# Scheme of work

## Combined Science: Trilogy - Foundation

## Biology – Bioenergetics

This resource provides guidance for teaching the Bioenergetics topic from our new GCSE in Combined Science; Trilogy (Biology) 8464. It has been updated from the draft version to reflect the changes made in the accredited specification.

There are some changes to the wording of the required practical in section 4.4.1.2, In addition some minor changes have been made to the specification in sections 4.4.1.2 Rate of photosynthesis, 4.4.2.2 Response to exercise and 4.4.2.3 Metabolism. These alterations have not required changes to the scheme of work.

The scheme of work is designed to be a flexible medium term plan for teaching content and development of the skills that will be assessed.

It is provided in Word format to help you create your own teaching plan – you can edit and customise it according to your needs. This scheme of work is not exhaustive; it only suggests activities and resources you could find useful in your teaching.

### 4.4 Bioenergetics

### 4.4.1 Photosynthesis

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes** *What most candidates should be able to do* | **Suggested timing (hours)** | **Opportunities to develop scientific communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment****Opportunities and resources***Reference to past questions that indicate success*  |
| --- | --- | --- | --- | --- | --- | --- |
| 4.4.1.1 | Photosynthetic reaction | Photosynthesis is represented by:$$carbon dioxide+water → $$$glucose+oxygen$ Photosynthesis is an endothermic reaction.Energy is transferred from the environment to the chloroplast by light. | 1 | Ask students to recap KS3 and define the word equation for photosynthesis when given the reactants and products.Describe the method used to test a leaf for starch, including a risk assessment.Describe the need for chlorophyll and light for the photosynthetic reaction to occur. | Students can test for starch in a green leaf compared to a variegated leaf or leaf kept in the dark. | [Exampro user guide PowerPoint](http://filestore.aqa.org.uk/resources/science/AQA-GCSE-SCIENCE-EXAMPRO-UG.PPTX) |
| 4.4.1.2 | Rate of photosynthesis**Required practical: photosynthesis**Investigate the effect of light intensity on the rate of photosynthesis using an aquatic organism such as pondweed.AT skills covered by this practical activity: biology AT 1, 2, 3, 4 and 5. | The rate of photosynthesis may be affected by:* temperature
* level of carbon dioxide
* light intensity
* amount of chlorophyll.
 | 1 | Describe the effects of temperature, light intensity and carbon dioxide concentration on the rate of photosynthesis.Draw graphs to illustrate the effect that changing these factors has on the rate of photosynthesis.Define limiting factor.Describe how to test the effects of changing light intensity on photosynthetic rate in pond weed. Draw a graph of photosynthesis rate with light intensity and describe results.Provide students with different graph shapes of the four factors against rate of photosynthesis or amount of O2 produced. Ask students to describe what factor is changing, how this affects the others and how the rates change.  | Required practical 3:investigate the effect of a factor on the rate of photosynthesis.Investigate the rate of photosynthesis with changing light intensity. Use numbers of bubbles of oxygen from Elodea or similar pondweed to measure the rate. |  |
| 4.4.1.3 | Uses of glucose from photosynthesis | The glucose produced in photosynthesis maybe:* used for respiration
* converted into insoluble starch for storage
* used to produce fat or oil for storage
* used to produce cellulose, which strengthens the cell wall
* used to produce amino acids for protein synthesis.

To produce proteins, plants also use nitrate ions that are absorbed from the soil. | 1 | Describe the products plants make from glucose plants. Group the products into how they are used in a plant.Describe how humans get nitrogen in their diet from eating protein (mainly meat). Discuss how vegetarians get protein from plants.Compare the elements in carbohydrates (CHO) with protein (CHON).Recap KS3 to describe how the plant gets nitrogen from the soil through the roots. | Demonstrate a range of products: sunflower seeds, flour, vegetable oil, tofu, potato, sugar, glucose.Investigate their solubility in ‘rain‘ water to find out how plants store water-soluble glucose.Students can test onion, apple, pear, celery, potato and grapes for:* starch and sugar using iodine and Benedict’s reagent
* cellulose using Schultz solution (risk assessment required).
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### 4.4.2 Respiration

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes** *What most candidates should be able to do* | **Suggested timing (hours)** | **Opportunities to develop scientific communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment****Opportunities and resources***Reference to past questions that indicate success*  |
| --- | --- | --- | --- | --- | --- | --- |
| 4.4.2.1 | Aerobic respiration | Respiration in cells can take place aerobically (using oxygen) or anaerobically (without oxygen), to transfer energy.Reactions which transfer energy to the environment are exothermic reactions.Organisms need energy for:* chemical reactions to build larger molecules
* movement
* keeping warm.

