

Topic 6: Human physiology

20 hours

Essential idea: The structure of the wall of the small intestine allows it to move, digest and absorb food.

6.1 Digestion and absorption	
<p>Nature of science: Use models as representations of the real world—dialysis tubing can be used to model absorption in the intestine. (1.10)</p>	<p>Utilization:</p> <ul style="list-style-type: none"> Some hydrolytic enzymes have economic importance, for example amylase in production of sugars from starch and in the brewing of beer. <p>Syllabus and cross-curricular links: Biology Topic 2.1 Molecules to metabolism Topic 2.5 Enzymes</p>
<p>Understandings:</p> <ul style="list-style-type: none"> The contraction of circular and longitudinal muscle of the small intestine mixes the food with enzymes and moves it along the gut. The pancreas secretes enzymes into the lumen of the small intestine. Enzymes digest most macromolecules in food into monomers in the small intestine. Villi increase the surface area of epithelium over which absorption is carried out. Villi absorb monomers formed by digestion as well as mineral ions and vitamins. Different methods of membrane transport are required to absorb different nutrients. <p>Applications and skills:</p> <ul style="list-style-type: none"> Application: Processes occurring in the small intestine that result in the digestion of starch and transport of the products of digestion to the liver. Application: Use of dialysis tubing to model absorption of digested food in the intestine. 	

6.1 Digestion and absorption	
<ul style="list-style-type: none">• Skill: Production of an annotated diagram of the digestive system.• Skill: Identification of tissue layers in transverse sections of the small intestine viewed with a microscope or in a micrograph.	<p>Guidance:</p> <ul style="list-style-type: none">• Students should know that amylase, lipase and an endopeptidase are secreted by the pancreas. The name trypsin and the method used to activate it are not required.• Students should know that starch, glycogen, lipids and nucleic acids are digested into monomers and that cellulose remains undigested.• Tissue layers should include longitudinal and circular muscles, mucosa and epithelium.

Core topics

Essential idea: A balanced diet is essential to human health.

D.1 Human nutrition

Nature of science:

Falsification of theories with one theory being superseded by another—scurvy was thought to be specific to humans, because attempts to induce the symptoms in laboratory rats and mice were entirely unsuccessful. (1.9)

Understandings:

- Essential nutrients cannot be synthesized by the body, therefore they have to be included in the diet.
- Dietary minerals are essential chemical elements.
- Vitamins are chemically diverse carbon compounds that cannot be synthesized by the body.
- Some fatty acids and some amino acids are essential.
- Lack of essential amino acids affects the production of proteins.
- Malnutrition may be caused by a deficiency, imbalance or excess of nutrients in the diet.
- Appetite is controlled by a centre in the hypothalamus.
- Overweight individuals are more likely to suffer hypertension and type II diabetes.
- Starvation can lead to breakdown of body tissue.

Applications and skills:

- Application: Production of ascorbic acid by some mammals, but not others that need a dietary supply.
- Application: Cause and treatment of phenylketonuria (PKU).

International-mindedness:

- The Vitamin and Mineral Nutrition Information System (VMNIS), formerly known as the Micronutrient Deficiency Information System (MDIS), was established in 1991 following a request by the World Health Assembly to strengthen surveillance of micronutrient deficiencies at the global level.

Theory of knowledge:

- There are positive effects of exposure to sun such as the production of Vitamin D as well as health risks associated with exposure to UV rays. How can conflicting knowledge claims be balanced?

Utilization:

Syllabus and cross-curricular links:

Biology
Topic 6.1 Digestion and absorption
Geography
Part 2F The geography of food and health
Chemistry
Topic B5 Vitamins

<p>D.1 Human nutrition</p>	<ul style="list-style-type: none">• Application: Lack of Vitamin D or calcium can affect bone mineralization and cause rickets or osteomalacia.• Application: Breakdown of heart muscle due to anorexia.• Application: Cholesterol in blood as an indicator of the risk of coronary heart disease.• Skill: Determination of the energy content of food by combustion.• Skill: Use of databases of nutritional content of foods and software to calculate intakes of essential nutrients from a daily diet.
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Essential idea: Digestion is controlled by nervous and hormonal mechanisms.

