and **PROTEINS**. There are additional nutrients that are extremely important to efficient bodily functions such as vitamins, minerals and water.

CARBOHYDRATES are consumed from foods such as sugars, fruit, vegetables, cereals and other grain products such as bread and pasta. Once digested it is broken down into **glucose** (a very small molecule) for transportation in the blood stream. It is then stored as **glycogen** (a complex molecule consisting of a number of glucose molecules joined together) in the muscles and liver. Carbohydrates are the preferred fuel source for physical activity, due to their easy access (as they are stored in the muscle cells), their plentiful supply and because they can be utilised under both aerobic (with oxygen) and anaerobic (without oxygen) conditions. Excess carbohydrate, that cannot be stored as glycogen or used for ATP production, is converted to fat and stored as adipose tissue.

The **glycaemic index (GI)** is a means of measuring the rate of breakdown and the effect on blood glucose of different carbohydrates. All carbohydrates are ranked against the reference value of glucose that carries a value of 100. Carbohydrates that are considered Low GI (<55) are slowly digested and absorbed, releasing their energy slowly over a longer period of time. They are particularly useful for people involved in endurance activities. Foods that have a High GI (70 – 100), breakdown and release their energy more quickly. They are of particular use during endurance events when taken as gels or in fluids and also post-exercise as part of the recovery and replenishment process.

Low GI Foods (<55)	Moderate GI Foods (55 – 70)	High GI Foods (70 – 100)
Porridge	Boiled potato	Sports drink
Lentils	Sultanas	Watermelon
Whole grain bread	Basmati rice	White bread
Low fat yoghurt	Muffin	Baked potato
Chocolate	Pancakes	Honey

FATS can be found in foods such as dairy products (milk, butter, cheese etc.), oils, nuts and meats. Fats are digested and broken down into **free fatty acids** for transportation and stored as **adipose tissue** at various locations around the body or as triglycerides in the muscle. Fats provide the majority of fuel for long-term, sub-maximal activity and at rest. They can only be utilised under aerobic conditions but result in a greater amount of ATP production than carbohydrates.

The relative energy yield of fats and carbohydrates is quite different with fats producing approximately 460 molecules of ATP from one triglyceride molecule as opposed to the 38 ATP molecules produced from one molecule of glucose. As stated earlier, carbohydrates are the preferred fuel source during physical activity due to the ready availability of glycogen and the fact that it can be used in both aerobic and anaerobic pathways. It is also more economical to use carbohydrates as less oxygen is required to breakdown glucose to release energy for ATP production than for fats (about 50% more).

PROTEINS are rarely utilised for ATP production, but can be used under extreme circumstances when all carbohydrate and fat stores are depleted (such as during starvation or in ultra-marathon events). Protein is stored as muscle tissue and as **amino acids** around the entire body. The breakdown of protein requires very high amounts of oxygen, but results in a very low ATP yield.

Summary of Food Fuels

Food Fuel and % of Daily Diet	Stored As	Storage Site	Transported As	Excess
Carbohydrate 55-60%	Glycogen	Muscles Liver Around body	Glucose	➡ Liver – stored as Glycogen ➡ Converted to Adipose tissue.
Fats 25-30%	Triglycerides	Adipose tissue Muscles Around body	Free Fatty Acids and Glycerol	Adipose Tissue
Protein 10-15%	Amino Acids	Muscles Around Body	Amino Acids	Adipose Tissue

Summary of Food Fuel usage at various intensities

Food Fuel	Rest	Prolonged sub-maximal activity	Maximal
Carbohydrates	33%	80%	100%
Fats	67%	15%	0%

Proteins	0%	5%	0%

Chemical Fuels

The main chemical fuel used by the body for ATP production is Phosphocreatine (also sometimes known as, Creatine Phosphate). It is utilised under anaerobic conditions to produce ATP for physical activity that is of maximum intensity and very short duration. It is stored in the muscle in very small amounts.

Review Questions

1. Create a glossary of definitions of the following terms.

a. Food fuel.

b. Carbohydrate

c. Protein

d. Fat

e. Adipose Tissue

f. Triglycerides

Solutions to Review Questions

1.

g. A fuel source that is derived directly from foods consumed by the athlete/participant.

h. An essential component of a balanced diet that produces a quick release of energy.

i. An essential component of a balanced diet that has a minor role to play in energy production but is mainly responsible for growth and repair of tissue.

j. An essential component of balanced diet that contributes towards energy production at rest and during long duration, sub-maximal activities.

k. The stored form of fats within the body. Found at various sites around the body.

l. Stored form of fats found in fat cells and in muscle.

m. Broken down form of fats for transport within the blood.

n. Broken down form of carbohydrates for transport within the blood.

o. Stored form of carbohydrates, found in muscle and liver.

p. Broken down form of proteins found in blood.

q. Means in the presence of oxygen.

r. Without oxygen.

s. The chemical responsible for creating energy for muscular movement. All energy systems are involved in the creation of ATP.

t. Chemical fuels are those that are not directly related to diet.

u. A chemical fuel involved in the rapid, anaerobic production of ATP for maximal intensity activities.

v. A scale used to measure the rate of breakdown and effect on blood glucose levels of all carbohydrates.

2.

a. 55 – 60%

b. 25 -40%

c. 10 – 15%

3.

a. 67% Fats
33% Carbohydrates
0% Protein

b. 100% Carbohydrates
0% Fats
0% Proteins

4. *Answer:* E

Explanation:

Glycogen is stored in both the muscle and liver.

5. *Answer:* D

Explanation:

Excess carbohydrate is converted to fat and stored as adipose tissue at various sites around the body.

6. *Answer:* A

Explanation:

Fats are utilised for energy production in long duration, sub-maximal events. All the events other than the marathon are of short duration and high intensity.

7. Readily available at the muscle site (no transport required).
Can be utilised by either aerobic or anaerobic pathways.
More economical in terms of oxygen requirements.

8.

a. Consumption of Low GI foods results in a slow release of glucose and a minimal effect on blood glucose. This means that there is a relatively high level of free fatty acids in the blood stream and is used first as a fuel source. This "spares" glycogen for later in the event when a higher intensity burst of effort may be required.

b. Endurance athletes are more likely to "glycogen spare".

9.

a.

Bananas
Honey
Sports drinks
Jelly beans

b.

Baked beans
Dried apricots
Wholegrain bread
Oats

10. *Answer:* C

Explanation:

Fats should be 25 – 30% of total diet, Carbs 55 – 60% and Protein 10 – 15%.

11. *Answer:* B

Explanation:

In maximal intensity activities 100% of energy is contributed by carbohydrates. Fats are an increasing contributor as intensity decreases and proteins only a minor contributor in prolonged activity.