

# BIOLOGY

## Experiment outline paragraphs

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### **Describe how you modelled natural selection.**

A game was played with cards of different colours representing lizards on a yellow sheet of cardboard. In the first round, the lizards were 'crossed' and the phenotypes of their offspring were determined by the roll of a die and a probability table. In the second round, the player becomes the predator and they have 3 seconds to pick up (to 'eat') as many lizards as possible from the table. The orange and especially the yellow lizards are better camouflaged and so are predated the least. After several repetitions of these rounds, the red lizards invariably became extinct and the yellow lizards came to predominate in the population. This is because in the model they were the best adapted to their environment and so survived to pass on their favourable yellow genes to their offspring.

### **Describe how you performed a first-hand investigation to demonstrate the effect of environment on phenotype.**

The effect of light upon the expression of the green colour in the phenotype of grass plants was investigated by exposing the control group of plants to light under a clear sheet and denying the experimental group light by covering them with a black sheet. After a week the control group was green whilst the experimental group was yellow due to this differing environmental factor. This is because the expression of the gene that codes for chlorophyll which causes this green colour requires the presence of light.

### **Describe how you performed a first-hand investigation to test the effect of temperature on enzyme activity.**

The substrate of hydrogen peroxide was added to test tubes in water baths of different temperatures. Potato puree, containing the enzyme catalase was then added to the test tubes. This increased the rate of decomposition of hydrogen peroxide into water and oxygen. Detergent was added to the test tubes so that the rate of reaction could be quantified by measuring the height of oxygen bubbles up the side of the test tube with a ruler. The height of the bubbles across the different temperatures were compared and the approximate optimum temperature was that for which the test tube had the highest bubbles and hence the greatest rate of reaction.

### **Describe how you performed a first-hand investigation to test the effect of pH levels on enzyme activity.**

The substrate of hydrogen peroxide was added to test tubes, as well as differing amounts of sodium hydroxide to alter the pH levels. The control group did not have any sodium hydroxide added. Potato puree, containing the enzyme catalase was then added to the test tubes. This increased the rate of decomposition of hydrogen peroxide into water and oxygen. Catalase breaks down hydrogen peroxide (in cells) into water and oxygen gas. Detergent was added to the test tubes so that the rate of reaction could be quantified by measuring the height of oxygen bubbles up the side of the test tube with a ruler. The height of the bubbles across the different pH levels were compared and the approximate optimum pH level was that for which the test tube had the highest bubbles and hence the greatest rate of reaction.

**Describe how you performed a first-hand investigation to test the effect of substrate concentration on enzyme activity.**

Differing amounts of the substrate of hydrogen peroxide were added to test tubes. Potato puree, containing the enzyme catalase was then added to the test tubes. This increased the rate of decomposition of hydrogen peroxide into water and oxygen. Catalase breaks down hydrogen peroxide (in cells) into water and oxygen gas. Detergent was added to the test tubes so that the rate of reaction could be quantified by measuring the height of oxygen bubbles up the side of the test tube with a ruler. The height of the bubbles across the different substrate concentrations were compared and the approximate optimum substrate concentration was that for which the test tube had the highest bubbles and hence the greatest rate of reaction.

**Describe how you performed a first-hand investigation to demonstrate the effect of dissolved carbon dioxide on the pH of water in class.**

Universal indicator was added to water and a pH scale was used to measure the initial pH. Exhaled air containing CO<sub>2</sub> was bubbled into the water through a straw for 5 minutes. The pH was then measured again and compared with the initial recording to find the change. The CO<sub>2</sub> reacted with water to form carbonic acid which reduced the pH of the water, making it more acidic.

**Describe how you performed a first-hand investigation to estimate the size of red and white blood cells.**

The diameter of the high-power field of view of a microscope was estimated by placing a minigrd on the stage, looking through the eyepiece and counting the number of 1mm increments fitting across the diameter. A prepared slide of red and white blood cells was then examined in this field of view and the number of red blood cells (RBC) fitting across the diameter was counted. The size of an RBC was estimated by dividing the diameter by this number. The size of a white blood cell was then estimated by comparing it to the size of the RBCs under the microscope.

**Describe how you performed a first-hand investigation to investigate the structure of the mammalian kidney by dissection.**

A scalpel was used to cut a longitudinal section of the mammalian kidney containing the renal artery, renal vein and ureter. This was investigated with a hand lens to also identify the cortex, medulla and pelvis. A microscope was used to identify the nephrons. The appearance of the structures were noted and then related to their functions using second-hand data.

**Describe how you performed a first-hand investigation to gather information about structures in plants that assist in the conservation of water.**

A hand lens and a microscope was used to investigate various cuttings from xerophyte plants and their structural adaptations to survive in their arid environment were noted. For instance, eucalypt and hakea cuttings had woody fruits, for they required less water to grow. Hakea leaves also had sunken stomata to minimise water loss by transpiration. Mulga cuttings had needle-like leaves to minimise their surface-area exposed to the sun's radiation and hence also reduce water loss by transpiration. These structures were observed and recorded in a table.

