

Teaching ideas for Topic 2: Molecular biology

This chapter covers basic biochemistry for SL students but is only a preliminary introduction for HL students. Many aspects of this chapter are vital to the understanding of other chapters in the course so it is important that students understand them clearly.

Ideas for the lesson

- Invite students to name as many substances as they can that contain carbon atoms. They should then sub-divide the substances into organic and inorganic molecules.
- Ask students to compare the thermal properties of water with another solvent such as methylated spirit. Their suggestions can be investigated in a simple practical. Invite them to discuss why the thermal and solvent properties of water are so important to living things and chemical reactions in the body.
- Draw up comparative tables to discuss the structure and functions of three vital polysaccharides: cellulose, starch and glycogen.
- Discuss the properties of trans fats and saturated fats and their implications for health. This can be linked to International mindedness (see below).
- Ask students to compose their own acronym to help remember the complementary base pairs of DNA and RNA, for example, **Apple–Tart** and **Chocolate–Gateaux**. Supply pre-prepared card cut-outs for sugar (deoxyribose), phosphate and four base shapes and invite them to build and label their own ‘ladder-shaped’ DNA molecule. HL students should label 5' and 3' ends. The double strands should pair correctly.
- Demonstrate the nature of the double helix with a 3D model or video clip. Suitable videos are available at www.corbismotion.com.
- Provide a table of the genetic code and ask students to deduce which amino acids correspond to a given codon so as to enable them to discover for themselves that the code is universal and carries redundancy.
- Ask students to describe the effects of anaerobic respiration on their own bodies after a period of intense exercise. Alternatively, raising one arm while lowering the other provides a very simple, effective way to show how tissue that is deprived of oxygen can look and feel.

Practical activities

- Invite students to assemble polysaccharides from basic card cut-outs of glucose, galactose and fructose to assist their understanding of the composition of different larger molecules from the same subunits. They should be able to build disaccharides as well as starch, glycogen and cellulose.
- Provide students with the opportunity to investigate lactose-free products. This can be achieved by research or visits to supermarkets to assess the availability of such products.
- Students can carry out practical work using immobilised lactase enzymes to produce lactose-free products, mirroring and demonstrating the commercial process. (This procedure is described in detail in Practical 3.)
- Experimental work with yeast in aerobic and anaerobic conditions can be used to demonstrate aerobic and anaerobic respiration. Carbon dioxide production can be measured, and Janus Green is a good indicator of the presence or absence of oxygen in a yeast–glucose suspension.
- Students must be familiar with the measurement of respiration rates in small invertebrates and the use of a respirometer (see Figure 2.32 in the student’s book).
- Provide students with lamps and acetate filters to investigate the absorbance of different colours of light by different coloured objects, in order to understand that pigments absorb certain colours and reflect others.
- Supply students with aquatic plants such as *Elodea* or *Cabomba*, lamps and other necessary equipment to design their own investigations to measure the rate of photosynthesis directly from carbon dioxide produced at different light intensities.

ICT

- Students can plot continuous cooling curves for water and other solvents using data-loggers, and compare the patterns of heat loss over time for these substances. They should relate these thermal properties to the importance of water in organisms, oceans and lakes.
- Data-logging can be used to good effect in a number of enzyme-based investigations. For example, the pH of full fat milk can be monitored to follow lipase activity in the presence and absence of bile salts. Students can design their own investigations for assessment using enzyme-controlled reactions at different pHs, temperatures or concentrations. Amylase and starch, and protease and albumin are both suitable examples. Temperature and pH probes can be used or colour change monitored with colorimeters.
- Students should gather information from a databank and obtain visualisations of complex proteins such as hemoglobin or immunoglobulins. Sites such as www.umass.edu/microbio/rasmol and www.umass.edu/microbio/chime can be helpful.

Common problems

- Students who are not studying chemistry often have difficulty remembering and drawing molecular structures. Simple cut-outs can be used to support their learning and enable them to build up polymers from the basic monomers.

Theory of knowledge (TOK)

- Students can consider the changes in understanding of lactose intolerance (see International mindedness, below) and how new knowledge is used to modify an accepted theory.
- Students can discuss the importance of teamwork in scientific endeavour, with reference to the discovery of DNA structure by Watson and Crick and the contribution of Rosalind Franklin. The syllabus suggests considering that her contribution was made without her knowledge or consent.
- The ‘one gene, one polypeptide’ theory can be cited as an example of a paradigm shift. As knowledge of gene structure and interaction has advanced, this theory has been modified and eventually discarded. This can be linked to aspects of Topic 7, *Nucleic acids (HL)*.

International mindedness

- Lactose intolerance is not evenly distributed geographically and varies with different populations. Previous research had suggested that lactase production has declined in cultures where milk is not a large part of the adult diet. Most recent research suggests that genetic mutation has created the ability to digest lactose in adults, called the ‘lactose persistence’ condition. This example can be used to discuss the distribution of such conditions and also how biotechnology is used in different parts of the world.
- The occurrence of health problems, including obesity and coronary heart disease, has been linked to diet. Students could consider whether there is sufficient evidence to connect levels of obesity and coronary heart disease with the type of fat prevalent in the diets of different parts of the world.