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| **D.1.U1** | **Essential nutrients cannot be synthesized by the body; therefore they have to be included in the diet.*** Define “essential” as related to dietary nutrients.
* Define “non-essential” as related to dietary nutrients.
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| **D.1.U2** | **Dietary minerals are essential chemical elements.*** State the difference between a vitamin and a mineral.
* List two example essential minerals.
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| **D.1.U3** | **Vitamins are chemically diverse carbon compounds that cannot be synthesized by the body.*** Define vitamin.
* Given a molecular diagram of a vitamin, determine if t is hydrophobic or hydrophilic.
* Compare the properties of water soluble and fat soluble vitamins.
* List two example water soluble vitamins and two example fat soluble vitamins.
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| **D.1.U4** | **Some fatty acids and some amino acids are essential.*** Outline the concept of “conditionally essential” using amino acid examples.
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| **D.1.U5** | **Lack of essential amino acids affects the production of proteins.*** Outline the effect of protein deficiency malnutrition on children and adults.
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| **D.1.U6** | **Malnutrition may be caused by a deficiency, imbalance or excess of nutrients in the diet.*** Outline two causes of malnutrition.
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| **D.1.U7** | **Appetite is controlled by a centre in the hypothalamus.*** Describe how hormones and the appetite control center regulate a desire to eat.
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| **D.1.U8** | **Overweight individuals are more likely to suffer hypertension and type II diabetes.*** Define hypertension.
* Outline the reasons for the relationship between weight gain and hypertension.
* Outline the causes of the two type of diabetes mellitus.
* List risk factors associated with type II diabetes.
* State symptoms of type II diabetes.
* List cardiovascular effects of type II diabetes.
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| **D.1.U9** | **Starvation can lead to breakdown of body tissue.*** State the cause of starvation.
* Explain loss of muscle mass during starvation.
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| **D.1.A1** | **Production of ascorbic acid by some mammals, but not others that need a dietary supply.** |

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| **D.1.A2** | **Cause and treatment of phenylketonuria (PKU).*** Outline the genetic cause of phenylketonuria.
* List consequences of phenylketonuria if untreated.
* State how phenylketonuria is treated.
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| **D.1.A3** | **Lack of Vitamin D or calcium can affect bone mineralization and cause rickets or osteomalacia.*** Explain the relationship between vitamin D, calcium, osteomalacia and skin cancer.
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| **D.1.A4** | **Breakdown of heart muscle due to anorexia.*** List symptoms associated with anorexia nervosa.
* Outline the effect of anorexia nervosa on heart muscle tissue.
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| **D.1.A5** | **Cholesterol in blood as an indicator of the risk of coronary heart disease.*** Outline factors that indicate that dietary cholesterol may not be the exclusive cause of the correlation between blood plasma cholesterol levels and risk of coronary heart disease.
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| **D.1.S1** | **Determination of the energy content of food by combustion.*** Explain how a calorimeter can be used to determine the energy content in food.
* Calculate the energy content of a food sample using calorimetry data.
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| **D.1.S2** | **Use of databases of nutritional content of foods and software to calculate intakes of essential nutrients from a daily diet.*** Use a computer application to keep a record of food consumed in a single day.
* Compare tracked food intake to the recommended intake of nutrients.
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| **D.1.****NOS** | **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.** |

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| **D.2.U1** | **Nervous and hormonal mechanisms control the secretion of digestive juices.*** Describe when the secretion of digestive juices must be controlled.
* State to mechanisms by which secretion of gastric juices is controlled.
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| **D.2.U2** | **Exocrine glands secrete to the surface of the body or the lumen of the gut.*** Define alimentary canal.
* Contrast endocrine glands with exocrine glands.
* Label a diagram of an exocrine gland with the following terms:  secretory cells, lumen, duct, secretory vesicles, basement membrane and acinus.
* Discuss the relationship between the structures of an exocrine gland cell and the function of the cell.
* State the name and location of three exocrine glands associated with the alimentary canal.
* State the composition of saliva, gastric juice and pancreatic juice.
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| **D.2.U3** | **The volume and content of gastric secretions are controlled by nervous and hormonal mechanisms.*** Using a flow chart or concept map, diagram the interactions between nervous and hormonal mechanisms that regulated the secretion of gastric juices.
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| **D.2.U4** | **Acid conditions in the stomach favour some hydrolysis reactions and help to control pathogens in ingested food.*** Outline three roles of acid in the stomach.
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| **D.2.U5** | **The structure of cells of the epithelium of the villi is adapted to the absorption of food.*** Outline the role of the following structures of villi epithelial cells:  tight junctions, microvilli, mitochondria, pinocytic vesicles, proteins imbedded on the apical surface and proteins imbedded on the basal surface.
