Experiments

Experiment 1.4: Marshmallow slingshots

Teacher notes (page 159)

Safety

Care should be taken when using rubber bands in this activity. A risk assessment should be completed before undertaking this experiment. A suggested risk assessment template is provided in the teacher resources.

Discussion

**1** The independent variable is the distance the marshmallow is pulled back. The dependent variable is the distance the marshmallow travels.

**2** Student responses will vary.

**3** Student responses will vary but should include links to evidence.

Conclusion

The further it is pulled back, the further the marshmallow should travel.

Experiment 2.5: Making sedimentary rocks

Teacher notes (page 163)

The mixing can be done in old Petri dishes or evaporating dishes. These will contain the mixtures; however, mixing on the white tile looks great. If mixed carefully, there should be no problem with mess.

Lab tech notes

Dry clay, which is used clay, can be obtained from your Art department. It may be their waste. Otherwise, make some of your own by allowing clay to dry out in the air. Use a blunt knife to scrap the sides of the dry clay: it comes off easily, ready to be ground.

Aquarium stones work well.

Remember to collect used matchboxes.

Safety

 A risk assessment should be completed before undertaking this Experiment. A suggested risk assessment template is provided in the teacher resources.

Discussion

**1** The rocks will be composed of different types of smaller rocks including sand and pebble.

**2** Student responses will vary but should include the lack of weathering and layers added over time.

Conclusion

Student answers will vary. However, students should understand that sedimentary rock is formed when loose particles are compressed.

Experiment 2.6: Making a metamorphic rock

Teacher notes (page 164)

Shales that are subject to heat and pressure change into a hard, fissile rock known as slate.

Expected results:

• The original shale sample breaks down rather quickly (within 5 minutes) when placed in the beaker of cold water.

 • The newly formed metamorphic rock holds its shape

Safety

All safety issues relating to the use of a Bunsen burner need to be observed. Lab coats and/or aprons and safety glasses must be worn and hair tied back. After heating for half an hour on a blue flame, the sample, evaporating dish and Bunsen burner equipment will be extremely hot. Leave to cool for 10 minutes. Use a heatproof glove to carefully remove the evaporating dish and the sample. A risk assessment should be completed before undertaking this Experiment.

Discussion

**1** The prepared samples are similar to real samples in that they were formed when loose particles were pressed together.

**2** Strong heat can change the properties of rocks over time.

**3** The new metamorphic rock sample differs from the original shale sample in that it is stronger than the original material. It may also be drier, shinier and a lighter colour.

Conclusion

Student answers will vary. However, students should understand that metamorphic rocks are formed when other types of rocks are changed by heat or pressure.

Experiment 3.2: What if the amount of elastic potential energy was increased?

Teacher notes (page 170)

Students should be encouraged to think critically about modifications they could make to improve their boats, and to subsequently test this.

Safety

A risk assessment should be completed before undertaking this activity. A suggested risk assessment template is provided in the teacher resources.

Discussion

**1** Quantitative, numerical data was collected.

**2** Three attempts were made in order to provide conditions for a fair test.

**3** Kinetic energy. Elastic potential energy is involved when the propeller is wound up; kinetic energy is involved when the propeller is released and the boat moves forward. There may also be some sound energy and some heat energy.

**4** Chemical energy stored in your body.

Challenge 3.3: Exploring sound energy

Teacher notes (page 171)

The pitch of a tuning fork depends on the length of the two prongs. Tuning forks are mainly used to tune other musical instruments by providing a standard of pitch; however, they are slowly being replaced by electronic tuners.

Safety

A risk assessment should be completed before undertaking this activity. A suggested risk assessment template is provided in the teacher resources.

Discussion

**1** If you blow harder into a recorder, you produce a louder sound.

**2** A pianist hits the keys harder to produce a louder sound.

**3** If you want to yell or speak louder, you push more air out of your throat to produce a louder sound.

**4** Drummers hit the drum skins harder to produce a louder sound.

Challenge 3.4: Energy converters

Teacher notes (page 171)

**1**

|  |  |  |
| --- | --- | --- |
| **Device** | **Energy input** | **Energy output** |
| Drum | Kinetic | Sound |
| Electric guitar | Electrical | Sound |
| Light bulb | Electrical | Light |
| Battery | CPE | Electrical |
| Car engine | Chemical | Kinetic |
| Rubber band (or others) | Elastic potential | Kinetic |
| Gas heater | Chemical | Heat |
| Solar panel | Light | Electrical |
| Phone charger | Electrical (or CPE at power station) | Electrical |

**2** Potential energy is often an input rather than an output. Sound and light are often energy outputs rather than energy inputs.

**3** Student answers will vary.

Experiment 3.5: What if you bounced a ball?

Teacher notes (page 172)

Lab tech notes

A suitable and safe area outside must be found for this experiment.

Safety

A risk assessment should be completed before undertaking this activity. A suggested risk assessment template is provided in the teacher resources.

Discussion

**1** Student answers will vary. As the height of the drop increased, so should the height of the bounce. The efficiency should remain fairly constant.

