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**Knowledge Rich Curriculum Plan**

Biology 3.6

Organisms Respond to changes in their internal and external environments

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| **Lesson/Learning Sequence** | **Intended Knowledge:**  *Students will know that…* | **Prior Knowledge:**  *In order to know this, students need to already know that…* | **Tiered Vocabulary and Reading Activity** |
| **Survival and response Plant Growth** | Students will know that organisms increase their chance of survival by responding to changes in their environment. In flowering plants, specific growth factors move from growing regions to other tissues, where they regulate growth in response to directional stimuli. Students will know that plants sense the direction of light and grow towards it to maximise light absorption for photosynthesis. They sense gravity so the roots and shoots grow in the right direction. Climbing plants have a sense of touch so they can attach and grow to the sun. A tropism is a response of a plant to a directional stimulus (Change in the environment). Positive tropism is towards and stimulus and negative tropism is away from a stimulus. Phototropism is the plant response to light. Gravitropism is the plant response to gravity. Auxins are hormone like chemicals that speeds up or slows down plant growth. Auxins are made in the root tips and shoot tips and move to other parts of the plant. Auxins diffuse in the plant and cause cells to elongate. If the tip is removed the plant will not grow. Auxin stimulates growth in the shoot but inhibits growth in the roots. Students will learn that Indoleacetic acid (IAA) is an important auxin that is produced in the tips of shoots and roots in flowering plants. It is moved around the plant by diffusion and active transport (short distances) and via the phloem (long distances). Different parts of the plant will therfore have different concentrations of IAA which leads to uneven growth of the plant. Students will describe phototropism and geotropism and be able to explain experimental data. | Students who have studies triple science should already know the auxin in a hormone that affects plant growth. | Tropism  Hormone  Stimulus  Phototropism  Gravitropism  Auxin  Indoleacetic acid (IAA)  Thigmotropism  Elongate  Inhibit |
| **Taxis and Kinesis** | Students will know that Organisms respond to changes in their internal and external environment. A stimulus is a change in the environment. Mobile organisms (those that move around a lot) use Tactic responses (taxis) directional movement in response to a stimulus. The direction of the stimulus affects the response. Mobile organisms use Kinetic responses (Kinesis) non directional random movement in response to a stimulus. Here the intensity affects the response. Students will investigate the response of woodlice using choice chambers (Required Practical) | Students will already know what woodlice area and where they are found. Students will know that organisms respond to things like light, sound, pressure, temperature as part of their survival | Taxis  Kinesis  Stimulus |
| **Reflex Arc GCSE Review** | Students will know that a reflex is a fast, (involuntary) automatic response that doesn't involve the conscious part of the brain. Reflexes protect us from danger. Receptors are cells or proteins on the cell surface membranes that detect stimuli (changes in the environment). Effectors are muscles or glands that bring about a response to a stimulus. Students will learn that there are 3 types of neurone; Sensory which transmit electrical impulses from receptors to the CNS. Motor neurones transmit electrical impulses from the CNS to the effectors. Relay neurones (inter-neurones) transmit electrical impulses between sensory and motor neurones. Students will learn that when the nerve impulse reaches the end of the neurone, chemical messenger- neurotransmitter is released . NTs are quickly removed once they’ve done their job so the response is short lived. Students will learn how to use SRSRMER to recall the stages of the reflex arc. Students will learn how to apply this to various examples including responding to hot objects (thermoreceptors involved) Students will learn that if there is a relay neurone involved, then the reflex can be overridden. | Students have previously studied the nervous system in GCSE and should recall that neurones are specialised cells that carry electrical impulses around the body. Students will know that the CNS is made up of the brain and spinal cord. Students will know that reflex actions protect us from dangers in the environment and that dangers in the environment are called stimuli. | Reflex  Involuntary  Receptor cells  Effector  Neurone  Neurotransmitter |