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| **D.2.U6** | **The rate of transit of materials through the large intestine is positively correlated with their fibre content.*** List benefits of fibre in a healthy diet.
* State the relationship between food fibre contents and rate of transit through the large intestine.
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| **D.2.U7** | **Materials not absorbed are egested.*** Define dietary fibre.
* State two examples of dietary fibre.
* Define egestion.
* List materials that are egested from the body.
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| **D.2.A1** | **The reduction of stomach acid secretion by proton pump inhibitor drugs.*** State the role stomach mucus.
* State the cause of ulcer and acid reflux.
* Outline the role of the H+, K+ -ATPase protein pump in the production of an acidic stomach.
* Outline the use, function and effect of proton pump inhibitors to treat gastric disease.
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| **D.2.A2** | **Dehydration due to cholera toxin.*** Outline the cause and consequences of cholera infection.
* Explain the effect of cholera toxin on intestinal cells.
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| **D.2.A3** | ***Helicobacter pylori* infection as a cause of stomach ulcers.*** Define stomach ulcer.
* Outline evidence that suggest *Helicobacter pylori* infection has a role in stomach ulcer and stomach cancer.
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| **D.2.S1** | **Identification of exocrine gland cells that secrete digestive juices and villus epithelium cells that absorb digested foods from electron micrographs.*** List three features that can be used to identify exocrine gland cells as viewed in electron micrographs.
* List four features that can be used to identify villus epithelium cell as viewed in electron micrographs.
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| **D.2.****NOS** | **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.*** Describe how William Beaumont was able to determine the role of the stomach in chemical digestion of food.
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| **D.3.U1** | **The liver removes toxins from the blood and detoxifies them.*** Define “detoxification” as related to liver function.
* Explain the role of the liver in the detoxification of alcohol (including role of ethanol dehydrogenase).
* Outline the role of the liver in the detoxification of ammonia (and formation of urea).
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| **D.3.U2** | **Components of red blood cells are recycled by the liver.*** State the length of a typical red blood cell life span.
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| **D.3.U4** | **Iron is carried to the bone marrow to produce hemoglobin in new red blood cells.*** Explain how and why iron is transported to the bone marrow bound to transferrin.
* List three anatomical structures that have transferrin receptors on their cell membranes.
* Outline the storage of iron in the liver and spleen (including the role of ferritin).
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**D.3.U3** | **The breakdown of erythrocytes starts with phagocytosis of red blood cells by Kupffer cells.*** Explain how the structure of Kupffer cells fits their endosymbiosis function.

Create a flowchart to illustrate the steps and products of the splitting of hemoglobin |

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| **D.3.U5** | **Surplus cholesterol is converted to bile salts.*** Outline the roles of hepatocytes in the conversion of excess cholesterol into a component of bile.
* Explain the synthesis of VLDL cholesterol by hepatocytes for transport of triglycerides.
* Describe how the amount of saturated fat in a diet affects the amount of VLDL cholesterol synthesis by the liver.
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| **D.3.U6** | **Endoplasmic reticulum and Golgi apparatus in hepatocytes produce plasma proteins.*** Define and list examples of “plasma proteins.”
* Explain why hepatocytes have a lot of RER and Golgi.
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| **D.3.U7** | **The liver intercepts blood from the gut to regulate nutrient levels.*** Explain the storage and release of glucose (including the role of glycogen, insulin and glucagon).
* Outline the role of the liver in protein metabolism (and resulting nitrogenous waste formation).
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| **D.3.U8** | **Some nutrients in excess can be stored in the liver.*** List four example nutrients that can be stored by the liver.
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| **D.3.A1** | **Causes and consequences of jaundice.*** Outline the function and source of bilirubin.
* Explain the role of hepatocytes and glucuronic acid in the conversion of bilirubin.
* List components of bile.
* Outline the role of bile ducts and gall bladder in the transport and storage of bile.
* Describe when, where and why bile is secreted during digestion.
* Define and list causes and symptoms of jaundice.
* Describe the use of UV light as a treatment for jaundice.
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| **D.3.A2** | **Dual blood supply to the liver and differences between sinusoids and capillaries.*** Draw and label a diagram of the liver, including the left and right lobes, hepatic portal vein, hepatic artery and the hepatic vein.
* Compare liver blood supplies in terms of blood source (arrives from…), blood destination (flows towards…), and relative oxygen concentration.
* Draw a labeled diagram of a sinusoid, inclusive of:  bile canal cells, bile duct, hepatocytes, Kupffer cells, arterioles and venules.
* Compare sinusoids to capillaries.
* Outline the relationship between liver lobes, lobules and sinusoids.
