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| **6.1.U1** | **The contraction of circular and longitudinal muscle of the small intestine mixes the food with enzymes and moves it along the gut.*** Outline the role of peristalsis in the digestive process.
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| **6.1.U2** | **The pancreas secretes enzymes into the lumen of the small intestine.*** List the name and substrate of the three major classes of enzymes secreted by the pancreas.
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| **6.1.U3** | **Enzymes digest most macromolecules in food into monomers in the small intestine.*** List the name, substrate and product of four pancreatic enzymes that hydrolyze food in the small intestine.
* List the name, substrate and product of six enzymes produced by gland cells in the small intestine wall.
* Describe why enzymes produced by gland cells in the small intestine wall often remain immobilized in the cell membrane.
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| **6.1.U4** | **Villi increase the surface area of epithelium over which absorption is carried out.*** List three adaptations that increase the surface area for absorption on the small intestine.
* Draw the villi as viewed in cross section.
* Label the following on a diagram of a villi:  capillary, epithelial cell, lacteal, and goblet cell.
* State the function of the following villi structures: capillary, epithelial cell, lacteal, and goblet cell.
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| **6.1.U5** | **Villi absorb monomers formed by digestion as well as mineral ions and vitamins.*** Define absorption.
* List materials absorbed by the villi cells of the small intestine.
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| **6.1.U6** | **Different methods of membrane transport are required to absorb different nutrients.*** List four methods of membrane transport required to absorb nutrients.
* Describe the absorption of triglycerides.
* Describe the absorption of glucose.
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| **6.1.A1** | **Processes occurring in the small intestine that results in the digestion of starch and transport of the products of digestion to the liver.*** Describe the structure of starch.
* Outline the source, function and specificity of amylase.
* Outline the digestion of maltose, maltotriose and dextrins into glucose.
* Describe absorption of glucose by villus epithelial cells.
* Describe transport of glucose into and through villi capillaries.
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| **6.1.A2** | **Use of dialysis tubing to model absorption of digested food in the intestine.*** Explain the use of dialysis tubing as a model for the small intestine.
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| **6.1.S1** | **Production of an annotated diagram of the digestive system.*** State the role of the digestive system.
* Draw a diagram of the human digestive system.
* Outline the function of the following digestive system structures:  mouth, esophagus, stomach, small intestine, pancreas, liver, gall bladder, and large intestine.
 |
| **6.1.S2** | **Identification of tissue layers in transverse sections of the small intestine viewed with a microscope or in a micrograph.*** Outline the function of the four layers of tissue found in the wall of the small intestine.
* Label the four layers of tissue found in the wall of the small intestine as viewed with a microscope or in a micrograph.
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| **6.1.****NOS** | **Use models as representations of the real world-dialysis tubing can be used to model absorption in the intestine.*** Explain the use of models in physiology research.
* State two examples of model systems used to study digestion.
* State limitations of using model systems in physiology research.
 |
| **6.2.U1** | **Arteries convey blood at high pressure from the ventricles to the tissues of the body.*** State the function of arteries.
* Outline the role of elastic and muscle tissue in arteries.
* State the reason for toughness of artery walls.
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| **6.2.U2** | **Arteries have muscle cells and elastic fibres in their walls.*** Describe the structure and function of the three layers of artery wall tissue.
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| **6.2.U3** | **The muscle and elastic fibres assist in maintaining blood pressure between pump cycles.*** Describe the mechanism used to maintain blood flow in arteries between heartbeats.
* Define systolic and diastolic blood pressure.
* Define vasoconstriction and vasodilation.
 |
| **6.2.U4** | **Blood flows through tissues in capillaries with permeable walls that allow exchange of materials between cells in the tissue and the blood in the capillary.*** Describe the structure and function of capillaries.
* Describe the cause and effect of diffusion of blood plasma into and out of a capillary network.
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| **6.2.U5** | **Veins collect blood at low pressure from the tissues of the body and return it to the atria of the heart.*** State the function of veins.
* Outline the roles of gravity and skeletal muscle pressure in maintaining flow of blood through a vein.
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| **6.2.U6** | **Valves in veins and the heart ensure circulation of blood by preventing backflow.*** Outline the structure and function of a pocket valve.