**2** Student answers will vary.

**3 a** Gravitational potential energy.

**b** Kinetic energy

**c** Elastic potential energy

**4** Sound and heat energy.

**5** Student diagram.

**7** Student answers will vary.

Experiment 3.8: Investigating structures and materials using icy pole sticks

Teacher notes (page 175)

Students should use the knowledge gained in chapter 3 to help them understand support structure.

Lab tech notes

This activity should be undertaken outside or somewhere the water will do the least amount of damage and require the least clean up.

Discussion

**1** Student responses will vary but should include discussion of the orientation of the icy pole sticks.

**2** Student responses will vary.

**3** Student responses will vary but should include that icy pole sticks on their side do require more force to break.

Conclusion

As discussed above, the structural capacity of the beam is stronger when on its side.

Challenge 3.8: Leakywater Council swimming pool and waterslide

Teacher notes (page 176–177)

Students should use the knowledge gained in chapter 3 to help them choose suitable materials.

They will need to consider things such as what the Leakywater Council wants, what materials are most durable, the size of the materials and the cost of the materials.

Students may benefit from conducting some research to help them decide what material best suits their prototype. They may like to conduct some experiments with the materials to also help them decide whether it is suitable or not.

Experiment 4.1: Comparing states of matter

Teacher notes (page 178)

Students could investigate whether their results are applicable for all substances or objects by testing other liquids, solids and gases. They should test more viscous liquids, such as oil, and less dense objects, such as cotton balls or marshmallows.

Practical hints

• Have as many electronic balances set up as possible. There is a lot of weighing so balances will be in high demand.

• Supervise the use of the electronic balances. They are delicate instruments and the students may need direction on how to tare an object and place it gently on the pan.

Results

• Solids cannot take on the shape of their container and are not able to be compressed.

• Liquids can take on the shape of their container, but cannot be compressed.

• Gases can take on the shape of their container, and can be compressed. Their mass cannot be measured.

Discussion

**1** Liquids and solids have measurable mass. Gas also has a mass, however, it is hard to measure.

**2** Each substance does take up space.

**3** Liquids and gases took on the shape of their container.

**4** Gas can be compressed into a smaller space.

Conclusion

Solids, liquids and gases all have mass. Solids are not able to take on the shape of their container or be compressed. Liquids and gases can both take on the shape of their container. Liquids cannot be compressed but gases can.

Challenge 4.3A: Modelling matter

Teacher notes (page 179)

Students will commonly use atomic model balls, plasticine or lollies to represent atoms. They will use toothpicks to join them into molecules. These are all legitimate items to use.

Safety

A risk assessment should be completed before undertaking this activity. A suggested risk assessment template is provided in the teacher resources.

Discussion

**1** The model can represent the distance between particles but is unable to demonstrate movement. The model particles are fairly uniform as they would be in real particles.

**2** The model can represent the position and arrangement fairly well but is not representative of the random nature of particles in a gas.

**3** No there are limitations to any type of model.

**4** To represent the melting of a solid, the model would need to be animated to show movement and dispersion of particles.

**5** Student results will vary; some examples could be rice, beads, polystyrene balls and ball bearings.

Challenge 4.3B: Making a cuppa

Teacher notes (page 179)

Safety

Although this activity utilises the diffusion of tea it is best not to use boiling water. It will still work effectively with hot water and poses less of a safety risk.

Class clean up

Tea bags can be composted.

Experiment 4.5B: From ice to steam

Teacher notes (page 184)

Students will note that some variation existed in the class. Ask students to suggest ways to try and minimise these variations. Some examples include measuring accurately and deciding on how much water to add to the crushed ice in.

Have one set-up ready to go to show the students. Show the students how a retort stand, boss head and clamp work. Explain that the thermometer is very delicate, particularly when placed in a clamp. Do not over-tighten. 

Safety

Follow safety procedures for working with Bunsen burners. Lab coats/aprons and safety glasses should be worn and hair tied back. 

Advise students not to put their faces or hands directly above the boiling water or they may be scalded from the steam. 

Allow the beaker of water and Bunsen burner equipment to cool for at least 15 minutes before putting away. 

Discussion

**1 a, b** The temperature at which melting point was measured will vary; however, it will be relatively close to the standard measurement of 0°C. 

**2 a, b** The temperature at which boiling point was measured will vary; however, it will be relatively close to the standard measurement of 100°C. 

**3** Answers will vary but could include the clamp blocking the temperature and condensation.

**4**  Variation will occur mainly due to the accuracy of measurements such as time and temperature. The amount of tap water added to the crushed ice in step 1 will also influence the results. 

Conclusion

The melting and boiling points of water should be consistently around 0 and 100 degrees Celsius respectively.

Experiment 4.6: Properties of the elements

Teacher notes (page 187)

Although students may not have used simple circuits before, they are very easy and safe to use. If time permits, students can set up a simple circuit and test the conductivity of other various items in order to practice using the circuit. They can then see first-hand that some substances are conductors and some are insulators. Suggested items for testing include: a strip of aluminium, a nail, a piece of rubber, a piece of fabric, a paperclip and a piece of wood or paddle pop stick.