| **Receptors-**  **Pacinian Corpuscle** | Students will learn that there are different receptors for detecting different environmental changes. (Specific)  Photoreceptors detect changes in light, thermoreceptors – temp, chemoreceptors detect changes in chemicals/taste/smell (eg CO2 in the blood), Baroreceptors detect changes in blood pressure, mechanoreceptors detect changes in pressure/vibrations (Pacinian Corpuscle)  Resting potential = not stimulated (approx. -70mV)  There is a difference in charge inside and outside the cell. More negative inside so creates a voltage (PD) . Maintained through sodium potassium pump. More permeable to K+. Na+ pumped out, K=+ in  When stimulated, cell membrane excites and becomes more permeable so more ions can move in and out. This change in PD is called a generator potential. If this exceeds **threshold level** then AP is generated.  An action potential has an all-or-nothing property which means that any stimulus producing a lower than threshold potential will potentially result in no response, while a stimulus producing threshold potential will produce a full response in the excitable cell. Therefore, increasing the strength of the stimulus will not increase the strength of the action potential but rather increase the frequency of the action potential.  Students will learn the various parts of the Pacinian corpuscle and how when the Na+ channels become distorted by pressure, they open to allow Na+ to diffuse in, initiating an action potential. | Students will already know that receptors detect changes in the environment. They convert the energy of the stimulus into electrical energy to be carried by nerve impulses | Resting potential  Generator potential  Action Potential  Threshold |
| **Photoreceptors and visual acuity** | Students will learn that photoreceptors are found at the retina at the back of the eye and detect light.  In particular the fovea is an area of the retina that contains lots of receptors. Nerve impulses are carried from the retina via the optic nerve to the brain.  Blind spot is an area where there are no photoreceptors.  When light enters the eye, it hits the photoreceptors and is absorbed by optical pigments. Light bleaches the pigments which causes a chemical change altering the permeability of the cell membrane to sodium ions. If a certain threshold is reached a generator potential is created and a nerve impulse is sent along a bipolar neurone.  Rods contain rhodopsin (sensitive to dim light) cones contain iodopsin (sensitive to bright light)  Cones are sensitive to red, green and blue- when stimulated in different proportions, different colours are seen.  Students will learn that Rods are very sensitive to light (work well in dim light) have many rods joining to one bipolar neurone so lots of weak GPs combine to reach the threshold for an AP.  Cones are less sensitive to light (work best in bright light) since one cone joins to one bipolar neurone so more light needed to reach threshold for AP.  Students will learn that rods give low visual acuity because many rods join to one bipolar neurone so light from 2 points close together cannot be told apart.  Cones have high visual acuity because cones are close together and one cone joins one bipolar neurone. When light from 2 points hit 2 cones 2 Aps can be generated to go to the brain so 2 points can be interpreted. | Students should be able to label a diagram of the eye (parts and what happens).  Students should know that light enters through the pupil, the iris is the coloured part of the eye and contains muscles to control the size of the pupil. Light rays are focussed by the lens onto the retina at the back of the eye (Refraction) | Photoreceptors  Visual Acuity  Fovea  Optical Pigments  Monochromatic  Trichromatic  Bipolar neurone |