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| **6.2.U7** | **There is a separate circulation for the lungs.*** Draw a diagram to illustrate the double circulation system in mammals.
* Compare the circulation of blood in fish to that of mammals.
* Explain the flow of blood through the pulmonary and systemic circulations.
* Explain why the mammalian heart must function as a double pump.
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| **6.2.U8** | **The heart beat is initiated by a group of specialized muscle cells in the right atrium called the sinoatrial node.*** Define myogenic contraction.
* Outline the role of cells in the sinoatrial node.
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| **6.2.U9** | **The sinoatrial node acts as a pacemaker.*** State the reason why the sinoatrial node is often called the pacemaker.
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| **6.2.U10** | **The sinoatrial node sends out an electrical signal that stimulates contraction as it is propagated through the walls of the atria and then the walls of the ventricles.*** Describe the propagation of the electrical signal from the sinoatrial node through the atria and ventricles.
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| **6.2.U11** | **The heart rate can be increased or decreased by impulses brought to the heart through two nerves from the medulla of the brain.*** Outline the structures and functions of nervous tissue that can regulate heart rate.
* Describe factors that will increase heart rate.
* Describe factors that will decrease heart rate.
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| **6.2.U12** | **Epinephrine increases the heart rate to prepare for vigorous physical activity.*** Outline conditions that will lead to epinephrine secretion.
* Explain the effect of epinephrine on heart rate.
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| **6.2.A1** | **William Harvey’s discovery of the circulation of the blood with the heart acting as the pump.*** Outline William Harvey’s role in discovery of blood circulation.
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| **6.2.A2** | **Causes and consequences of occlusion of the coronary arteries.*** Describe the cause and consequence of atherosclerosis.
* Outline the effect of a coronary occlusion on heart function.
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| **6.2.A3** | **Pressure changes in the left atrium, left ventricle and aorta during the cardiac cycle.*** Explain the pressure changes in the left atrium, left ventricle and aorta during the cardiac cycle.
* Explain the relationship between atrial and ventricular pressure and the opening and closing of heart valves.
* Explain the atrial, ventricular and arterial pressure changes as illustrated on a graph of pressure changes during the cardiac cycle.
* Identify the time of opening and closing of heart valves on a graph o f pressure changes during the cardiac cycle.
 |
| **6.2.S1** | **Identification of the blood vessels as arteries, capillaries or veins from the structure of their walls.*** Compare the diameter, relative wall thickness, lumen diameter, number of wall layers, abundance of muscle and elastic fibres and presence of valves in arteries, capillaries and veins.
* Given a micrograph, identify a blood vessel as an artery, capillary or vein.
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| **6.2.S2** | **Recognition of the chambers and valves of the heart and the blood vessels connected to it in dissected hearts or in diagrams of heart structure.*** Label a diagram of the heart with the following structure names:  superior vena cava, inferior vena cava, pulmonary semilunar valve, aorta, pulmonary artery, pulmonary veins, aortic semilunar valve, left atrioventricular valve, left ventricle, septum, right ventricle, left atrium, right atrium and right atrioventricular valve.
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| **6.2.****NOS** | **Theories are regarded as uncertain- William Harvey overturned theories developed by the ancient Greek philosophy Galen on movement of blood in the body.*** Outline Galen’s description of blood flow in the body.
* Describe how Harvey was able to disprove Galen’s theory.
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| **6.3.U1** | **The skin and mucous membranes form a primary defense against pathogens that cause infectious disease.*** Define pathogen.
* State that skin and mucous membranes form the first line of defence against pathogens.
* Outline the role of skin, sebaceous glands and mucous membranes in the defence against pathogens.
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| **6.3.U2** | **Cuts in the skin are sealed by blood clotting.*** State two benefits of blood clotting when skin is cut.
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| **6.3.U3** | **Clotting factors are released from platelets.*** Outline two roles of platelets in the blood clotting cascade.
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| **6.3.U4** | **The cascade results in the rapid conversion of fibrinogen to fibrin by thrombrin.*** Describe the blood clotting cascade, including the role of platelets, clotting factors, thrombin, fibrinogen and fibrin.
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| **6.3.U5** | **Ingestion of pathogens by phagocytic white blood cells gives non-specific immunity to diseases.*** State the white blood cells are the second line of defence against pathogens.
* Outline the function of phagocytic white blood cells in defense against pathogens.
