Learning aim B
Know about the different energy systems used during sports performance

Assessment criteria

2B.P5 Describe the function of the three energy systems in the production and release of energy for sports performance.

2B.M5 Using two selected sports, explain how the body uses both the anaerobic and aerobic energy systems.

2B.D2 Compare and contrast how the energy systems are used in sports with different demands.

Topic B.1 The anaerobic energy system – not using oxygen

The anaerobic energy system creates energy without using oxygen. This type of energy can be produced for only a very short period of time, but allows the sports person to work at a high intensity. Sports activities which use this energy system last for only a few seconds, such as throwing a punch in boxing, performing a golf swing or taking a penalty kick.

Topic B.2 ATP-CP/alactic acid anaerobic system

Reliance on stored ATP
Adenosine triphosphate (ATP) is a molecule that produces energy in the cells of all living things. In sport we rely on the ATP which is stored in the mitochondria in our muscle cells.

ATP is made up of an adenosine molecule with three phosphates. Energy is released when the bonds between the adenosine and the phosphates break. This energy supply lasts up to four seconds. The energy produced powers high intensity, short duration sports activities. Activities fuelled by this energy system may be used for a discuss throw, a long jump or performing a lay-up in basketball.

Creatine phosphate (CP) helps restore ATP
Creatine phosphate (CP) is made up of a creatine molecule and a phosphate.
CP is stored in the muscle cells and is used to help restore ATP molecules without using oxygen, so that they can be used again to produce energy. CP releases energy when the bond between the creatine and phosphate breaks.

**CP is restored aerobically (with oxygen)**

CP can be restored in order to release energy again, but this requires oxygen.

In the recovery phase after exercising, oxygen is used to restore the bond between the creatine and phosphate.

**Energy is supplied by ATP and CP (four to twenty seconds)**

The energy released by ATP and CP will last for between four and twenty seconds. This may be the energy needed for a sprinter to complete a 100 m race, or for a footballer to intercept a pass and dribble on to score a goal. The energy made by ATP and CP will produce high intensity and low duration activities. After 20 seconds, the body’s creatine supply will be exhausted. The body can store only a small amount of CP, so that once the bonds have been broken and the energy has been released, CP will no longer produce energy.

**When this system runs out of ATP-CP stores, glycolysis takes place**

When the ATP and CP stores have been used up, glycolysis will take over. Glycolysis is the breakdown of glucose to produce energy. This is an anaerobic energy system because it works without the need for oxygen. This means that the performer has a constant supply of energy, so can continue to perform.

**Knowledge recap**

1. What is meant by anaerobic?
2. Name two sports activities which use the anaerobic energy system.
3. What is ATP?
4. How long does ATP-CP energy last?
5. What is glycolysis?
**Topic B.3 Glycolysis/lactic acid anaerobic system**

**ATP is made from glucose stored in the liver and muscles**

Glycolysis or lactic acid anaerobic system produces energy quite quickly by using glucose and not using oxygen. Glucose is the sugar our bodies need to make energy. We can get glucose into our blood and delivered to our muscles quite quickly by eating a very sugary food, such as a chocolate bar. We cannot keep much glucose in our blood, so it is stored in the liver and the muscles. This means that we have a store of energy to call on whenever we need it. Glucose is stored as a slightly different substance called glycogen. Our body turns glucose into glycogen to store it, so it can be ready when needed.

Figure 2.1 shows how glucose is stored as glycogen in our muscles and converted into energy by glycolysis when needed.

**Energy is supplied by ATP, CP and muscle glycogen**

*(20 to 45 seconds)*

The energy produced by ATP, CP and muscle glycogen will give 20–45 seconds of high intensity energy. After 45 seconds, these systems begin to run out and produce energy less effectively. This energy would give the performer fuel to perform a 200 m sprint or 50 m swim.

**Energy is supplied by muscle glycogen**

*(45 to 240 seconds)*

The energy produced by glycolysis or the lactic acid anaerobic system provides enough energy for a performer to work at a
high intensity for 45–240 seconds. The glucose stored in our muscle cells as glycogen is used by the glycolysis energy system without oxygen to produce enough energy for a boxer to fight a three minute round, or for a cricketer to bat and score four runs.

**Waste product is lactic acid**
Lactic acid is a waste product produced when glucose is used to make energy without oxygen.

Because glucose is being used without oxygen, it cannot be fully broken down into water and carbon dioxide. Instead it is partially broken down into lactic acid. Once oxygen is used to break down the lactic acid, it is converted into water and carbon dioxide, and safely removed from the muscles. Lactic acid can be a problem when it starts to build up in the muscles. A build-up of lactic acid can cause muscles to fatigue, which leads to a rapid decrease in performance. It is very important for sports people to remove lactic acid from their muscles as soon as possible.