| **Control of Heart Rate** | Students will know that cardiac muscle is myogenic (contracts and relaxes without receiving signals from nerves) Students will be able to label the Sinoatrial Node (SAN), Atrioventricular node (AVN), Purkyne fibres and bundles of His on a diagram of the heart. Students will know that the SAN is like a 'pacemaker' and sends out regular waves of electrical activity to the atrial walls. This causes the left and right atria to contract at the same time. Students will know that there is a band on non conductive collagen tissue preventing the waves of electrical activity passing from the atria to the ventricles. Instead waves travel from the SAN to the Atrioventricular node (AVN). The AVN is responsible for passing waves of electrical activity on the bundles of His. The bundles of HIs is a small group of muscle fibres responsible for conducting the waves of electrical activity between the ventricles to the bottom of the heart (apex) The bundle then splits into finer muscle fibres called Purkyne tissue which carries the electrical activity to the muscular walls of the right and left ventricles causing them to contract simultaneously (together) from the bottom up. | Students will already know the main structures of the heart and valves. Students will already be able to describe the stages of the cardiac cycle and how to calculate cardiac output (volume of blood pumped out of the heart per minute (cm3min-1) | Myogenic  Pace maker  Non conductive  Apex  Simultaniously |
| **Communication between the heart and brain** | Students will know that the heart has to respond to internal stimuli (changes in the internal conditions eg CO2 levels, pH, O2, blood pressure) Students will know that heart rate is subconsciously controlled by a part of the brain called the medulla. Students will learn that there are 2 types of receptors involved; pressure (baroreceptors) and chemoreceptors. Pressure receptors are located in the aorta and carotid arteries and are stimulated by changes in pressure. Chemoreceptors are located in the aorta, carotid arteries and in the medulla to monitor changes in pH, O2, CO2. Electrical impulses are sent to the medulla along sensory neurones. The medulla processes the information and sends impulses along the SAN along sympathatic (unconscious actions fight/flight)) or parasympathatic neurones (rest and digest). | Students should already know the location of the aorta and carotid arteries. Triple science students will know the location of the medulla in the brain. Students will know that sensory neurones carry electrical impulses from receptor cells to the CNS. | Medulla  Carotid Arteries  Sympathetic  Parasympathatic |
| **Homeostasis** | Students will learn the definition: Homeostasis involves physiological control systems that maintain the internal environment within restricted limits.  Students will learn why blood pH should be kept constant 7.35, any deviation from normal can result in enzymes becoming denatured.  Blood glucose levels must be maintained within narrow limits.  Students will learn that it is beneficial to have separate mechanisms involving negative feedback controls departures in different directions from the original state giving a greater degree of support. Students will learn about oxytocin in positive feedback. Students will learn how to use pH=-log10[H+} to calculate pH and how to interpret enzyme activity graphs | Students will define homeostasis as the maintenance of a constant internal environment  Students will know that core body temperature is 37oC and this needs to be maintained for effective enzyme activity. pH also affects enzyme activity.  Students will already know that blood glucose concentration is maintained by the pancreas and liver  Students will know that negative feedback mechanisms act to restore normal levels | Homeostasis  Denatured  Deviation |
| **Control of Blood Glucose Concentration** | Students will learn that blood glucose concentration is around 90mg per 100cm3 of blood.  Hormones are chemicals released by glands which travel through the blood stream to target cells.  Insulin and glucagon are secreted by clusters of cells in the pancreas called the islets of Langerhans. These contain alpha and beta cells.  Beta cells secrete insulin and alpha cells secrete glucagon.  glycogenesis (synthesis of glycogen from glucose) glycogenolysis (breakdown of glycogen to glucose) gluconeogenesis (conversion of glycerol/amino acids to glucose)  Students will learn that adrenaline and glucagon require second messengers . This involves involving adenyl cyclate, cyclic AMP (cAMP) and protein kinase. | Students should already be able to give reasons for increases of decreases in blood glucose concentration  Students will already know that when blood glucose levels are high, insulin is released from the pancreas which is detected by receptor cells on the liver and the liver will store the excess glucose as glycogen  Students will already know that when blood glucose levels are low, glucagon is released from the pancreas which is detected by receptor cells on the liver and the liver will release the stored as glycogen. | Glycogenesis  glycogenolysis  gluconeogenesis  islets of Langerhans  alpha cells  beta cells |