D.2 Digestion	
<p>Nature of science:</p> <p>Serendipity and scientific discoveries—the role of gastric acid in digestion was established by William Beaumont while observing the process of digestion in an open wound caused by gunshot. (1.4)</p>	<p>Utilization:</p> <p>Syllabus and cross-curricular links: Biology Topic 1.2 Ultrastructure of cells Topic 6.5 Neurons and synapses Chemistry Topic D4 pH regulation of stomach</p>
<p>Understandings:</p> <ul style="list-style-type: none"> • Nervous and hormonal mechanisms control the secretion of digestive juices. • Exocrine glands secrete to the surface of the body or the lumen of the gut. • The volume and content of gastric secretions are controlled by nervous and hormonal mechanisms. • Acid conditions in the stomach favour some hydrolysis reactions and help to control pathogens in ingested food. • The structure of cells of the epithelium of the villi is adapted to the absorption of food. • The rate of transit of materials through the large intestine is positively correlated with their fibre content. • Materials not absorbed are egested. <p>Applications and skills:</p> <ul style="list-style-type: none"> • Application: The reduction of stomach acid secretion by proton pump inhibitor drugs. • Application: Dehydration due to cholera toxin. • Application: <i>Helicobacter pylori</i> infection as a cause of stomach ulcers. • Skill: Identification of exocrine gland cells that secrete digestive juices and villus epithelium cells that absorb digested foods from electron micrographs. <p>Guidance:</p> <ul style="list-style-type: none"> • Adaptations of villus epithelial cells include microvilli and mitochondria. 	

Essential idea: The chemical composition of the blood is regulated by the liver.

D.3 Functions of the liver	
<p>Nature of science: Educating the public on scientific claims—scientific studies have shown that high-density lipoprotein could be considered “good” cholesterol. (5.2)</p>	<p>Theory of knowledge:</p> <ul style="list-style-type: none"> Excessive alcohol consumption may cause liver cirrhosis. Are attitudes to drugs and alcohol an example of something that is relative to culture? Is all knowledge dependent on culture? <p>Aims:</p> <ul style="list-style-type: none"> Aim 6: Temporary mounts of hepatocytes can be prepared from fresh liver. Aim 8: Given the pressure on health resources, especially the availability of organs for transplant, should an alcoholic be allowed a liver transplant?
<p>Understandings:</p> <ul style="list-style-type: none"> The liver removes toxins from the blood and detoxifies them. Components of red blood cells are recycled by the liver. The breakdown of erythrocytes starts with phagocytosis of red blood cells by Kupffer cells. Iron is carried to the bone marrow to produce hemoglobin in new red blood cells. Surplus cholesterol is converted to bile salts. Endoplasmic reticulum and Golgi apparatus in hepatocytes produce plasma proteins. The liver intercepts blood from the gut to regulate nutrient levels. Some nutrients in excess can be stored in the liver. <p>Applications and skills:</p> <ul style="list-style-type: none"> Application: Causes and consequences of jaundice. Application: Dual blood supply to the liver and differences between sinusoids and capillaries. 	

Essential idea: Internal and external factors influence heart function.

D.4 The heart	
<p>Nature of science: Developments in scientific research followed improvements in apparatus or instrumentation—the invention of the stethoscope led to improved knowledge of the workings of the heart. (1.8)</p>	<p>Theory of knowledge:</p> <ul style="list-style-type: none"> • Symbols are used as a form of non-verbal communication. Why is the heart used as a symbol for love? What is the importance of symbols in different areas of knowledge?
<p>Understandings:</p> <ul style="list-style-type: none"> • Structure of cardiac muscle cells allows propagation of stimuli through the heart wall. • Signals from the sinoatrial node that cause contraction cannot pass directly from atria to ventricles. • There is a delay between the arrival and passing on of a stimulus at the atrioventricular node. • This delay allows time for atrial systole before the atrioventricular valves close. • Conducting fibres ensure coordinated contraction of the entire ventricle wall. • Normal heart sounds are caused by the atrioventricular valves and semilunar valves closing causing changes in blood flow. <p>Applications and skills:</p> <ul style="list-style-type: none"> • Application: Use of artificial pacemakers to regulate the heart rate. • Application: Use of defibrillation to treat life-threatening cardiac conditions. • Application: Causes and consequences of hypertension and thrombosis. • Skill: Measurement and interpretation of the heart rate under different conditions. • Skill: Interpretation of systolic and diastolic blood pressure measurements. • Skill: Mapping of the cardiac cycle to a normal ECG trace. • Skill: Analysis of epidemiological data relating to the incidence of coronary heart disease. <p>Guidance:</p> <ul style="list-style-type: none"> • Include branching and intercalated discs in structure of cardiac muscle. 	