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| **6.3.U6** | **Production of antibodies by lymphocytes in response to particular pathogens gives specific immunity.*** Define “specific immune response.”
* Contrast antigen and antibody.
* Describe the structure and function of antibodies.
* State the function of plasma cells and memory cells.
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| **6.3.U7** | **Antibiotic blocks processes that occur in prokaryotic cells but not in eukaryotic cells*** Define antibiotic.
* Outline the mechanisms by which antibiotics kill bacteria.
* Explain why antibiotics are ineffective against viruses.
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| **6.3.U8** | **Viruses lack a metabolism and cannot therefore be treated with antibiotics.*** Explain why antibiotics are ineffective against viruses.
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| **6.3.U9** | **Some strains of bacteria have evolved with genes that confer resistance to antibiotics and some strains of bacteria have multiple resistance.** |
| **6.3.A1** | **Causes and consequences of blood clot formation in coronary arteries.*** State the function of the coronary arteries.
* Define coronary thrombosis.
* List sources of arterial damage that increase the risk of coronary thrombosis.
* List factors that are correlated with an increased risk of coronary thrombosis and heart attack.
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| **6.3.A2** | **Effects of HIV on the immune system and methods of transmission.*** Describe the consequences of the HIV on the immune system.
* Outline the relationship between HIV and AIDS.
* List ways the HIV virus is spread.
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| **6.3.A3** | **Florey and Chain’s experiments to test penicillin on bacterial infections in mice.*** Explain methods and results of Florey and Chain’s experiments.
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| **6.3.****NOS** | **Risks associated with scientific research- Florey and Chain’s tests on the safety of penicillin would not be compliant with current protocol on testing.*** Compare allowable research risks of the past with those of the present.

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| **6.4.U1** | **Ventilation maintains concentration gradients of oxygen and carbon dioxide between air and alveolu and blood flowing in adjacent capillaries.*** Define gas exchange and ventilation.
* State the location of gas exchange in humans.
* Outline the mechanism of gas exchange in humans.
* Draw a diagram showing the structure of an alveolus and an adjacent capillary.
 |
| **6.4.U2** | **Type I pneumocytes are extremely thin alveolar cells that are adapted to carry out gas exchange.*** Describe how the structure of the alveoli increases surface area for gas exchange.
* Outline the structure of type 1 pneumocytes.
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| **6.4.U3** | **Type II pneumocytes secrete a solution containing surfactant that creates a moist surface inside the alveoli to prevent the sides of the alveolus adhering to each other by reducing surface tension.*** Outline the structure and function of type II pneumocytes.
* Describe two functions of the fluid secreted by type II pneumocytes.
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| **6.4.U4** | **Air is carried to the lungs in the trachea and bronchi and then to the alveoli in bronchioles.*** Outline the flow of air into the lungs.
* State the role of cartilage in the trachea and bronchi.
* State the role of smooth muscle fibres in the bronchioles.
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| **6.4.U5** | **Muscle contraction causes the pressure changes inside the thorax that force air in and out of the lungs to ventilate them.*** State the relationship between gas pressure and volume.
* Outline the pressure and volume changes that occur during inspiration and expiration.
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| **6.4.U6** | **Different muscles are required for inspiration and expiration because muscles only do work when they contract.*** Explain the contraction and relaxation of muscles through the use of antagonistic muscle pairs.
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| **6.4.A1** | **External and internal intercostal muscles, and diaphragm and abdominal muscles as examples of antagonistic muscle action.*** Outline the direction of movement of the diaphragm and rib-cage during inspiration and expiration.
* Describe the antagonistic muscle contraction and relaxation required to move the rib-cage and diaphragm during inhalation and expiration.
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| **6.4.A2** | **Causes and consequences of lung cancer.*** Outline the causes of lung cancer.
* List symptoms of lung cancer.
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| **6.4.A3** | **Causes and consequences 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.
 |
| **6.4.S1** | **Monitoring of ventilation in humans at rest and after mild and vigorous exercise. (Practical 6)*** Identify the manipulated and responding variables in a test of the effect of exercise on ventilation.
* Outline techniques for measuring ventilation rate or lung tidal volume.
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| **6.4.****NOS** | **Obtain evidence for theories- epidemiological studies have contributed to our understanding of the causes of the lung cancer.*** Define epidemiology.