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| **D.3.****NOS** | **Educating the public on scientific claims—scientific studies have shown that high-density lipoprotein could be considered “good” cholesterol.*** Compare and define LDL, HDL, IDL, VLDL and chylomicrons.
* Explain the structure of lipoproteins, including the types of molecules found in the hydrophobic core and hydrophilic surface.
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| **D.4.U1** | **Structure of cardiac muscle cells allows propagation of stimuli through the heart wall.*** Compare cardiac muscle tissue to skeletal muscle tissue.
* Contrast cardiac muscle tissue to skeletal muscle tissue.
* Describe how the Y-shape, intercalated discs and gap junctions of cardiac muscle cells allow for propagation of the stimulus to contract.
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| **D.4.U2** | **Signals from the sinoatrial node that cause contraction cannot pass directly from atria to ventricles.*** Explain the events of the cardiac cycle, including atrial and ventricular systole and diastole and the movement of the signal to contract through the heart.
* Outline the role of the atrioventricular node in the cardiac cycle.
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| **D.4.U3** | **There is a delay between the arrival and passing on of a stimulus at the atrioventricular node.*** Outline the causes of the delayed initiation of contraction of ventricles.
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| **D.4.U4** | **This delay allows time for atrial systole before the atrioventricular valves close.*** State the function of a delayed contraction of the ventricle.
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| **D.4.U5** | **Conducting fibres ensure coordinated contraction of the entire ventricle wall.*** Describe the motion of the signal to contract from the AV node through the ventricles.
* List features of Purkinje fibers that facilitate rapid conduction of the contraction signal through the ventricle.
* State that the contraction of the ventricle begins at the heart apex.
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| **D.4.U6** | **Normal heart sounds are caused by the atrioventricular valves and semilunar valves closing causing changes in blood flow.*** State the cause of each of the two sounds of the heartbeat.
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| **D.4.A1** | **Use of artificial pacemakers to regulate the heart rate.*** State the purpose of an artificial pacemaker device.
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| **D.4.A2** | **Use of defibrillation to treat life-threatening cardiac conditions.*** State the cause and effect of ventricular fibrillation.
* State the purpose of a defibrillator.
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| **D.4.A3** | **Causes and consequences of hypertension and thrombosis.*** Describe the relationship between atherosclerosis and thrombosis.
* Describe the relationship between atherosclerosis and hypertension.
* List consequences of hypertension.
* Outline factors that are correlated with a greater incidence of thrombosis and hypertension.
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| **D.4.S1** | **Measurement and interpretation of the heart rate under different conditions.*** List variables that can influence heart rate.
* Outline methods for detecting heart rate.
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| **D.4.S2** | **Interpretation of systolic and diastolic blood pressure measurements.*** State the cause of systolic and diastolic pressure.
* Describe how sound is used to measure blood pressure.
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| **D.4.S3** | **Mapping of the cardiac cycle to a normal ECG trace.*** State the function of an electrocardiogram.
* Label the P, Q, R, S and T waves on an ECG trace.
* State the cause of the P wave, the QRS wave and the T wave.
* State an application of the use of ECG technology.
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| **D.4.S4** | **Analysis of epidemiological data relating to the incidence of coronary heart disease.*** Define epidemiology.
* List epidemiological factors that can predispose ethnic groups to coronary heart disease.
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| **D.4.****NOS** | **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.*** List variables that lead to the development of the stethoscope.
* State the function of the stethoscope.
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| **D.5.U1** | **Endocrine glands secrete hormones directly into the bloodstream.*** State the function of endocrine glands.
* State the function of hormones.
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| **D.5.U2** | **Steroid hormones bind to receptor proteins in the cytoplasm of the target cell to form a receptor–hormone complex.*** Describe the mechanism of steroid hormone action.
* List two example steroid hormones.
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| **D.5.U3** | **The receptor–hormone complex promotes the transcription of specific genes.*** List locations at which a steroid hormone binds its receptor.
* Outline one example of a steroid hormone promoting transcription of specific genes.
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| **D.5.U4** | **Peptide hormones bind to receptors in the plasma membrane of the target cell.*** State the location at which a protein hormone binds its receptor.
* List two example protein hormones.
* Define “second messenger system.”
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| **D.5.U5** | **Binding of hormones to membrane receptors activates a cascade mediated by a second messenger inside the cell.*** List the two most common second messengers.
* Describe the mechanism of epinephrine action.
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| **D.5.U6** | **The hypothalamus controls hormone secretion by the anterior and posterior lobes of the pituitary gland.*** Draw a diagram to illustrate the relationship between the hypothalamus and pituitary.
* Describe how releasing factors regulate anterior pituitary action.