| **Diabetes** | **Type 1 diabetes**  Immune system attacks the Beta cells in Islets of Langerhans  Beta cells don’t make insulin  Hyperglycaemia following a meal  Kidney’s can’t reabsorb all of the glucose so one symptom is glucose in urine  Treatment – Insulin Injections  Cause- Unknown. Genetic links/Viral infection  **Type 2 diabetes**  Late onset. Links to obesity, family history  Beta cells in Islets of Langerhans don’t produce enough insulin or body doesn’t respond.  Treatment – Diet  Cause- Unknown. Genetic links/Viral infection  Students will learn how to carry our a quantitative Benedict’s test glucose in a sample by creating a calibration curve. This will involve making up serial dilutions, using a water bath and taking readings using the colorimeter.  Results will be analysed to diagnose which patients have diabetes. | Students will know that there are 2 types of diabetes- Type 1 don’t make insulin, Type 2 make insulin but liver doesn’t respond  Students will know the treatments/management of this disease.  Students will know that Benedict’s reagent is used to test for sugar and a colour change blue to red is observed once heated. | Hyperglycaemia  Hypoglycaemia  Quantitative  Qualitative |
| **Marking and Feedback Point** | **Students will complete and marking and feedback point** |  |  |
| **Kidney (GCSE REVIEW)** |  | Kidney structure and function is a Triple Science only topic so GCSE basic knowledge will be reviewed/Taught.  Students will already know that the job of the kidneys is to filter the blood and urine is produced. Students will know that dialysis is a treatment offered to patients whilst they wait for an organ transplant. Students will already be able to suggest some pros and cons of transplants. |  |
| **Nephron structure** | Students will learn that osmoregulation is the process of maintaining salt and water balance (osmotic balance) across membranes within the body.  Hypothalamus- is the part of the brain that contains ADH receptors  posterior pituitary- the back part of the pituitary that secretes ADH  Antidiuretic hormone (ADH)- hormone that makes collecting duct walls more permeable to water so more water can be reabsorbed into the blood.  The kidneys contain millions of tiny nephrons which make up a complex filtration system.  Students with learn that the nephron consists of the glomerulus, Bowman’s capsule, proximal convoluted tubule, Loop of Henle, distal convoluted tubule, collecting duct.  Blood enters via the renal artery and enters smaller arterioles in the cortex of the kidney. In the glomerulus, high pressure filtration occurs. Liquid and small molecules are forced out and into the Bowman’s capsule. The liquid and small molecules (glomerular filtrate) pass through 3 layers (capillary wall, basement membrane and epithelium of Bowman’s capsule. Large molecules like proteins and red blood cells remain in the blood as they are too big to pass through the membrane.  The glomerular filtrate continues to pass through to the proximal convoluted tubule, Loop of Henle, distal convoluted tubule and then collecting duct to the ureter to be excreted from the body.  Selective reabsorption occurs in the proximal convoluted tubule, loop of Henle and distal convoluted tubule.  The PCT is adapted for absorption by having microvilli to increase the surface area, and lots of mitochondria to release energy for active transport.  Glucose, is absorbed by AT and FD.  Water enters the blood by osmosis.  Sodium ions move out by AT | Students will know that | Osmoregulation  Hypothalamus  posterior pituitary gland  Antidiuretic hormone (ADH)  Glomerular filtrate  Basement membrane |
| **Controlling blood water potential** | Osmoreceptors in the brain (hypothalamus)  When water potential decreases, water will move out of cells by osmosis. This is detected by the hypothalamus and the posterior pituitary gland. ADH is released which makes the walls of the collecting duct more permeable to water so more water is reabsorbed. Less urine is produced.  When water potential increases, this is detected so less ADH is produced meaning the walls of the collecting duct remain less permeable so less water is reabsorbed. A larger volume of more dilute urine is produced. | Water is essential to keep the body functioning so this must be kept constant. Any changes could cause cells to undergo lysis/crenation. Water is lost from the body through sweating and excretion.  If water potential is too high a higher volume of more dilute urine is produced. If water potential is too low, a lower volume of more concentrated urine is produced. | Osmoregulation  Anti diuretic hormone |