* Outline how epidemiological studies contributed to understanding the association between smoking and lung cancer
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| **6.5.U1** | **Neurons transmit electrical impulses.*** State the function of the nervous system.
* Draw the structure of a neuron.
* Annotate a neuron drawing with the name and function of the following cell parts:  dendrites, axon and cell body.
 |
| **6.5.U2** | **The myelination of nerve fibres allows for saltatory conduction.*** Outline the structure and function of myelin.
* State the role of Schwann cells in formation of myelin.
* Outline the mechanism and benefit of saltatory conduction.
* Compare the speed of nerve impulse conduction myelinated and non-myelinated neurons.
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| **6.5.U3** | **Neurons pump sodium and potassium ions across their membranes to generate a resting potential.*** Define resting potential.
* Explain three mechanisms that together create the resting potential in a neuron.
* State the voltage of the resting potential.
 |
| **6.5.U4** | **An action potential consists of depolarization and repolarization of the neuron.*** Define action potential, depolarization and repolarization.
* Outline the mechanism of neuron depolarization.
* Outline the mechanism of neuron repolarization.
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| **6.5U5** | **Nerve impulses are action potentials propagated along the axons of neurons.*** Define nerve impulse.
* Describe how nerve impulses are propagated along the neuron axon.
* Outline the cause and consequence of the refractory period after depolarization.
 |
| **6.5.U6** | **Propagation of nerve impulses is the result of local currents that cause each successive part of the axon to reach the threshold potential.*** Explain how the movement of sodium ions propagates an action potential along an axon.
* Explain movement of sodium ions in a local current.
* Describe that cause of and effect of membrane potential reaching the threshold potential.
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| **6.5.U7** | **Synapses are junctions between neurons and between neurons and receptors or effector cells.*** Define synapse, synaptic cleft and effector.
* State the role of neurotransmitters.
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| **6.5.U8** | **When presynaptic neurons are depolarized they release a neurotransmitter into the synapse.*** Outline the mechanism of synaptic transmission, including the role of depolarization, calcium ions, diffusion, exocytosis, neurotransmitters, receptors, sodium ions, sodium channels, threshold potential and action potential.
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| **6.5.U9** | **A nerve impulse is only initiated if the threshold potential is reached.*** Outline the role of positive feedback and sodium ions in the reaching of threshold potential.
* Explain why some synaptic transmissions will not lead to an action potential in a postsynaptic cell.
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| **6.5.A1** | **Secretion and reabsorption of acetylcholine by neurons at synapses.*** Outline the secretion, action, reabsorption and formation of acetylcholine.
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| **6.5.A2** | **Blocking of synaptic transmission at cholinergic synapses in insects by binding of neonicotinoid pesticides to acetylcholine receptors.*** Outline the mechanism of action of neonicotinoids use as insecticides.
* Define cholinergic synapse.
* Compare the proportion of cholinergic synapses in insects and humans.
* State why neonicotinoids insecticides are not highly toxic to humans.
 |
| **6.3.S1** | **Analysis of oscilloscope traces showing resting potentials and action potentials.*** Outline the use of oscilloscopes in measuring membrane potential.
* Annotate an oscilloscope trace to show the resting potential, action potential (depolarization and repolarization), threshold potential and refractory period.
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| **6.5.****NOS** | **Cooperation and collaboration between groups of scientists-biologists are contributing to research into memory and learning.*** ​Describe the effects of cooperative and collaboration between groups of scientists.
* State an example of how people from multiple scientific disciplines are collaborating to understand learning and/or memory.
* Compare the growth and fixed mindsets effect on learning.
* Explain the basic biology of learning.
* Draw and explain the Ebbinghaus forgetting curve.
* Outline the impact of repetition and review on learning.
* State the impact of multitasking on memory consolidation.

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| **6.6.U1** | **Insulin and glucagon are secreted by beta and alpha cells of the pancreas respectively to control blood glucose concentrations.*** Explain the control of blood glucose concentration, including the roles of glucagon, insulin and the alpha and beta cells in the pancreatic islets.
 |
| **6.6.U2** | **Thyroxin is secreted by the thyroid gland to regulate the metabolic rate and help control body temperature.*** Describe the structure and function of thyroxin.
