STEM CLUBS

NUMBER 1 FOR STEM

SURVIVAL STEM: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

STEM Learning activity resources

SUBJECT LINKS:

Science, design and technology, computing, engineering and maths

STEM CLUBS

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Could you survive on a desert island?

STEM Learning activity resources

Introduction

This programme has been created by STEM Learning, the largest provider of STEM education and careers support in the UK. It has been developed in partnership with Club leaders.

This programme is part of Survival STEM, a set of three programmes exploring science, technology, engineering and maths in survival scenarios.

Could you survive on a desert island?

You're in the middle of a once-in-a-lifetime sailing trip around the world. As you pass the tropics, you plough into a pile of floating debris. A large log smashes into your hull and your yacht quickly sinks. Luckily for you, you're a great swimmer, and you can see a small island on the horizon. Unluckily for you, it is uninhabited. Your challenge is to stay alive until help arrives.

This programme investigates the science, technology, engineering and maths involved in surviving on a desert island – from making rope to building a shelter to telling the time without a watch.

Key information

AGE RANGE: 11–14

SUBJECT LINKS: Science, design and technology, computing, engineering and maths

DURATION: A range of activities from 40 to 60 minutes – at least 6 hours in total.

FLEXIBILITY: Complete the whole programme over a half term or choose individual activities to suit the needs of your Club.

RESOURCES: Each activity includes a list of the resources required and a comprehensive set of Club leader and student notes in the form of guides.

IMPACT MEASUREMENT: Each set of resources is designed to help evaluate and assess the progress of Club-based learning on Club members. A useful set of assessment tools are available at www.stem.org.uk/enrichment/stem-clubs

ACHIEVEMENT: students that successfully complete a complete set of activities can be rewarded with the downloadable STEM Clubs Certificate of Achievement. Successfully completing a set of themed activities enables students to enter for a CREST Discovery Award. Further information is available on the STEM Clubs website.

APPROPRIATE VENUES: Club leaders can run most activities in general spaces e.g. classrooms, halls, and outdoor areas. Some activities need to be conducted in labs and workshops – these are marked clearly in the Club leader guide and in the table below.

SAFETY: Each Club leader guide includes details about the relevant health and safety requirements. A full risk assessment should be done before completing any practical activity. See the STEM Clubs Best Practice Guide for advice (page 20).

OTHER ACTIVITIES: Visit www.stem.org.uk/resources/stem-clubs/ for a wealth of ideas for STEM-related Clubs.

FURTHER SUPPORT: The STEM Clubs Best Practice Guide includes comprehensive support for leaders of all STEM-related Clubs. It can be found at www.stem.org.uk/stem-clubs/getting-started

Activities

1	**WATER-POWERED FAN:** students build their own watermill and explore how to harness the kinetic energy from a gushing river on a desert island.	40 minutes	
2	**INVISIBLE INK:** students write a message and use heat to reveal it. Students explore how heat can decompose a substance, changing its colour and making it visible.	50 minutes	(lab required)
3	**PAPER RECYCLING:** students explore how paper is made up of different fibres, which can be broken down with water and mechanical processing (mixing) to then form a new sheet. Students compare recycling new paper and already recycled paper to understand that paper can only be recycled a finite number of times.	40 minutes	
4	**NEED A ROPE:** students explore different ways to make rope using plastic bags. Students test the strength of their rope with newton meters and masses to see whose is the strongest!	40 minutes	
5	**COCONUT CARBON FILTER:** students build their own water filters complete with coconut carbon to cleanse water of microbes. Students explore how different types of filters are required to remove different sized impurities.	50 minutes	
6	**SUNDIAL:** students choose the best materials from the island to design their own sundial. Students explore how we can use changing shadows formed from the rotation of the Earth to tell the time.	40 minutes	
7	**ORGANIC TOOTHPASTE:** students formulate their own toothpaste. Students explore the cleansing power of eggshell and charcoal.	40 minutes	(lab required)
8	**FISH DISSECTION:** students explore the anatomy of a fish, making comparisons between the organs of a fish and those of a human.	50 minutes	(lab required)
9	**GET CREST DISCOVERY AWARDS:** By completing all nine activities in this resource pack, your STEM Club members can get a CREST Discovery Award.		

STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

1 Water-powered fan

Objective

In this activity, students build their own watermill and explore how to harness the kinetic energy from a gushing river on a desert island.

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity. Safety goggles should be worn.

Students should take special care when using sharp pointed BBQ skewers.

TOPIC LINKS

- Physics and engineering: Energy transfer
- Design and technology: Renewable energy

TIME

40 minutes

RESOURCES AND PREPARATION

(On a desert island, you would use resources like coconuts, dried banana leaves, tree sap and bamboo. As these are difficult to get hold of, we've suggested alternative apparatus!)

- plastic cups
- thick cardboard or construction card
- a stapler
- a wooden BBQ skewer
- scissors
- thin card
- paper and pencil
- sticky tape
- straws
- large tray
- water

DELIVERY

1. Discuss what a freshwater river on an island could supply, apart from drinking water.
2. Explain how kinetic energy could be harnessed from the river to turn a watermill. The watermill can then be used to turn or rotate anything – a spit over a fire or the blades of a fan to keep you cool on the desert island.
3. Assist students as they plan and make a watermill, and apply this to power a basic fan, following the instructions on the student guide.
4. Encourage the students to design and test the water-powered fan throughout the activity to improve performance. Ask how they could make the card water proof – cover it in cling film or colour it with wax crayons.

TIPS

- You might need a hose connected to a tap to assist with testing.
- To make the activity more realistic you could replace the materials with:
  - coconuts (instead of plastic cups)
  - dried banana leaves (instead of thick cardboard)
  - tree sap (instead of a stapler)
  - bamboo (instead of a wooden BBQ skewer)
  - pocket knife (instead of scissors)

5. Testing the water powered fans:
   - place a water proof sheet on the floor or test outside
   - place two tables on either side of a large tray
   - at the edge of the tables firmly tape a straw with open end pointing towards the tray
   - the skewer should be fed into the straws and rest on each table with the water wheel suspended in between over the tray
   - make sure you have a good source of water
6. Ask the students to devise a simple experiment and record their observations to see if the speed of the water wheel is affected by changing the flow of water:
   - increase and decrease the speed of the water flow
   - increase and decrease how much water pours down
   - drop the water from different measured heights

EXTENSION IDEAS

1. What else could you attach the watermill to?
2. How does a watermill compare to a turbine used in a power station? What are the similarities and differences?
3. Using the principles learned, design and make a water-turbine to generate electricity. You will need suitable components.

DIFFERENTIATION IDEAS

Support: show a photo or movie clip of a water turbine or water wheel to generate ideas. Encourage students to follow the step by step instructions, offer suggestions on the size of the cardboard circles needed, (between 20-40cm), how to position the first cup or possible fan shapes. Suggest how the pupils could experiment with the flow of the water.

Challenge: students design and make a water-powered fan without the instructions. Students devise a series of experiments to test how the flow of the water affects the speed at which the water wheel turns and how this affects the flow of air.

STUDENT GUIDE: SUITABLE FOR AGE 11-14

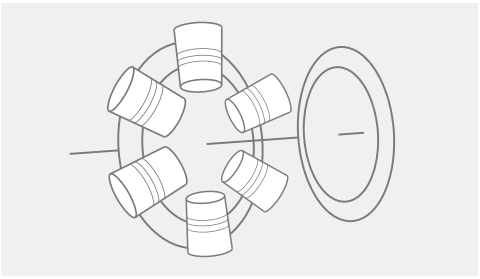
Could you survive on a desert island?

1 Water-powered fan

Briefing

Luckily for us, the desert island you have swum to has a gushing river flowing through it! Could you harness that energy and put it to good use? Use the water to make a water-powered fan that will keep you cool during the hottest part of the day.

