# Topic 3: Energy systems (13 hours)

### Nutrition – 4 hours

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| **Group** |  | **Assessment statement** | **Obj** | **Teacher’s notes** |
| A | 3.1.1 | List the macronutrients and micronutrients. | 1 | Macro–lipid (fat), carbohydrate, water and protein. Micro–vitamins, minerals and fibre. |
| A | 3.1.2 | Outline the functions of macronutrients and micronutrients. | 2 | Specific knowledge of individual vitamins and minerals is not required. |
| B | 3.1.3 | State the chemical composition of a glucose molecule. | 1 | C, H and O (1:2:1 ratio) |
| B | 3.1.4 | Identify a diagram representing the basic structure of a glucose molecule. | 2 |  |
| B | 3.1.5 | Explain how glucose molecules can combine to form disaccharides and polysaccharides. | 3 | Condensation reaction—the linking of a monosaccharide to another monosaccharide, disaccharide or polysaccharide by the removal of a water molecule. |
| C | 3.1.6 | State the composition of a molecule of triacylglycerol. | 1 | Limit to glycerol and three fatty acids. |
| C | 3.1.7 | Distinguish between *saturated*  and *unsaturated fatty acids*. | 2 | Saturated fatty acids have no double bonds between the individual carbon atoms of the fatty acid chain. Saturated fats originate from animal sources, for example meat, poultry, full-fat dairy products and tropical oils, such as palm and coconut oils. Unsaturated fatty acids contain one or more double bonds between carbon atoms within the fatty acid chain. Unsaturated fats originate from plant-based foods for example olive oil, olives, avocado, peanuts, cashew nuts, canola oil and seeds, sunflower oil and rapeseed. |
| D | 3.1.8 | State the chemical composition of a protein molecule. | 1 | Limit to C, H, O and N. |
| D | 3.1.9 | Distinguish between an *essential*  and a *non-essential amino acid*. | 2 | Essential amino acids cannot be synthesized by the human body and must be obtained from diet.  Non-essential amino acids can be synthesized by the human body. |

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| **Group** |  | **Assessment statement** | **Obj** | **Teacher’s notes** |
| E | 3.1.10 | Describe current recommendations for a healthy balanced diet. | 2 | Consider recommendations for carbohydrates, proteins, lipids, fibre, water and salt for adults in the general population. The relative contribution of carbohydrate, protein and lipid (including monounsaturated, polyunsaturated and saturated) should be given.  **Aim 9:** Recommended intakes of nutrients have been published in some countries. The  recommendations vary and this raises questions about how the levels are decided.  **Int/Aim 8:** Students can be made aware of the sociocultural influences of food selection and preparation across populations, for example, Mediterranean, Japanese, Western (USA, UK) and Indian.  **TOK:** Justification of how a balanced diet is defined. |
| E | 3.1.11 | State the approximate energy content per 100 g of  carbohydrate, lipid and protein. | 1 | Students should know that the energy content values per 100 g are: carbohydrate 1760 kJ, lipid 4000 kJ and protein 1720 kJ. |
| E | 3.1.12 | Discuss how the recommended energy distribution of the dietary macronutrients differs between endurance athletes and non-athletes. | 3 | Limit to the important difference in carbohydrate intake and how therefore this also affects fat and protein intake. For example, carbohydrate intake is higher, protein and fats intake is slightly higher  for a marathon runner than a non-athlete, and vice versa.  **Int:** Variation between countries, for example, a high-carbohydrate diet consumed by athletes in some countries.  **Aim 8:** Some sports require smaller stature therefore diet manipulation may occur prior to competition.  **Aim 9:** Recommended intakes vary within published literature.  **TOK:** Justification of how diet contributes to performance. |

### Carbohydrate and fat metabolism – 2 hours

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| **Group** |  | **Assessment statement** | **Obj** | **Teacher’s notes** |
| F | 3.2.1 | Outline metabolism, anabolism*,* aerobic catabolism and anaerobic catabolism. | 2 | *Metabolism:* All the biochemical reactions that occur within an organism, including anabolic and catabolic reactions.  *Anabolism:* Energy requiring reactions whereby small molecules are built up into larger ones.  *Catabolism:* Chemical reactions that break down complex organic compounds into simpler ones, with the net release of energy. |
| F | 3.2.2 | State what glycogen is and its major storage sites. | 1 |  |
| F | 3.2.3 | State the major sites of triglyceride storage. | 1 | Adipose tissue and skeletal muscle. |
|  | 3.2.4 | Explain the role of insulin in the formation of glycogen and the accumulation of body fat. | 3 |  |
|  | 3.2.5 | Outline glycogenolysis and lipolysis. | 2 |  |
|  | 3.2.6 | Outline the functions of glucagon and adrenaline during fasting and exercise. | 2 |  |
|  | 3.2.7 | Explain the role of insulin and muscle contraction on glucose uptake during exercise. | 3 | Emphasize that both insulin and muscle contraction stimulate glucose uptake from the blood into skeletal muscle. |

* 1. **Nutrition and energy systems – 7 hours**

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| **Group** |  | **Assessment statement** | **Obj** | **Teacher’s notes** |
|  | 3.3.1 | Annotate a diagram of the ultrastructure of a generalized animal cell. | 2 | The diagram should show ribosomes, rough endoplasmic reticulum, lysosomes, Golgi apparatus, mitochondrion and nucleus. |
|  | 3.3.2 | Annotate a diagram of the ultrastructure of a mitochondrion. | 2 | Cristae, inner matrix and outer smooth membrane. |
|  | 3.3.3 | Define the term *cell respiration*. | 1 | Cell respiration is the controlled release of energy in the form of ATP from organic compounds in cells. |
|  | 3.3.4 | Explain how adenosine can gain and lose a phosphate molecule. | 3 |  |

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| **Group** |  | **Assessment statement** | **Obj** | **Teacher’s notes** |
|  | 3.3.5 | Explain the role of ATP in muscle contraction. | 3 | Limit to the breakdown of ATP to ADP releasing a phosphate molecule, which provides energy for muscle contraction.  Cross reference with 4.1.3. |
|  | 3.3.6 | Describe the re-synthesis of ATP by the ATP–CP system. | 2 | Creatine phosphate (a high energy molecule) is broken down to provide a phosphate molecule for the re-synthesis of ATP that has been utilized during the initial stages of exercise. |
|  | 3.3.7 | Describe the production of ATP by the lactic acid system. | 2 | Also known as anaerobic glycolysis—the breakdown of glucose to pyruvate without the use of oxygen. Pyruvate is then converted into lactic acid, which limits the amount of ATP produced (2 ATP molecules). |
|  | 3.3.8 | Explain the phenomena of oxygen deficit and oxygen debt. | 3 | Oxygen debt is now known as excess post- exercise oxygen consumption (EPOC). |
|  | 3.3.9 | Describe the production of ATP from glucose and fatty acids by the aerobic system. | 2 | Limit to: in the presence of oxygen pyruvate is processed by the Krebs cycle which liberates electrons that are passed through the electron transport chain producing energy (ATP).  Fats are also broken down by beta oxidation that liberates a greater number of electrons thus more ATP. In the presence of oxygen and in extreme cases protein is also utilized. |
|  | 3.3.10 | Discuss the characteristics of the three energy systems and their relative contributions during exercise. | 3 | Limit to fuel sources, duration, intensity, amount of ATP production and by-products. |
|  | 3.3.11 | Evaluate the relative contributions of the three energy systems during different types of exercise. | 3 | Energy continuum. Different types of exercise (endurance athlete, games player, sprinter) should be considered. |