Safety

All safety procedures relating to the use acid in class must be adhered to.

Discussion

**1** All of the elements should conduct electricity. The elements have similar properties except graphite.

**2** The materials can be divided into two groups, metals and non-metals (graphite). The properties used to separate them into groups are listed in the table.

**3** Metals.

**4** Conduct electricity, react with acid.

Conclusion

Metals are shiny, malleable, conduct electricity and react with acid. In this instance, with graphite as the example of a non-metal, it demonstrates that non-metals are dull, brittle and do not react with acid.

Experiment 4.7: Decomposing copper carbonate

Teacher notes (page 188)

Students should avoid inhaling the copper carbonate during heating as smoke and fumes are created.

This reaction is permanent and cannot be reversed.

Practical hints

• Have as many electronic balances set up as possible. There is a lot of weighing so balances will be in high demand.

• Supervise the use of the balances. They are delicate instruments and the students may need direction on how to tare an object and place it gently on the pan.

Safety

• All safety procedures relating to the use of a Bunsen burner need to be observed. Lab coats/aprons and safety glasses must be worn and hair tied back.

• When heating the copper carbonate in the test tube over the flame, point the opening of the test tube away from others and yourself. If it gets too hot, it may explode from the test tube

Class clean-up

Collect all copper carbonate in a beaker for the lab tech to dispose of. Do not put down sinks.

Lab tech notes

• Collect copper carbonate and store in a labelled waste container for waste collection.

• Supply each electronic balance with a plastic beaker or similar, so the test tubes can be weighed and copper carbonate added.

• Use spatulas that will fit inside the test tubes when adding the copper carbonate. This will help stop spillage. Supply small brushes so the pan or beaker can be dusted, if copper carbonate is spilt.

Expected results

• Copper carbonate goes a blackish colour. It also goes through a stage of looking like a liquid when it is not.

• Below is an example of the type of expected results.

| **Weight of copper carbonate before heating (W1) (g)** | **Weight of copper carbonate after heating (W2) (g)** | **Difference W2 – W1 (g)** |
| --- | --- | --- |
| 3.25 grams | 2.68 grams | 0.57 grams |

Discussion

**1** The copper carbonate gives off carbon dioxide, and leaves copper oxide. The copper oxide is black in colour, and the mass of the final is less than that of the copper carbonate because carbon dioxide is released.

**2** It is evident that copper carbonate is a compound because carbon dioxide is released and a black residue of copper oxide is left.

**3** The possible sources of error in this experiment are: condensation in the top of the heated test tube containing the copper carbonate.

Conclusion

When copper carbonate decomposes, carbon dioxide is released and a black residue called copper oxide is left.

Experiment 5.1: Melting chocolate

Teacher notes (page 189)

Practical hints

• In Part A, use hot tap water in the water bath. Otherwise, boil the jug to about 80°C and use this as it will melt chocolate and warm it to 40°C, at a gentle rate of heating.

Safety

• The students are using a Bunsen burner so all safety precautions for Bunsen burner use must be observed. Hair must be tied back, a lab coat and safety glasses worn, and loose clothing removed or secured. Know where the fire blanket and fire extinguisher are.

• For any burns, run under cold water immediately for at least 15 minutes. Seek medical advice from the school nurse or doctor if required.

Class clean-up

Collect melted chocolate. When hardened, empty to bin.

Lab tech notes

The large chocolate buttons work best. If you only have the small ones, double the amount required in the method.

Expected results

Slow warming will melt the chocolate and create a smooth, shiny appearance.

A faster and hotter melting process creates a lumpy, slightly burned, dull-looking chocolate.

Discussion

**1** Yes.

**2** Observations may vary.

**3** When the chocolate was heated rapidly it becomes lumpy or grainy and is burned. The smell of the chocolate also changes. Chef’s should cook chocolate gradually.

**4** Answers will vary.

**5** A chemical change occurs when chocolate is burned, and is indicated by a distinct change in the chemical composition of the product (e.g. grainy/lumpy/taste and smells different).

Conclusion

Answers will vary depending on a number of factors including brand but could include colour variation, speed of melting and texture.

Experiment 5.2: Observing chemical reactions

Teacher notes (page 191)

The mixture of baking soda and 1M hydrochloric acid will fizz. It will give off carbon dioxide which will put a lighted taper out when placed in the top of the test tube where the gas collects.

Steel wool (iron wool) turns an orange/copper colour almost immediately when it is put in copper sulfate solution. If left for 20 minutes or so, the iron wool will become very orange and the copper sulfate a darker shade of blue.

Lab tech notes

Filter the waste solution containing the iron wool and copper sulfate through a sieve, collecting the copper sulfate into a waste collection vessel specifically for copper sulfate. You may be able to reuse this in the future or, alternatively, save for waste removal/collection at a later date. Rinse the iron wool and put it in the bin.

Collect waste copper carbonate and store in a waste container for future waste pick up.

Try to give spatulas to the students that will actually go in the test tube or alternatively ask that they use small powder funnels to get the copper carbonate into the test tube.

Safety

1M hydrochloric acid is corrosive. Safety glasses and lab coats or aprons must be worn.