WHAT YOU NEED TO DO



1. Design and make a basic model using the materials provided.
2. Draw a diagram of your intended design considering the materials you have been given.
3. Draw and cut two circles of card, ensure they are sized to support the plastic cups.
4. Make a hole in the centre of each circle of card. Carefully, insert a BBQ skewer through the middle of the two circles. CAUTION: the tip of the BBQ skewer will be sharp!
5. Use a stapler to fasten a plastic cup to one circle of card, so the open end can receive a flow of water. Repeat with the rest of the cups and attach the second circle of card.
6. Insert your skewer through the holes in the middle of the cards.
7. Test your waterwheel. Feed the ends of your skewer into the straws, pour a slow and constant stream of water into the cup in the 1 o'clock position, keep up the flow of water and watch it turn.
8. Does it successfully turn in the flow of water? How could you improve the design to make it more effective?
9. When your waterwheel is finished, design and make a set of fan blades, using the card provided and attach to one end of the skewer. Make sure you leave room to thread the skewer back into the straws.
10. Test the water-powered fan and make improvements to increase how much air is blown.
11. Create a simple experiment to show how the speed of the water wheel is affected by the flow of the water. Can you prove that the speed of the water wheel turning affects the amount of air blown?
12. Record your observations in the area provided.

FUN FACTS

1. It's thought that early water wheels were used in ancient China to power a piston that would blast air onto a fire, keeping it as hot as possible.
2. Some of the biggest turbines are found in offshore wind farms and can be as big as 180m in diameter! That's 450 times bigger than the turbine you've made!
3. Giant turbines are also used in dams, where the pressure of water behind the dam spins it to generate electricity. The Three Gorges Dam in China is the biggest, producing 22,500MW! It was completed in 2012, though the initial idea for this dam started in 1919.

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

1 Water-powered fan

Water-powered fan design

Experiment and observations

STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

2 Invisible ink

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity. Appropriate eye protection should be worn.

CAUTION: ensure the Bunsen burner is used only on a low heat, as white tiles can crack when heated. The tile will get very hot so students must use tongs to handle the paper.

Objective

In this activity, students write a message and use heat to reveal it. Students will explore how heat can decompose a substance, changing its colour and making it visible.

TOPIC LINKS

- Chemistry: irreversible reactions

TIME

- 50 minutes

RESOURCES AND PREPARATION

- any fresh acidic fruit juice (lemon juice, apple juice, orange juice)
- onion juice
- dilute honey
- milk
- sugary water (two teaspoons of sugar in 20ml of water)
- water
- pipette
- small dishes
- paper
- straw or toothpick
- cotton
- Bunsen burner
- tripod
- white tile
- tongs
- stop watch
- hairdryer (or direct sunlight)
- an iron and suitable heat proof mat (if available)
- clean cloth
- safety goggles

DELIVERY

1. Discuss why you would need to write on a desert island: to write a diary; to keep track of days; to send a message in a bottle for help!
2. Explain that you would need to use natural resources to write. Many naturally occurring substances don't have pigment, but if you change the substance by heating it, colour can be achieved.
3. Allow students time to explore the natural inks and select which one they think will work best. They can use straws, toothpicks or cotton buds as pens, or encourage them to think of natural items that they could find on an island, such as a stick.
4. Assist students as they write their messages and take the steps to reveal it, following the instructions on the student guide.
5. Assist students as they explore the effect concentration has on ink levels.

TIPS

- Don't heat the paper directly with the Bunsen as it will catch fire. Instead, place the paper on a white tile over a tripod and heat the tile so the paper dries without burning.
- If you prefer a safer alternative to the Bunsen burner, you can use an iron on a low heat and a heat proof safety mat.
- On a desert island, you'd place a rock in the midday sun and then dry the paper on the rock or even use a hot rock as an iron!

EXTENSION IDEAS

1. Explain that in addition to heat making these inks visible, indicators could work too. These natural inks all have a specific pH. Encourage pupils to apply universal indicator to the inks to yield colour. Then ask them to research what indicators can be found in our natural environment (eg red cabbage).
2. Explore online how invisible inks were used by spies during WWII to transport crucial messages. They even had a list of the characteristics of a good invisible ink. Students can research those requirements and evaluate their own ink against the list to see if their ink is spy-worthy.

DIFFERENTIATION IDEAS

Support: provide students with a variety of inks that work. Students choose a single ink and trial different concentrations to decide which works the best. Students record their observations.

Challenge: provide students with a variety of inks, including safe liquids which won't work, e.g. salt water. Encourage students to predict which inks will colour upon heating and which won't. Students test 3-4 different inks and record the effectiveness of their experiments, including different concentrations to decide which ink is the most effective.

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

2 Invisible ink

Briefing

Anyone stuck on a desert island needs to send a message in a bottle – but what could you write with? Can you create a short letter or sentence using natural ingredients to write with?

