

4.2 Organisation

In this section we will learn about the human digestive system which provides the body with nutrients and the respiratory system that provides it with oxygen and removes carbon dioxide. In each case they provide dissolved materials that need to be moved quickly around the body in the blood by the circulatory system.

Damage to any of these systems can be debilitating if not fatal. Although there has been huge progress in surgical techniques, especially with regard to coronary heart disease, many interventions would not be necessary if individuals reduced their risks through improved diet and lifestyle.

We will also learn how the plant's transport system is dependent on environmental conditions to ensure that leaf cells are provided with the water and carbon dioxide that they need for photosynthesis.

4.2.1 Principles of organisation

Cells are the basic building blocks of all living organisms.

A tissue is a group of cells with a similar structure and function.

Organs are aggregations of tissues performing specific functions.

Organs are organised into organ systems, which work together to form organisms.

4.2.2 Animal tissues, organs and organ systems

4.2.2.1 The human digestive system

This section assumes knowledge of the digestive system studied in Key Stage 3 science.

The digestive system is an example of an organ system in which several organs work together to digest and absorb food.

Students should be able to relate knowledge of enzymes to Metabolism.

Students should be able to describe the nature of enzyme molecules and relate their activity to temperature and pH changes.

Students should be able to carry out rate calculations for chemical reactions.

Enzymes catalyse specific reactions in living organisms due to the shape of their active site.

Students should be able to use the 'lock and key theory' as a simplified model to explain enzyme action.

Students should be able to recall the sites of production and the action of amylase, proteases and lipases.

Students should be able to understand simple word equations but no chemical symbol equations are required.

Digestive enzymes convert food into small soluble molecules that can be absorbed into the bloodstream.

Carbohydrases break down carbohydrates to simple sugars. Amylase is a carbohydrase which breaks down starch.

Proteases break down proteins to amino acids.

Lipases break down lipids (fats) to glycerol and fatty acids.

The products of digestion are used to build new carbohydrates, lipids and proteins. Some glucose is used in respiration.

Bile is made in the liver and stored in the gall bladder. It is alkaline to neutralise hydrochloric acid from the stomach. It also emulsifies fat to form small droplets which increases the surface area. The alkaline conditions and large surface area increase the rate of fat breakdown by lipase.

Required practical activity 4: use qualitative reagents to test for a range of carbohydrates, lipids and proteins.

To include: Benedict's test for sugars; iodine test for starch; and Biuret reagent for protein.

Required practical activity 5: investigate the effect of pH on the rate of reaction of amylase enzyme.

Students should use a continuous sampling technique to determine the time taken to completely digest a starch solution at a range of pH values. Iodine reagent is to be used to test for starch every 30 seconds. Temperature must be controlled by use of a water bath or electric heater.

4.2.2.2 The heart and blood vessels

Students should know the structure and functioning of the human heart and lungs, including how lungs are adapted for gaseous exchange.

The heart is an organ that pumps blood around the body in a double circulatory system. The right ventricle pumps blood to the lungs where gas exchange takes place. The left ventricle pumps blood around the rest of the body.

Knowledge of the blood vessels associated with the heart is limited to the aorta, vena cava, pulmonary artery, pulmonary vein and coronary arteries. Knowledge of the names of the heart valves is not required.

Knowledge of the lungs is restricted to the trachea, bronchi, alveoli and the capillary network surrounding the alveoli.

The natural resting heart rate is controlled by a group of cells located in the right atrium that act as a pacemaker. Artificial pacemakers are electrical devices used to correct irregularities in the heart rate.

The body contains three different types of blood vessel:

- arteries
- veins
- capillaries.

Students should be able to explain how the structure of these vessels relates to their functions.

Students should be able to use simple compound measures such as rate and carry out rate calculations for blood flow.

4.2.2.3 Blood

Blood is a tissue consisting of plasma, in which the red blood cells, white blood cells and platelets are suspended.

Students should know the functions of each of these blood components.

Students should be able to recognise different types of blood cells in a photograph or diagram, and explain how they are adapted to their functions.

4.2.2.4 Coronary heart disease: a non-communicable disease

Students should be able to evaluate the advantages and disadvantages of treating cardiovascular diseases by drugs, mechanical devices or transplant.

In coronary heart disease layers of fatty material build up inside the coronary arteries, narrowing them. This reduces the flow of blood through the coronary arteries, resulting in a lack of oxygen for the heart muscle. Stents are used to keep the coronary arteries open. Statins are widely used to reduce blood cholesterol levels which slows down the rate of fatty material deposit.