Aerobic respiration is represented by the equation:$$glucose+oxygen \rightarrow $$$$carbon dioxide+water$$Students should be able to compare the processes of aerobic and anaerobic respiration with regard to the need for oxygen, the differing products and the relative amounts of energy transferred. | 1 | Give students the products and reactants for aerobic respiration and ask them to recap KS3 by putting them into the correct order.Write the word equation for aerobic respiration.Describe what respiration is used for in all living organisms. | Investigate aerobic respiration in:* germinating seeds (measure temperature change)
* woodlice (use limewater to measure CO2).

Students can check the products of their respiration by breathing out into limewater (CO2) and cobalt chloride paper (H2O). |  |
| 4.4.2.1 | Anaerobic respiration | Anaerobic respiration in muscles is represented by the equation:$glucose \rightarrow lactic acid$ The energy transferred supplies all the energy needed for living processes. As the oxidation of glucose is incomplete in anaerobic respiration much less energy is transferred than in aerobic respiration. | 1 | Give students the products and reactants for anaerobic respiration and ask them to recap KS3 by putting them in the correct order. Compare this equation with the one for aerobic respiration.Write the word equation for anaerobic respiration. | Students can investigate the time they can continue clenching and unclenching their non-writing hand above and below the level of their heart. |  |
| 4.4.2.1 | Fermentation | Anaerobic respiration in plant and yeast cells is represented by the equation:$$glucose \rightarrow $$$ethanol+carbon dioxide$ Anaerobic respiration in yeast cells is called fermentation and has economic importance in the manufacture of bread and alcoholic drinks. | 1 | Ask students to recap from KS3 and write a definition for fermentation.Write the word equation for fermentation. | Investigate the amount of carbon dioxide produced from fermentation of yeast with varying amounts of sugar:1. Use three pre-made up solutions and add different food colourings to each to prevent confusion.
2. Use water as a control.
3. Use the change in the diameter of a balloon to measure amount of CO2 produced.
4. Incubate the yeast in a water bath.
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| 4.4.2.2 | Response to exercise | During exercise the human body reacts to the increased demand for energy.The heart rate, breathing rate and breath volume increase during exercise to supply the muscles with more oxygenated blood. This is needed for the increased cellular respiration to transfer more energy to meet the demand. If insufficient oxygen is supplied anaerobic respiration takes place in muscles. The incomplete oxidation of glucose causes a build-up of lactic acid and creates an oxygen debt.During long periods of vigorous activity muscles become fatigued and stop contracting efficiently. One cause of muscle fatigue is the build-up of acid in the muscles. The oxygen debt must be ‘repaid’ once exercise stops causing deep breathing for some time. | 1 | Describe the changes in the human body during and after exercise.Draw a cartoon strip to show the journey of an oxygen molecule from air through organs and blood to cell and mitochondrion with subsequent release of energy.Describe oxygen debt and how it is repaid through vigour breathing. | Investigate the effect of exercise on the heart rate.Measure breathing and pulse rates before and after vigorous exercise.Use plasticine to model the molecule for lactic acid C3H6O3.Determine that if 6 oxygen ‘balls’ are added, the resulting products are 3 lots of carbon dioxide (CO2) and water (H2O). |  |
| 4.4.2.3 | Metabolism | Metabolism is the sum of all the reactions in a cell or the body.The energy transferred by respiration in cells is used by the organism for the continual enzyme controlled processes of metabolism that synthesise new molecules.Metabolism includes:* conversion of glucose to starch, glycogen and cellulose
* the formation of lipid molecules from a molecule of glycerol and three molecules of fatty acids
* the use of glucose and nitrate ions to form amino acids which in turn are used to synthesise proteins
* respiration
* breakdown of excess proteins to form urea for excretion.
 | 1  | Define metabolism.Describe the processes involved in metabolism. | Students can calculate basal metabolic rate (BMR) using an online calculator.Investigate the amount of sugar in energy drinks and how they compare with recommended amounts. |  |