YOUR TASK **Write with inks that you can't see and use the power of heat to reveal your letters!**

WHAT YOU NEED TO DO

1. Select a straw or toothpick and twist into the cotton to create a soft nib.
2. Select an ink you would like to work with.
3. Dip your 'pen' into the ink and write your message on the paper. This will be your control experiment.
4. Leave the message to dry (or gently use a hairdryer.)
5. Put on your safety goggles and set up the Bunsen burner, tripod and tile. Make sure the Bunsen burner is on a low heat.
6. Place your letter carefully onto the tile using the tongs and watch as your message comes to life!
7. Remove with the tongs as soon as the message is clearly seen and record how long it takes in the table below.
8. Now you are going to test some different solutions of your chosen ink mixed with water. You will conduct several experiments to find which solution produces the best result for your chosen ink.
9. Make sure that each time you:
   - write the same sentence
   - use the same ink
10. Repeat the experiment a second time but double the amount of natural ingredient (eg 2 drops of ink and one drop of water). Record your findings in the table.
11. Then, repeat the experiment a third time but use half the amount of natural ingredient.
12. Compare the results you have recorded in the table below and note any differences.
13. Experiment further by increasing or decreasing the amount of natural ink.
14. Which ratio works best and why do you think this is? Different concentrations will give different results – and not always what you expect!

FUN FACTS

1. On a desert island, you'd place a rock in the midday sun and then dry the paper on the rock or even use a hot rock as an iron!
2. Despite their names, no inks are permanent, not even permanent ink! They can always be removed with the right chemical – lanolin-based products work very well at this.
3. Squid ink has been used for years and is even used in foods like pasta and risotto but it also has antioxidant properties, boosting white blood cells and fighting cancer!
4. Contradictory to what you see on TV, blood makes terrible ink. It quickly oxidises in air, losing its pigment so it can no longer be seen.

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

2 Invisible ink

Notes

Sentence written:

	Ratio of water to ink	Time to reveal message	Result
Control			
Experiment 1			
Experiment 2			
Experiment 3			

Observations

STEM CLUBS

NUMBER 1 FOR STEM

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

3 Paper recycling

Objective

In this activity, students explore how paper is made up of different fibres, which can be broken down with water and mechanical processing (mixing) to then form a new sheet.

Students learn why paper can only be recycled a finite number of times.

TOPIC LINKS

D&T: Sustainability, recycling

TIME

40 minutes

RESOURCES AND PREPARATION

- scrap paper
- recycled paper
- tray or washing up bowl
- coat hanger
- pair of tights
- blender (optional)
- large spoon or stirring rod
- two heat proof mats
- thick cloth (e.g. jay cloth or muslin)

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity. Safety goggles should be worn.

If using a blender, technicians or STEM leaders are required to complete this step for students.

DELIVERY

1. Discuss with students why they would want to write on a desert island – what would they want to record? How could they get a message out for help?
2. Elicit what students know about recycled paper already. How is it made?
3. What part of the paper do we want (the fibres) and what part do we not want (the ink). How could we go about separating these?
4. Support students as they make their own paper following the student guide.

TIPS

- If there is no blender available, ask technicians to have slurry of paper fibres prepared. Prepare this by adding small scraps of paper to water and leaving it to soak for five hours. Give the soaked paper a good mix, breaking down the fibres during mixing. Add more water so that it remains a slurry and leave it overnight.

  NB – one batch will need to be made with fresh paper, a second batch with already recycled paper.

EXTENSION IDEAS

1. Ask students to research how many times paper can be recycled. What happens to the appearance with each successive cycle? How about other recyclable materials like metal and glass? What impact does the recycling process have on the quality of these?

DIFFERENTIATION IDEAS

Support: give students the full instructions and support them as they follow them. Delegate some groups to make recycled paper from fresh paper and some to make recycled paper from paper that has already been through the recycling process.

Challenge: ask students to tell the difference between the recycled paper and fresh paper. Will this have an impact on the paper they make today? Why might this be? How could they experiment to tell?