**When this system is unable to maintain energy requirements, the aerobic system starts to produce energy**
Because glucose is being broken down to produce energy without oxygen, lactic acid is produced as a waste product. Lactic acid makes the acidity of the blood increase. When the blood becomes acid, chemical reactions which take place at a lower acid level stop working. The lactic acid (waste product) is actually causing the lactic acid system to stop working. Once this happens, the aerobic system starts to take over. This uses oxygen to make energy from glucose, and this energy system can use lactic acid to make energy and harmless waste products.

**Sports that use this system to provide energy are moderate to high intensity**
Activities which use this energy system are at a moderate to high intensity level and for a short duration. Activities can include running middle distances, swimming short distances and set sequences in games, e.g. taking a short corner in hockey.

**Knowledge recap**
1. What is glycogen?
2. What is lactic acid?
3. Why is it important to get rid of waste products?
**Topic B.4 The aerobic energy system – using oxygen**

**During longer periods of exercise/activity, sustained energy relies on this system**

Sports that mainly use this system to provide energy for sustained activity are long-distance events such as marathon running, long-distance swimming or long-distance cycling.

The aerobic energy system uses oxygen to convert glucose or fatty acids into energy. Activities which last for over 240 seconds use this energy system. Activities such as long-distance events, marathons, triathlons, open water swimming and long-distance cycling will use this energy system to provide fuel.

**Energy supplied by muscle glycogen and fatty acids (240 to 600 seconds)**

The aerobic energy system produces energy after the ATP-CP system and glycolysis or anaerobic lactic acid system have finished working. This system can produce energy for up to 600 seconds. As long as there is oxygen and glucose (glycogen) or fatty acids, the system can keep producing energy. See Figure 2.3.

**Uses oxygen as a means of making energy (re-synthesising ATP)**

The aerobic energy system uses oxygen to re-synthesise ATP. This means that when ATP releases energy, the bonds between the adenosine and
the phosphates break. In order to re-use the ATP, the bonds need to be restored. The aerobic energy system uses oxygen and glucose or fatty acids to re-synthesise these bonds so that the ATP can be used again and again, and energy can continually be released. See Figure 2.4.

Figure 2.3

Figure 2.4

**Low to moderate intensity (beyond 90 seconds)**

The aerobic energy system produces energy which will support a sports performer at a low to moderate intensity for a long duration. After 90 seconds, the aerobic energy system starts to work and begins making energy. This can be used by an athlete as their glycolysis energy system is winding down to help them to continue at a moderate level of intensity.

**Knowledge recap**

1. What is meant by aerobic?
2. Where do we get fatty acids?
Assessment guidance for learning aim B

Scenario
You have secured a voluntary work placement with a sports coaching company. The manager has asked you to help some of the young athletes (aged 13 to 14 years) who attend coaching sessions. The young athletes often struggle to understand the energy systems which their bodies need to fuel their different events. To assist the athletes, the manager has asked you to produce a presentation to help them to learn about energy systems. You will also need to show how the energy systems are used in different sporting situations.

2B.P5 Describe the function of the three energy systems in the production and release of energy for sports performance

Assessor report: The command verb in the grading criterion is describe. In learners’ answers we would expect to see a detailed account of the three energy systems in the production and release of energy for sports performance.

Learner answer

Energy systems
Main energy pathways

**ATP-CP** – Immediate energy supply
(4–20 seconds)

**Lactic acid** – Intermediate energy supply
(20–240 seconds)

**Aerobic** – Long-term energy supply
(240–600 seconds)

The function of the aerobic energy system

- To produce energy after 240 and for up to 600 seconds.
- To convert glucose and oxygen into energy, carbon dioxide and water.
- To produce energy by using oxygen.
- When the body has run out of glucose the body can use fatty acids as a fuel source.
- Sports using this energy system are low intensity and high duration, for example long-distance running, a marathon or a triathlon.
- This energy system can keep going as long as it has a fuel source, glucose or fatty acids.
UNIT 4 The Sports Performer in Action

Assessor report: The candidate has described the function of the aerobic energy system. To achieve the criterion for 2B.P5, they need to describe the functions of the other two energy systems and release of energy for sports performance.

**Which energy system is used?**

It depends on these:

- The type of activity or sport
- The speed of the task
- The intensity of the task
- Duration of the task
Assessor report – overall

What is good about this assessment evidence?

The learner has produced six PowerPoint slides. They have mentioned the three different energy systems and have included a diagram to show how the energy systems overlap. The learner has made some effort to describe when each energy system will be dominant. The learner has produced a good template from which the work could be developed to achieve 2B.P5 by adding descriptions of the lactic acid and ATP-CP energy systems.

What could be improved in this assessment evidence?

The learner has not produced enough evidence to meet the criterion for 2B.P5. They should include more slides to show their understanding of the energy systems, or they could add notes to their existing slides. The learner needs to ensure that they have described the function of all three energy systems; they must describe how these energy systems can fuel sports performance. The learner could focus on one sport for each energy system and describe its function in energy release, or they could look at one sport and identify the different activities in that sport which use the three different energy systems.