Write a risk assessment including safety advice from the Material Safety Data Sheets for each chemical.

Safety procedures for Bunsen burner use must be observed. Tie hair back and remove or tuck away any loose clothing.

Class clean-up

Do not put copper sulfate solution and iron wool down the sink. Copper sulfate is a hazard to the environment, particularly to aquatic/marine animals. Collect and put it in a waste beaker.

Copper carbonate is not to go down the sink. Collect in a waste beaker and pass on to the lab tech for disposal.

Discussion

**1** During heating, copper carbonate releases carbon dioxide gas and leaves a black residue of copper oxide.

**2** The copper carbonate turns into a black residue of copper oxide.

**3** This experiment is not similar to melting chocolate as it demonstrates chemical reactions. Melting chocolate is a physical reaction.

**4** The products of baking soda and hydrochloric acid are sodium chloride, water and carbon dioxide.

**5** The flame on the burning splint is extinguished if carbon dioxide is present because fire needs oxygen to feed it, but once added to carbon dioxide it doesn’t have any fuel it can use.

**6** The magnesium dissolves.

Conclusion

The reactants are the starting substances, and the products are the new substances produced after the chemical reaction. Products are a combination of the reactants.

Experiment 5.3: Comparing reactants and products

Teacher notes (page 192)

Safety

• Safety glasses and lab coats or aprons must be worn.

• 1 M hydrochloric acid is corrosive. Any spills can be neutralised with sodium bicarbonate and wiped up. Any spills on skin should be washed off with water as soon as possible.

• Write a risk assessment, including safety advice, from the Material Safety Data Sheets for each chemical.

Lab tech notes

• Pre-cut 1-cm strips of magnesium.

• Pour acid and magnesium through a sieve followed by tap water. Allow magnesium to dry. Use again or collect in a waste container.

Expected results

• Magnesium metal is more reactive than magnesium oxide. It also reacts for a lot longer period of time.

• When magnesium oxide reacts, the liquid becomes clear after a minute and then the reaction stops.

Discussion

**1** Magnesium and magnesium oxide do not have the same physical properties. Magnesium is a silver–grey metal, whereas magnesium oxide is a white crystalline powder.

**2** Magnesium and magnesium oxide do not have the same chemical properties. Magnesium oxide is formed by an ionic bond between one magnesium and one oxygen atom. Magnesium is a metal and a pure substance/element.

Conclusion

The physical and chemical properties of reactants and products are completely different. When a chemical reaction occurs or a chemical changes, the chemical properties also change. An example is salt (sodium chloride). Properties: sodium needs to be kept in oils as it reacts with oxygen, while chlorine is a pale green gas. When combined, they create salt—a totally different substance with completely different chemical and physical properties.

Experiment 5.4A: Effect of particle size on reaction rates

Teacher notes (page 193)

Safety

• Safety glasses and lab coats or aprons must be worn.

• 1 M hydrochloric acid is corrosive. Any spills can be neutralised with sodium bicarbonate and wiped up. Any spills on skin should be washed off with water as soon as possible.

• Write a risk assessment, including safety advice, from the Material Safety Data Sheets for each chemical.

Discussion

**1** The crushed eggshell will dissolve faster.

**2** Student results will vary dependent on size of crushed egg pieces.

**3** Small pieces react faster because they have a greater surface area.

**4** Stirring increases the rate of movement of the particles which in turn makes the eggshell dissolve faster.

**5** No.

Conclusion

The smaller the particle size, the faster the reaction rate.

Experiment 5.5: Making casein glue

Teacher notes (page 195)

Practical hints

• Ensure students do not over-heat the milk. The milk needs to be heated to close to 50°C or slightly lower before adding the vinegar for the best separation of curds and whey.

• Adding two drops of ammonia is optional. Casein with two drops of ammonia makes a stronger glue, however without ammonia it is still a pretty good glue.

Safety

• Students are using a Bunsen burner, so all Bunsen burner safety requirements must be followed.

• Safety glasses must be worn. Vinegar, although relatively harmless, is an acid and will sting eyes if it gets in them.

• If ammonia is used, please note that it has a pungent smell and is highly corrosive. If added, two drops of ammonia should be delivered by the teacher, in the fume cupboard.

Class clean-up

• Beakers may require additional cleaning in a dishwasher. The glue may be hard to get off the glass. Scoop excess glue onto a paper towel and discard this to the bin.

• The disposable cleaning cloths can be put in the bin.

• Check all sinks have no traces of milk, curd, whey or glue in them. If so, they will smell in a couple of days.

Lab tech notes

• Pre-cut the disposable cleaning cloths to fit the sieves prior to class.

• White vinegar from the supermarket is perfect to use.

• Full cream milk works best for making curds and whey.

Discussion

**1** It is important to wear safety glasses in this experiment to ensure chemicals or animal products don’t get in the eyes.

**2** The reactants in this experiment are milk, vinegar and ammonia. The products are curds, whey and, ultimately, casein glue.

**3** The strengths of different glues could be compared by gluing two icy pole sticks together and waiting until the glue is dried before trying to pry them apart.