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

3 Paper recycling

Briefing

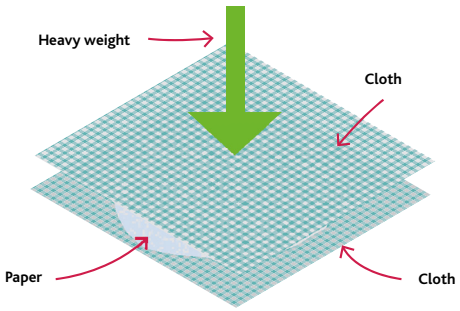
You've made ink but what are you going to write on? You may have a few scraps of paper at the bottom of your pocket and bag, or walk on the beach and find a washed up newspaper or magazine See how you can combine and recycle your own scrap paper to make a new clean sheet, ready to write on to send for help!

YOUR TASK

Complete the recycling process on fresh paper and already recycled paper. What differences do you note? Why is this?

WHAT YOU NEED TO DO

1. Cut your scrap paper into small pieces (about 2cm by 2cm) and place them into a large container
2. Add enough water to the paper to cover it.
3. Add the water paper mixture to a blender and blend it to make a pulp (your STEM leader needs to complete this step). If you do not have access to a blender, your technician will supply you with pulp that has been soaked in water for over 24 hours.
4. Use a spoon or glass rod to stir this slurry of water and paper, breaking down the fibres as much as possible.
5. Add a little more water so the mixture is just runny enough to be poured.
6. Stretch a pair of tights over a wire coat hanger to make a fine sieve (on a desert island you'd have to hope you were wearing tights and make a frame out of bamboo).
7. Submerge the sieve into the water–paper mix and gently lift it upwards and out of the mix so you have collected a layer of fibres on the surface.
8. Wait for the excess water to drain.
9. You should now have a layer of very wet paper fibres on your sieve.
10. Lay a jay cloth on a flat surface.
11. Turn the sieve upside down onto the cloth so the fibres are transferred to the jay cloth.
12. Fold the jay cloth over the fibres so the fibres are sandwiched between the cloths (you may need a second cloth).
13. Wedge the jay cloth between two heat-proof mats and apply a heavy weight to the top to squeeze out any water.
14. Remove the heat-proof mats and peel off the top layer of cloth to expose your paper.
15. Leave it to dry a little before peeling it away off the cloth to give you recycled paper (don't leave it too long or you won't be able to peel it off the cloth).
16. Give the paper some time to dry further.
17. How does final paper differ if you start with scrap paper that has already been recycled?



FUN FACTS

1. Recycled paper releases 78% less air pollution than if it was made from raw materials.
2. A recycling plant uses a method similar to the one above to recycle paper – just on a much larger scale! Chemical engineers are involved in the scale-up process, helping to turn a lab-based experiment into something much bigger!

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

3 Paper recycling

Experiment results and observations

STEM CLUBS

NUMBER 1 FOR STEM

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

4 Need a rope

Objective

In this activity, students use the only resource they can find on the island – a plastic bag – to make strong rope. Students explore how they can twining strips of plastic can join them together to form a strong rope and test to see whose rope is strongest!

TOPIC LINKS

- Design and technology: structural elements to achieve functioning solutions
- Engineering: manipulating materials to change their strength

TIME

40 minutes

RESOURCES AND PREPARATION

- a saw
- bin liners/plastic bags
- a newton meter
- masses
- a whole coconut (including the husk) that has been cut in two exposing the husk – x1 per group (for alternative/ extension activities)

DELIVERY

1. Ask students to consider the properties a good piece of rope has.
2. What could they build rope from on a desert island? What would they need to do to make rope? What could they make it out of? Explain that ocean plastic is a big problem – and plastic even washes up on the most remote of islands.
3. Allow students some time to look at the plastic bags at their tables and discuss how they could use them to make the strongest possible rope.
4. Assist students as they follow instructions on the student guide to make a rope.
5. Discuss how students might test how strong the rope is.
6. Quantify how good the rope is by using a newton meter and masses to see how much the rope can hold.
7. Encourage students to research alternative twining methods and trial these – which is strongest?

EXTENSION IDEAS

1. Try twining coconut husks. A teacher or technician will need to expose the husk prior to the activity. Put the coconut in a vice and use a saw to open the coconut and get to the husk.

   Coconut husks might be available for free from shops that sell fresh coconuts.

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity. Safety goggles should be worn.

TIPS

- It is easier to follow the twining steps by watching the process. See the Useful links for a video demonstrating the process.

DIFFERENTIATION IDEAS

Support: demonstrate the way to twist the plastic strips back on itself to strengthen the rope.