### **Describe how you performed a first-hand investigation to identify microbes in food or in water.**

Various water samples from different sources such as bottled water, seawater and pond water were added to an agar nutrient medium on petri dishes. The control group was an agar plate with no water added. They were incubated at 30° for 24 hours and then they were removed. The growth of microbes on each plate was observed and compared with the others with the naked eye. Furry fungi and smooth bacteria colonies were observed. The water containing the most microbes was identified to be the cultures for the plates that contained the most and the most variety of microbial growths. The control group also had fungal colonies however, indicating that the nutrient medium was contaminated, so this type of microbe growth was omitted from the results.

### **Describe how you performed a first-hand investigation to model Pasteur's experiment to identify the role of microbes in decay.**

A nutrient-rich broth was added to flasks which were placed on a hot plate to boil to kill any microbes that may be in the broth (sterilisation). They were then removed and half of them were left open-topped. The other half had their tops plugged with rubber stoppers, modelling the swan-necks of half of the flasks in Pasteur's experiment. These prevented the entry of microbes. They were then placed in a storage location together for 2 weeks and when removed, the differences in the appearance of the broth and the growth of microbes between the experimental groups were observed. The broth of the closed-top flasks had not changed in appearance, for microbes of decay could not enter the flasks. Contrarily, the broth of the open-topped flasks had turned dark in colour and floating fungal colonies were observed. Microbes had entered and multiplied in the broth and decomposed it.

### **Describe how you performed a first-hand investigation to model the process of accommodation by passing rays of light through convex lenses of different focal lengths.**

A lens was set up in front of a screen of white paper stuck to the side of a box. A candle was placed directly in front of it. The distance of the lens from the light source was adjusted to find when it focussed a clear image on the paper. At this point, the distance between the lens and the paper is the focal length. This procedure was repeated with lenses of different thicknesses and their focal lengths were recorded. The focal length was found to decrease as the lenses became thicker and increase as the lenses became thinner. This model differed from accommodation in the human eye, for multiple lenses of fixed focusses were used to adjust the focal length to form a clear image on the screen/retina, as opposed to one lens of varying thickness.

### **Describe how you performed an investigation to examine plant shoots and leaves and gather first-hand information of evidence of pathogens and insect pests.**

An area of vegetation was examined with the naked eye for plant pathogens and insect pests. When a plant pathogen was found, a cutting was taken and it was stored in a plastic bag. When an insect pest was found, it was photographed with the camera. Cuttings and photographs were then examined and observations recorded.

### **Describe how you performed a first-hand investigation of a mammalian eye to gather first-hand data to relate structures to functions.**

Fatty tissue was removed from around the eyeball using scissors, a scalpel and forceps. The external features of the eye were noted including the optic nerve, sclera and cornea. A line was cut around the circumference of the eye noting the aqueous humor, pupil, iris and retina. The lens was then removed and noted as well as the vitreous humor within the cornea. The magnifying effects of the lens were observed by placing it on newspaper and reading the text through it magnified. The experiment and equipment were disposed of and submitted in sanitary manners. The noted structures were related to their functions based on first-hand observations and second-hand data.

**Describe how you performed a first-hand investigation to gather data to identify the relationship between wavelength, frequency and pitch of a sound.**

Electronic leads were used to connect a power point to a transformer and this to a cathode ray oscilloscope (CRO). This was connected to a microphone. When the components were turned on, sounds varying in pitch were voiced into the microphone and the waves plotted were observed on the CRO and plotted on graph paper. From this it was found that short wavelength waves have high frequencies and a higher pitch, whilst long wavelength waves have low frequencies and a lower pitch.

**Describe how you performed a first-hand investigation using stained prepared slides and/or electron micrographs to gather information about the structure of neurones and nerves.**

Stained prepared slides of nerves and neurons were placed on the stage of a microscope. They were observed by looking through the eyepiece. Observations were also taken upon viewing electron micrographs of these structures. Labelled diagrams of nerves and neurons were constructed using paper and pencils using these observations.

**Describe how you performed a first-hand investigation to examine an appropriate mammalian brain or model of a human brain to gather information to distinguish the cerebrum, cerebellum and medulla oblongata and locate the regions involved in speech, sight and sound perception.**

A model of a human brain was examined. On this was identified the medulla oblongata. This is a white cord forming the lower portion of the brainstem. The cerebrum is the bulbous structure composing the uppermost and the largest portion of the brain. The cerebellum is the smaller structure protruding from the base of the cerebrum. It has a striped appearance.

Visual perception is conducted by the occipital lobe. This is located towards the back of the cerebral cortex.

Speech perception are conducted by the Broca's area and Wernicke's area. The former is located on the left hemisphere of the frontal lobe. The latter is located on the intersection between the temporal and parietal lobes.

Sound perception is conducted by the primary auditory cortex. This is located on the uppermost regions of the temporal lobes.

**Describe how you performed a first-hand investigation to gather first-hand data to draw transverse and longitudinal sections of phloem and xylem tissue.**

A stick of celery with leaves still attached was left to stand overnight in a beaker of water containing red food dye so that the water would flow upwards through the xylem, dying them to make them visible to the naked eye. Transverse and longitudinal slices of the celery were then cut using a scalpel. These were prepared as wet mounts on slides and examined under the microscope. Sketches were made of the observations.