**4** Casein glue was probably discovered by mistake.

Conclusion

Student answers will vary but should include that making glue involves a chemical reaction.

Skills lab 6.1: Drawing cells

Teacher notes (page 196)

Students should note that plant cells are rigid and structured and animal cells are not as structured.

Students will generally have issues drawing the cell as they have to remember what they saw and understand the structure of the cell. They are also likely to bump the microscope and not know that they have done so, and then draw something irrelevant.

Skills lab 6.2: Getting to know your microscope

Teacher notes (page 197)

Students should learn that objects viewed under the microscope are reversed. For example, it seems as though an organism is moving to the right when it is actually moving to the left side of the slide. This is because light rays from an object cross before reaching the eye so that the image you see through the light microscope is inverted or reversed.

Questions

**1** The image of the newspaper will be inverted or reversed, meaning that anything viewed through a microscope will be the opposite to what is seen without the microscope. Students should communicate that anything that is done actually occurs in the opposite way. For example, an organism moving to the right is actually moving to the left of the slide.

**2** Answers will vary. However, students should be able to see the detail such as fibers and glue.

**3** Student tables will vary.

Experiment 6.3A: Looking at organelles

Teacher notes (page 199)

Students are likely to need assistance with ensuring their onion skin is thin enough and with staining their onion cells. The most common errors are having too thick a piece of onion skin or applying too much stain, resulting in saturation of the cells. If saturation occurs, students will need to start again.

Safety

• Slides and coverslips are made of glass so can be broken. Coverslips, in particular, are very thin and can break, creating a cutting hazard.

• Iodine stain will stain clothing; ensure lab coats or aprons are worn. This is a weak solution of iodine; however, it is classified as corrosive in its solid state and skin contact should be avoided.

Class clean-up

• Remove coverslips from slides and place in a separate container to the microscope slides.

Lab tech notes

• Place coverslips in the glass bin or sharps container. Soak microscope slides in a strong detergent overnight, then rinse with water or wash in a dishwasher in an appropriate slide washer, allow to dry and reuse.

To prepare iodine stain

Make up at least 24 hours before it is required for use. For making up 300 mL of iodine stain, you will require the following:

• 1 g iodine (wear gloves)

• 5 g potassium iodide

• 300 mL distilled water

Method

• Dissolve 5 g of potassium iodide in 300 mL of distilled water.

• Add 1 g of iodine. Mix on a magnetic stirrer.

• Iodine solution will deteriorate in the presence of light and with time, so store in a dark bottle.

Discussion

**1** The stain makes the features of the onion cell easier to see.

**2** The cells will appear different as they have different roles within the plant.

**3** The nucleus in a leaf cell will be small and surrounded by many other prominent cell features.

**4** The prominent feature seen will be the cell wall which ensures the cell keeps its rigid shape.

**5** Colour is already present in leaf cells.

Conclusion

Student responses will vary but should make mention of differing organelles dependent on the function of the cell.

Experiment 6.3B: Measuring cells

Teacher notes (page 200)

Safety

• Slides and coverslips are made of glass so can be broken. Coverslips, in particular, are very thin and can break, creating a cutting hazard.

• Coverslips should be placed in the glass bin or sharps container. Soak microscope slides in a strong detergent overnight, then rinse in water or wash in a dishwasher in an appropriate slide washer, allow to dry and reuse.

Discussion

The students’ ranking should be similar that of Table 9.18.

Conclusion

Answers will vary. However, students should understand that the sizes of plant and animal cells differ depending on its function.

Challenge 6.4: Classifying using cells

Teacher notes (page 200)

Practical hint

Use aluminium foil to cover the names on the prepared slides and label with stickers A, B, C and D.

Experiment 6.4: Plant and animal cells

Teacher notes (page 201)

Students are likely to need assistance with ensuring their onion skin is thin enough and with staining their onion cells. The most common errors are having too thick a piece of onion skin or applying too much stain, resulting in saturation of the cells. If saturation occurs, students will need to start again.

Safety

• Slides and coverslips are made of glass so can be broken. Coverslips, in particular, are very thin and can break, creating a cutting hazard.

• Iodine stain will stain clothing; ensure lab coats or aprons are worn. This is a weak solution of iodine; however, it is classified as corrosive in its solid state and skin contact should be avoided.

Class clean-up

• Remove coverslips from slides and place in a separate container to the microscope slides.

Lab tech notes

• Place coverslips in the glass bin or sharps container. Soak microscope slides in a strong detergent overnight, then rinse with water or wash in a dishwasher in an appropriate slide washer, allow to dry and reuse.

Discussion

**1**  The purpose of staining the onion skin cells is to see the components of the cell more clearly.

**2** The onion skin came from a plant.

**3** Differences between plant and animal cells include cell wall/shape and colour. Similarities include the presence of a nucleus and defined structure (either by a cell wall/membrane).

**4** Students need to represent their data in the Venn diagram.

Conclusion

Answers will vary. However, students should note that plant and animal cells have differences and similarities.