* Describe how neurosecretory cells carry hormones to the posterior pituitary.
* Outline how negative feedback is involved in the secretion of ADH from the posterior pituitary.
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| **D.5.U7** | **Hormones secreted by the pituitary control growth, developmental changes, reproduction and homeostasis.*** Outline the role of the hypothalamus as a link between nervous and endocrine systems.
* List hormones secreted by the anterior and posterior pituitary.
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| **D.5.A1** | **Some athletes take growth hormones to build muscles.*** State that growth hormone is a peptide hormone.
* Outline the mechanism of action of growth hormone.
* Evaluate the use of growth hormones by athletes.
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| **D.5.A2** | **Control of milk secretion by oxytocin and prolactin.*** List the source, target and function of oxytocin and prolactin as related to milk secretion.
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| **D.5.****NOS** | **Cooperation and collaboration between groups of scientists—the International Council for the Control of Iodine Deficiency Disorders includes a number of scientists who work to eliminate the harm done by iodine deficiency.*** Outline consequences of iodine deficiency.
* State the goal of the ICCIDD.
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| **D.6.U1** | **Oxygen dissociation curves show the affinity of hemoglobin for oxygen.*** Define partial pressure.
* State the relative partial pressures of oxygen  in the atmosphere at sea level, in the alveoli, in alveoli blood capillaries, and in respiring tissue.
* Define affinity.
* Describe the saturation of hemoglobin at different oxygen partial pressures.
* Draw the oxygen dissociation curve to show affinity of hemoglobin for oxygen at different partial pressures of oxygen.
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| **D.6.U2** | **Carbon dioxide is carried in solution and bound to hemoglobin in the blood.*** State the three ways carbon dioxide is carried in the blood.
* State which form of carbon dioxide transport accounts for the highest amount of carbon dioxide transported.
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| **D.6.U3** | **Carbon dioxide is transformed in red blood cells into hydrogen carbonate ions.*** Outline the reaction that transforms carbon dioxide into hydrogencarbonate ion, including the role of carbonic anhydrase.
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| **D.6.U4** | **The Bohr shift explains the increased release of oxygen by hemoglobin in respiring tissues.*** Explain the mechanism and benefit of the Bohr shift.
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| **D.6.U5** | **Chemoreceptors are sensitive to changes in blood pH.*** Outline the location and role of chemoreceptors that help regulate the ventilation rate.
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| **D.6.U6** | **The rate of ventilation is controlled by the respiratory control centre in the medulla oblongata.*** List the neural structures that control the rate of ventilation.
* Outline the feedback loop that regulates the rate of ventilation, including the role of stretch receptors.
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| **D.6.U7** | **During exercise the rate of ventilation changes in response to the amount of CO2 in the blood.*** Describe the relationship between carbon dioxide concentration and blood pH.
* State the effect of exercise on CO2 production.
* Outline the relationship between CO2 production and blood pH.
* Explain how and why hyperventilation occurs in response to exercise.
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| **D.6.U8** | **Fetal hemoglobin is different from adult hemoglobin allowing the transfer of oxygen in the placenta onto the fetal hemoglobin.*** Compare the oxygen dissociation curves of adult and fetal hemoglobin.
* State the reason why it is adaptive for fetal hemoglobin to have a higher oxygen affinity than adult hemoglobin.
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| **D.6.A1** | **Consequences of high altitude for gas exchange.*** State the effect of altitude on the atmospheric partial pressure of oxygen.
* Outline human physiological responses to high altitude.
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| **D.6.A2** | **pH of blood is regulated to stay within the narrow range of 7.35 to 7.45.*** State the range of normal human blood pH.
* Describe the relationship between carbon dioxide concentration and blood pH.
* Outline physiological responses that maintain blood pH.
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| **D.6.A3** | **Causes and treatments of emphysema.*** Outline the causes of emphysema.
* State the symptoms of emphysema.
* Outline reasons why gas exchange and ventilation are less effective in people with emphysema.
* List treatment options for people with emphysema.
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| **D.6.S1** | **Analysis of dissociation curves for hemoglobin and myoglobin.*** Contrast myoglobin and hemoglobin.
* Compare the oxygen dissociation curves of hemoglobin and myoglobin.
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| **D.6.S2** | **Identification of pneumocytes, capillary endothelium cells and blood cells in light micrographs and electron micrographs of lung tissue.*** Label the following structures on a micrograph of lung tissue:  type 1 pneumocyte, type 2 pneumocyte, capillary endothelium, basement membrane and blood cells.
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| **D.6.****NOS** | **Scientists have a role in informing the public—scientific research has led to a change in public perception of smoking.*** Describe how scientific evidence about the effects of smoking lead to a change in public perception of smoking.
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