In some people heart valves may become faulty, preventing the valve from opening fully, or the heart valve might develop a leak. Students should understand the consequences of faulty valves. Faulty heart valves can be replaced using biological or mechanical valves.

In the case of heart failure a donor heart, or heart and lungs can be transplanted. Artificial hearts are occasionally used to keep patients alive whilst waiting for a heart transplant, or to allow the heart to rest as an aid to recovery.

4.2.2.5 Health issues

Students should be able to describe the relationship between health and disease and the interactions between different types of disease.

Health is the state of physical and mental well-being.

Diseases, both communicable and non-communicable, are major causes of ill health. Other factors including diet, stress and life situations may have a profound effect on both physical and mental health.

Different types of disease may interact.

- Defects in the immune system mean that an individual is more likely to suffer from infectious diseases.
- Viruses living in cells can be the trigger for cancers.
- Immune reactions initially caused by a pathogen can trigger allergies such as skin rashes and asthma.
- Severe physical ill health can lead to depression and other mental illness.

Students should be able to translate disease incidence information between graphical and numerical forms, construct and interpret frequency tables and diagrams, bar charts and histograms, and use a scatter diagram to identify a correlation between two variables.

Students should understand the principles of sampling as applied to scientific data, including epidemiological data.

4.2.2.6 The effect of lifestyle on some non-communicable diseases

Students should be able to:

- discuss the human and financial cost of these non-communicable diseases to an individual, a local community, a nation or globally
- explain the effect of lifestyle factors including diet, alcohol and smoking on the incidence of non-communicable diseases at local, national and global levels.

Risk factors are linked to an increased rate of a disease.

They can be:

- aspects of a person's lifestyle
- substances in the person's body or environment.

A causal mechanism has been proven for some risk factors, but not in others.

- The effects of diet, smoking and exercise on cardiovascular disease.
- Obesity as a risk factor for Type 2 diabetes.
- The effect of alcohol on the liver and brain function.
- The effect of smoking on lung disease and lung cancer.
- The effects of smoking and alcohol on unborn babies.
- Carcinogens, including ionising radiation, as risk factors in cancer.

Many diseases are caused by the interaction of a number of factors.

Students should be able to understand the principles of sampling as applied to scientific data in terms of risk factors.

Students should be able to translate information between graphical and numerical forms; and extract and interpret information from charts, graphs and tables in terms of risk factors.

Students should be able to use a scatter diagram to identify a correlation between two variables in terms of risk factors.

4.2.2.7 Cancer

Students should be able to describe cancer as the result of changes in cells that lead to uncontrolled growth and division.

Benign tumours are growths of abnormal cells which are contained in one area, usually within a membrane. They do not invade other parts of the body.

Malignant tumour cells are cancers. They invade neighbouring tissues and spread to different parts of the body in the blood where they form secondary tumours.

Scientists have identified lifestyle risk factors for various types of cancer. There are also genetic risk factors for some cancers.

4.2.3 Plant tissues, organs and systems

4.2.3.1 Plant tissues

Students should be able to explain how the structures of plant tissues are related to their functions.

Plant tissues include:

- epidermal tissues
- palisade mesophyll
- spongy mesophyll
- xylem and phloem
- meristem tissue found at the growing tips of shoots and roots.

The leaf is a plant organ. Knowledge limited to epidermis, palisade and spongy mesophyll, xylem and phloem, and guard cells surrounding stomata.

4.2.3.2 Plant organ system

Students should be able to explain how the structure of root hair cells, xylem and phloem are adapted to their functions.

Students should be able to explain the effect of changing temperature, humidity, air movement and light intensity on the rate of transpiration.

Students should be able to understand and use simple compound measures such as the rate of transpiration.

Students should be able to:

- translate information between graphical and numerical form
- plot and draw appropriate graphs, selecting appropriate scales for axes
- extract and interpret information from graphs, charts and tables.

The roots, stem and leaves form a plant organ system for transport of substances around the plant.

Students should be able to describe the process of transpiration and translocation, including the structure and function of the stomata.

Root hair cells are adapted for the efficient uptake of water by osmosis, and mineral ions by active transport.

Xylem tissue transports water and mineral ions from the roots to the stems and leaves. It is composed of hollow tubes strengthened by lignin adapted for the transport of water in the transpiration stream.

The role of stomata and guard cells are to control gas exchange and water loss.

Phloem tissue transports dissolved sugars from the leaves to the rest of the plant for immediate use or storage. The movement of food molecules through phloem tissue is called translocation.

Phloem is composed of tubes of elongated cells. Cell sap can move from one phloem cell to the next through pores in the end walls.

Detailed structure of phloem tissue or the mechanism of transport is not required.