Experiment 6.5: Microbes all around

Teacher notes (page 202)

Practical hint

Sterile swabs can be bought. A cheaper but not as sterile option is to use new packets of cotton buds, which are probably good enough for this exercise. Try swabbing a plate with a clean cotton bud for interest.

Safety

• Wear gloves for sampling. The students will possibly pick the dirtiest spots to sample.

• Wash hands with soap and hot water after you have finished the prac.

Class clean-up

• Place used swabs in a plastic bag and give to the lab tech to autoclave.

• Wipe benches with a mild antiseptic.

Lab tech notes

How to prepare nutrient agar plates

• Follow instructions for making up nutrient agar on the label.

• Transfer agar into autoclave-strength media bottles (Schott bottles are perfect), allowing space in the top for the agar to expand. Put the lid loosely on top of the bottles. The smaller 250-mL bottles are easier to handle when pouring the plates. Autoclave for 15 minutes at 121°C. Put a strip of autoclave tape on each lid; the white strip will become black if autoclaving has been done properly. Tighten lids when cooled a little.

• Clean and dry the bench you will be using when pouring the plates. Wipe the bench with cotton wool soaked in methylated spirits. Cut open the end of the bags containing the sterile Petri dishes. You will place the poured plates back into these bags. Spread the plates over the swabbed area. Do not open the lids.

• When the agar has cooled a little, but not turning solid, use a cloth or heatproof glove to remove the lid from the bottle. When opening the bottle, pass it over a Bunsen burner flame. Lift the lid of the Petri dish a little and pour approximately a 3-mm layer of agar. Replace the lid. Pass the neck of the bottle over the Bunsen burner flame after five plates have been poured.

• Allow agar to set.

• When the agar has set, turn the plate over (lid down) and stack on top of each other. Place the original plastic bag over the plates. Seal the bottom of the bag with sticky tape. Label with the date and place in the refrigerator until required.

Agar plate clean-up

Place dirty agar plates and used cotton buds in an oven bag and loosely seal. Autoclave at 121°C for 15 minutes. When cool, dispose to rubbish. Place autoclave tape on bag to ensure sterilisation has taken place.

Discussion

**1** Answers will vary depending on locations swabbed.

**2** Answers will vary. However, any answer is acceptable as long as the student justifies the answer. If there is more than one type of bacteria present, these should look different on the agar plate. There shouldn’t actually be much, if any, bacterial growth on the control plate.

**3** Answers will vary.

**4** Growth on the plates may differ between students for many reasons, including: location of swab, how well the area was swabbed, the transfer of the swab onto the agar, and the sterility of the agar plate and swab prior to exposure.

**5** Both the agar plate and swab need to be sterile prior to exposure to the environment to ensure that the results are reliable. If both are not sterile, there may be contamination and, therefore, unreliable results.

**6** The control plate is to used compare growth with that on the exposed plates. This enables us to determine whether the growth on the exposed plates is a result of the environment or not. It also provides a way to identify what types of microbes are present in different environments.

Conclusion

Student conclusions will vary but should refer to the amount that detergent inhibits the growth of microbes.

Experiment 7.2A: Digesting protein

Teacher notes (page 204)

Practical hints

• Use permanent marker for labelling in place of masking tape for easier clean-up if required.

• Test tubes can be left in test tube racks for incubating.

• Be aware of test tube size as the cubed egg white should be in the bottom of the test tube.

• Use dropper bottles for 0.1M NaOH and 1M HCl.

Safety

• 0.1M NaOH and 1M HCl are corrosive. Safety glasses, lab coats and gloves must be worn. If there is a spill, water will suffice for clean-up; this includes contact with skin.

• Risk assessment needs to be completed by teacher and lab tech.

Class clean-up

Egg can cause allergic and anaphylactic reactions. Wiping of benches and collection of egg waste needs to be thorough, so no traces are left for current and future classes.

Lab tech notes

• Pepsin is an enzyme that needs to be stored in the refrigerator in its solid and liquid form.

• Hard boil egg. Peel shell off and cut egg white into equal sizes. Discard egg yolk.

• 0.1M NaOH made up as follows: add 0.4 g of sodium hydroxide to 100 mL of distilled water in a 250-mL beaker. Stir. Wear safety glasses, lab coat and gloves. Make up in a fume cupboard.

• 1M HCl made up as follows: add 10 mL of 32% hydrochloric acid to 100 mL of distilled water in a 250-mL beaker. Stir. Wear safety glasses, lab coat and gloves. Make up in a fume cupboard.

• Egg solids can be collected and disposed into normal rubbish. Liquids can be put down the sink with water flushed behind them.

Expected results

Test tube A contains HCl, pepsin and egg white. The liquid will become cloudy and the egg white will have a furry appearance and may have dissolved after 24 hours at 37°C. Tubes B, C and D will remain clear and the egg white edges will be sharp. This confirms that pepsin will function as an enzyme in the presence of acid (HCl) to break down protein.

Discussion

**1** This experiment is considered to be controlled, as there is a test tube in which nothing is changed. This is used as a comparison or baseline.

**2** Combining class data can improve accuracy of the interpretations, as there is more data from which to form a conclusion. The more tests that are done, the more data there is to compare.