* Outline thyroxin’s role in body temperature regulation.
* List symptoms of thyroxin deficiency.
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| **6.6.U3** | **Leptin is secreted by cells in adipose tissue and acts on the hypothalamus of the brain to inhibit appetite.*** State that leptin is a protein hormone.
* Outline the mechanism of action of leptin.
* Describe the role and discovery of the ob allele in obese mice.
 |
| **6.6.U4** | **Melatonin is secreted by the pineal gland to control circadian rhythms.*** Define circadian rhythm.
* Describe the secretion and action of melatonin.
* Outline the mechanism that regulates melatonin secretion in response to the day-night cycle.
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| **6.6.U5** | **A gene on the Y chromosomes causes embryonic gonads to develop as testes and secretes testosterone.*** Describe the mechanism by which the SRY gene  regulates embryonic gonad development.
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| **6.6.U6** | **Testosterone causes pre-natal development of male genitalia and both sperm production and development of male secondary sexual characteristics during puberty.*** Outline role of testosterone in prenatal development of male genitalia.
* State testosterone's role in stimulating the primary sexual characteristic of males.
* List secondary sexual characteristics triggered by testosterone at puberty.
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| **6.6.U7** | **Estrogen and progesterone cause pre-natal development of female reproductive organs and female secondary sexual characteristics during puberty.*** State the sources of estrogen and progesterone used in embryonic development.
* Describe prenatal development of female reproductive organs.
* List secondary sexual characteristics triggered by estrogen and progesterone at puberty.
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| **6.6.U8** | **The menstrual cycle is controlled by negative and positive feedback mechanisms involving ovarian and pituitary hormones.*** Outline events occurring during the follicular and luteal phases of the menstrual cycle.
* State the source and location of action of hormones in the menstrual cycle, including FSH (follicle stimulating hormone), LH (luteinising hormone), estrogen and progesterone.
* Outline the role of hormones in the menstrual cycle, including FSH (follicle stimulating hormone), LH (luteinising hormone), estrogen and progesterone.
* Describe the negative feedback loops that regulates secretion of FSH.
* Describe the positive feedback loop that regulates secretion of estrogen.
* Annotate a graph showing hormone levels in the menstrual cycle, illustrating the relationship between changes in hormone levels and follicular development, ovulation, changes to the corpus luteum, menstruation and the thickening of the endometrium.
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| **6.6.A1** | **Causes and treatment of Type I and Type II diabetes.*** Distinguish between causes of type I and type II diabetes.
* Distinguish between treatment of type I and type II diabetes.
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| **6.6.A2** | **Testing of leptin on patients with clinical obesity and reasons for the failure to control the disease.*** Explain the double blind study that tested the effect of leptin treatment on human obesity.
* Outline role of leptin resistance in human obesity.
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| **6.6.A3** | **Causes of jet lag and use of melatonin to alleviate it.*** State symptoms of jet lag.
* Outline the biological cause of jet lag.
* Describe use of melatonin in treatment for jet lag.
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| **6.6.A4** | **The use of IVF of drugs to suspend the normal secretion of hormones, followed by the use of artificial doses of hormones to induce superovulation and establish a pregnancy.*** Define in vitro fertilization.
* Outline the process of in vitro fertilisation including down-regulation, superovulation, harvesting, fertilization and implantation.
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| **6.6.A5** | **William Harvey’s investigation of sexual reproduction in deer.** |
| **6.6.S1** | **Annotate diagrams of the male and female reproductive system to show names of structures and their functions.*** Label a diagram of the male reproductive system, including the bladder, sperm duct, penis (with foreskin and erectile tissue), urethra, testis, scrotum, epididymis, prostate gland and seminal vesicle.
* Outline the function of the following male reproductive structures:  testis, scrotum, epididymis, sperm duct, seminal vesicle, prostate gland, urethra and penis.
* Label a diagram of the female reproductive system, including the ovary, uterus, bladder, urethra, vulva, vagina, cervix and oviduct.
* Outline the function of the following female reproductive structures: ovary, oviduct, uterus, cervix, vagina, and vulva.
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| **6.6.****NOS** | **Developments in scientific research follow improvements in apparatus- William Harvey was hampered in his observational research into reproduction by lack of equipment. The microscope was invented 17 years after his death.** |

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