

## **9.2 Maintaining a Balance**

### **Contextual Outline**

Multicellular organisms have specialised organ systems that are adapted for the uptake and transport of essential nutrients from the environment, the utilisation or production of energy and the removal of waste products arising from cellular activities.

The basis of healthy body-functioning in all organisms is the health of their cells. The physical and chemical factors of the environment surrounding these cells must remain within narrow limits for cells to survive. These narrow limits need to be maintained and any deviation from these limits must be quickly corrected. A breakdown in the maintenance of this balance causes problems for the organism.

The nervous and endocrine systems in animals and the hormone system in plants bring about the coordinated functioning of these organ systems. They are able to monitor and provide the feedback necessary to maintain a constant internal environment. Enzyme action is a prime example of the need for this balance. Enzymes control all of the chemical reactions that constitute the body's metabolism. As enzymes normally function only within a narrow temperature range, even a small rise in body temperature can result in the failure of many of the reactions of metabolism that are essential to life.

This module increases students' understanding of the applications and uses of biology, implications for society and the environment and current issues, research and developments in biology.

**1. Most organisms are active in a limited temperature range**

*Students learn to:*

- identify the role of enzymes in metabolism, describe their chemical composition and use a simple model to describe their specificity on substrates
- identify the pH as a way of describing the acidity of a substance
- explain why the maintenance of a constant internal environment is important for optimal metabolic efficiency
- describe homeostasis as the process by which organisms maintain a relatively stable internal environment
- explain that homeostasis consists of two stages:
  - detecting changes from the stable state
  - counteracting changes from the stable state
- outline the role of the nervous system in detecting and responding to environmental changes
- identify the broad range of temperatures over which life is found compared with the narrow limits for individual species
- compare responses of named Australian ectothermic and endothermic organisms to changes in the ambient temperature and explain how these responses assist temperature regulation
- identify some responses of plants to temperature change

*Students:*

- identify data sources, plan, choose equipment or resources and perform a first-hand investigation to test the effect of:
  - increased temperature
  - change in pH
  - change in substrate concentrations on the activity of named enzyme(s)
- gather, process and analyse information from secondary sources and use available evidence to develop a model of a feedback mechanism
- analyse information from secondary sources to describe adaptations and responses that have occurred in Australian organisms to assist temperature regulation

**2. Plants and animals transport dissolved nutrients and gases in a fluid medium**

*Students learn to:*

- identify the form(s) in which each of the following is carried in mammalian blood:
  - carbon dioxide
  - oxygen
  - water
  - salts
  - lipids
  - nitrogenous waste
  - other products of digestion
- explain the adaptive advantage of haemoglobin
- compare the structure of arteries, capillaries and veins in relation to their function
- describe the main changes in the chemical composition of the blood as it moves around the body and identify tissues in which these changes occur
- outline the need for oxygen in living cells and explain why removal of carbon dioxide from cells is essential
- describe current theories about processes responsible for the movement of materials through plants in xylem and phloem tissue

*Students:*

- perform a first-hand investigation to demonstrate the effect of dissolved carbon dioxide on the pH of water
- perform a first-hand investigation using the light microscope and prepared slides to gather information to estimate the size of red and white blood cells and draw scaled diagrams of each
- analyse information from secondary sources to identify current technologies that allow measurement of oxygen saturation and carbon dioxide concentrations in blood and describe and explain the conditions under which these technologies are used
- analyse information from secondary sources to identify the products extracted from donated blood and discuss the uses of these products
- analyse and present information from secondary sources to report on progress in the production of artificial blood and use available evidence to propose reasons why such research is needed
- choose equipment or resources to perform a first-hand investigation to gather first-hand data to draw transverse and longitudinal sections of phloem and xylem tissue

**3. Plants and animals regulate the concentration of gases, water and waste products of metabolism in cells and in interstitial fluid**

*Students learn to:*

- explain why the concentration of water in cells should be maintained within a narrow range for optimal function
- explain why the removal of wastes is essential for continued metabolic activity
- identify the role of the kidney in the excretory system of fish and mammals
- explain why the processes of diffusion and osmosis are inadequate in removing dissolved nitrogenous wastes in some organisms
- distinguish between active and passive transport and relate these to processes occurring in the mammalian kidney
- explain how the processes of filtration and reabsorption in the mammalian nephron regulate body fluid composition
- outline the role of the hormones, aldosterone and ADH (anti-diuretic hormone) in the regulation of water and salt levels in blood
- define enantiostasis as the maintenance of metabolic and physiological functions in response to variations in the environment and discuss its importance to estuarine organisms in maintaining appropriate salt concentrations
- describe adaptations of a range of terrestrial Australian plants that assist in minimising water loss

*Students:*

- perform a first-hand investigation of the structure of a mammalian kidney by dissection, use of a model or visual resource and identify the regions involved in the excretion of waste products
- gather, process and analyse information from secondary sources to compare the process of renal dialysis with the function of the kidney
- present information to outline the general use of hormone replacement therapy in people who cannot secrete aldosterone
- analyse information from secondary sources to compare and explain the differences in urine concentration of terrestrial mammals, marine fish and freshwater fish
- use available evidence to explain the relationship between the conservation of water and the production and excretion of concentrated nitrogenous wastes in a range of Australian insects and terrestrial mammals
- process and analyse information from secondary sources and use available evidence to discuss processes used by different plants for salt regulation in saline environments
- perform a first-hand investigation to gather information about structures in plants that assist in the conservation of water