**3** Answers will vary, however students should note the following:

**a** Tube A most closely represents the human stomach, which contains acid and enzymes.

**b**  Tube B is missing pepsin, which is an enzyme found in the stomach and aids in the digestion of protein.

**c** Tube C is missing HCl, which is an acid found in the stomach and aids in digestion.

**d** Tube D is missing HCl, but has NaOH, which is a basic solution. This test tube is the exact opposite of what happens with the human body because the pH is increased from acidic (where enzymes work best) to basic.

**4** The protein will be completely digested in test tube A, as no protein is evident.

**5** Pepsin digests the protein in combination with acid; less protein is present in those test tubes containing pepsin and acid.

**6** Enzymes are chemicals that assist in a chemical reaction.

**7** HCl does not digest the protein by itself because the protein wasn’t broken down in test tube B, which had HCl and no pepsin.

**8** Word equations:

Tube A: protein + HCl + pepsin → amino acids

Tube B: water + HCl + protein → coagulated protein

Tube C: pepsin + water + protein → protein

Tube D: pepsin + KOH + protein → protein

**9** The body digests protein, as it is needed for growth and repair of cells. After the protein is digested it is absorbed across the intestinal walls and into the blood to be transported around the body.

**10** If this experiment was repeated using carbohydrates instead of protein, it is likely that the same results will occur as the pepsin and HCl emulate the human stomach and carbohydrates can be digested.

Conclusion

Pepsin controls digestion and works best when combined with HCl, another chemical found in the stomach.

Challenge 7.5B: Fish dissection

Teacher notes (page 206)

Fish can be bought from local markets or fishmongers. Fresh is always best; however, frozen works just as well. Students will benefit from dissecting an entire fish rather than one that has been gutted for consumption. Pre-ordering will usually enable this.

Safety

• Lab coats should be worn. Safety glasses should also be worn if there is a risk of fluid splashing in the eyes. If students have cuts on their hands, it is advisable to cover them with gloves. Hands should be washed thoroughly even if gloves are worn.

• The operculum (plate covering the gills) is quite sharp. Care should be taken to avoid injury. Even if students are wearing gloves, it might be appropriate to ask them to use their dissecting tools and not their hands to remove the gills.

Class clean-up

• Scalpels should be collected and placed without washing into a tub containing disinfectant or detergent. It is not advisable for students to wash scalpels due to the likelihood of injury. Other utensils need to be separated from the scalpels to eliminate the risk of cuts to lab techs.

• Gloves and dissection wastes can be wrapped in newspaper and placed in a sealed rubbish bag. This can later be discarded to standard rubbish bins.

• Dissecting trays or boards can be washed and dried. Plastic boards are much easier to clean than traditional wooden dissection boards.

Lab tech notes

• A short soaking time is enough for dissection tools. Keep soaking time brief and dry all the utensils thoroughly to avoid rusting.

• Scalpel blades can be removed with a commercial scalpel blade remover; however, a pair of pliers works just as well. Scalpel blades need to be put in a sharps container.

Discussion

Part A

**1** Fish organs are arranged in a fairly linear pattern in line with the body shape.

**2** Intertwined as they rely on one another.

**3** Some organs will be a darker red—the heart, liver and gills, for example.

**4**  Organs with a darker red colour have a higher concentration of oxygenated blood.

**5** The darker colour indicates the organ is of high importance.

Part B

**1**  Fish gills have similar features in that they exchange gases (oxygen and carbon dioxide) with the external environment.

**2** Gills do have different forms to achieve the same function.

Experiment 7.7: Heart dissection

Teacher notes (page 207)

Students will probably need a diagram of the heart to identify the parts of the heart. A video of a heart dissection is available on the obook for students who don’t want to complete their own dissection. In addition, an online search using the term ‘virtual heart dissection’ should identify many options. Students could take photographs while conducting the dissection for use in the results section of their report. These images could be analysed by students who do not wish to participate in the actual dissection.

Lab tech notes

A short soaking time is enough for dissection tools. It is advisable to keep soaking time brief and dry all the utensils thoroughly, to avoid rusting. Coating in a protective grease barrier is an option, but not necessary if the utensils are washed and dried promptly.

Scalpel blades can be removed with a commercial scalpel blade remover; however, a pair of pliers works just as well. Scalpel blades need to be put in a sharps container.

Discussion

**1** The artery leading from the right ventricle is called the pulmonary artery.

**2** The artery leading from the left ventricle is called the aorta.

**3** Artery walls are thicker than vein walls to cope with the high pressure needed to squeeze blood along.

**4** The ventricle walls are thicker than those of the atria to provide the pressure needed to push the blood out of the heart, rather than just between chambers.

**5** The left ventricle is thicker than the right ventricle because it has to push blood all the way around the body, whereas the right ventricle only pushes blood to the lungs and back. 

Conclusion

The structure of the heart enables it to push blood to various parts of the body, including the heart itself. The thickness of the muscle walls of each chamber is an indication of how far the blood needs to be pushed. The thicker the muscle, the further the blood needs to go.

Experiment 7.9: Kidney dissection

Teacher notes (page 208)

Safety

Lab coats should be worn. Safety glasses should also be worn if there is a risk of fluid splashing in the eyes. Disposable gloves are not essential. Hands should be washed thoroughly even if gloves are worn.

Class clean-up

• Scalpels should be collected and placed without washing into a tub containing disinfectant or detergent. It is not advisable for students to wash scalpels due to the likelihood of injury. Other utensils need to be separated from the scalpels to eliminate the risk of cuts to lab techs.

• Gloves and dissection wastes can be wrapped in newspaper and placed in a sealed rubbish bag. This can be discarded to standard rubbish bins.

Lab tech notes

Scalpel blades can be removed with a commercial scalpel blade remover. Scalpel blades need to be put in a sharps container.

Discussion

**1** The kidneys are a much darker red inside due to the high blood supply.

**2** Blood carrying waste products enters the kidneys and is filtered by the nephrons. The output is either clean blood or urine.

**3** Nephrons are too small to see, which indicates they are microscopic in size and also deal with microscopic substances.

**4** The collecting ducts connect the nephrons to the ureter to transport urine to the bladder.

Conclusion

The kidneys filter blood and remove wastes, which are diverted to the urinary bladder. The kidney is a bean-shaped structure, with both concave and convex surfaces. It contains nephrons, which are located in the medulla of the kidney.

Experiment 7.10: Factors that affect transpiration

Teacher notes (page 210)

The transpiration stream can be a tricky concept for students to understand. They tend to believe that gravity should prevent water from rising to the tops of trees. Capillary action is the ability of substances like water to rise up a tube against the force of gravity.

A number of different processes help push and pull water up the plant:

Osmosis of water from the soil into the roots pushes the existing water in the xylem upwards.

Water cohesion is the attraction force between water molecules that helps the water form a continuous column inside the xylem; without it, the transpiration stream would fail.

Water adhesion is the attraction force between water molecules and the inside surface of the xylem tissue. Adhesion is what forms the meniscus. The narrower the tube, the higher the water molecules can climb and the steeper the curve of the meniscus.

Transpiration of water through the stomata in the leaves helps ‘pull’ water up the plant.

Discussion

**1** Transpiration is the pull of water up the plant.

**2** Light, temperature, humidity, wind and the amount of water in the soil.

**3** Student responses will vary but should incorporate evidence to support their answer.

**4** Student responses will vary but could include ensuring water is available in the soil and plants are positioned in good sunlight.

Conclusion

The factors that affect transpiration are light, temperature, humidity, wind and the amount of water in the soil.

Experiment 8.5: Flower dissection

Teacher notes (page 212)

Safety

Scalpel blades are extremely sharp and need to be handled with care. Lab coats should be worn because pollen can stain clothing.

A risk assessment should be completed before undertaking this experiment. A suggested risk assessment template is provided in the teacher resources. 

Practical hints

Larger flowers are much easier to dissect. Lilies are perfect because they have simple structures, parts are clearly distinguished and the size makes them easier for students to handle. Complex flowers, such as sunflowers and daisies, are good for comparisons, but the reproductive structures can be very difficult to identify. Grevilleas are good examples of complex flower heads and the parts are easily identified. 

Class clean up

All scalpels should be returned to the teacher after use. Ensure scalpels do not remain in the newspaper when wrapping up flower remains. 

Scalpels should be collected and placed without washing into a tub containing disinfectant or detergent. It is not advisable for students to wash scalpels because of the likelihood of injury. Other utensils need to be separated from the scalpels to eliminate the risk of cuts to lab technicians.

Plant materials are best disposed of into compost bins if possible. Alternatively, the rubbish bin will suffice. 

Dissecting trays or boards can be washed and dried. Plastic boards are much easier to clean than traditional wooden dissection boards. 

Lab tech notes

A short soaking time is enough for dissection tools. It is advisable to keep soaking time brief and to dry all utensils thoroughly, to avoid rusting. Coating in a protective grease barrier is an option, but not necessary if the utensils are washed and dried promptly.

Scalpel blades can be removed with a commercial scalpel blade remover; however, a pair of pliers works just as well. Scalpel blades need to be put in a sharps container.

 Discussion

**1** The filament is yellow to attract pollinators.

**2**  Pollen grains are sticky and will stick to any surface, but are usually easily washed off. The pollen grains formed in the male stamen will stick to insects or other animals and be carried to the pistil of another flower, where they may fertilize the eggs. 

**3**  The anthers and stamens of a flower are usually central and prominent so they can easily come into contact with bees and other insects. Some flowers facilitate self-pollination by the placement of the male and female parts. The stamens can be found much higher or much lower than the anthers so visiting insects will not pollinate the flower with its own pollen. 

**4** Students will need to provide evidence for their decision. If both stamen and carpel appear to be ‘ripe’ at the same time, then the flower will self-pollinate. If only the male or female parts look ‘ripe’ then cross-pollination is more likely.

**5**  Students will need to provide evidence for their decision.

Conclusion

Student conclusions will vary but should include the presence of key reproductive organs.