Challenge: show students how to twist the husk into a rope but allow students to create their own ways to strengthen their rope. They can then devise a test to see whose rope is strongest.

USEFUL LINKS

- **YouTube video about making rope out of plastic bags**
  https://www.youtube.com/watch?v=3TpN4WT61hU
- **YouTube video about making rope out of coconuts**
  https://www.youtube.com/watch?v=U-Q0NVX2nt0
- **Making rope from dead plants**
  http://www.instructables.com/id/Make-rope-out-of-dead-plants----with-no-tools/

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

4 Need a rope

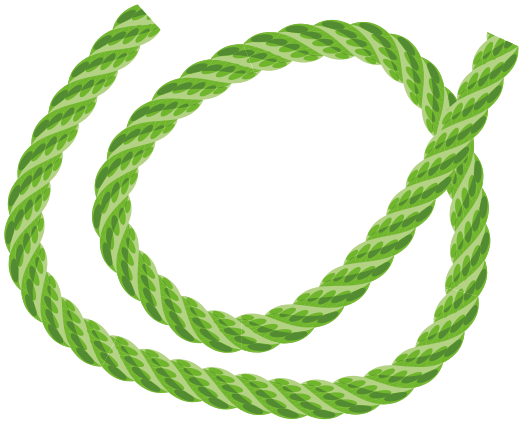
Briefing

Want to build a raft or a shelter? To do this, you will require one important thing… rope! But how can you make it with such limited resources?

YOUR TASK **Search the beach for carrier bags washed up onto the shore to make a rope. It will help protect the environment too!**

WHAT YOU NEED TO DO

1. Take a carrier bag and cut the plastic into long strips.
2. Fold the strip in half (or use two strips) and add a reverse twist to the strip to create your rope (watch the video demonstration in the links section).
3. Devise an experiment to test the strength of your carrier bag rope. Think about:
   - what apparatus you could use to quantify how strong each rope is
   - how to apply weights to the rope
   - what happens to the rope
   - how much weight it can hold before it breaks.
4. Now think about how you could make a stronger rope. Decide what you could change, and try your test again.
5. Record your observations and results



FUN FACTS

1. More than half the rope manufactured today is used in the fishing industry.
2. Egyptians were one of the first people to develop rope. They used water reeds, grass and even camel hair! They needed the ropes to pull the heavy stones needed to build the pyramids.
3. Cable is simply a type of rope, it's just made from iron or steel fibres rather than coconut husk! Metallurgists are a type of materials engineer who specialise in creating alloys that make the perfect rope for its purpose.

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

4 Need a rope

Experiment results and observations

STEM CLUBS

NUMBER 1 FOR STEM

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

5 Coconut carbon filter

TOPIC LINKS

- Chemistry: filtration
- Biology: microorganisms
- Engineering: application of particle size to solve a problem

TIME

50 minutes

RESOURCES AND PREPARATION

- a two-litre drinks bottle
- fine sand
- thick sand
- gravel/small stones
- large pebbles
- cotton wool
- pieces of coconut shell (charcoal as a substitute) caution: ensure no pupils are allergic to coconut prior to starting the experiment
- scissors
- thin, clean cloth
- a pestle and mortar
- Bunsen burner
- tongs (you may also want a Bunsen gauze or a mounted needle)
- an elastic band

For testing:

- magnifying glasses
- microscopes
- pH paper
- universal indicator [low hazard]

Objective

In this activity, students build their own water filter complete with coconut carbon to cleanse water of microbes. Students will explore how different types of filters are required to remove different sized impurities.

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity. Protective eyewear should be worn.

CAUTION: students must use tongs to heat the coconut or charcoal

Students must not drink the water.

DELIVERY

1. Discuss what the students would need to do first if they found themselves stranded on a desert island. Elicit that finding fresh water is key!
2. Explain we would need to clean our water to make it fit for drinking – how could we do this? Different grades of materials would be needed to eliminate different sized impurities from the water.
3. Allow students time to brainstorm what materials they could use. Allow pupils to add their own ideas to the filter, if feasible.
4. Assist students as they plan and make a water filter, following the instructions on the student guide.
5. How can they test how clean the water is? Students should explore ideas to test the water. [CAUTION: do not allow students to drink the water!]
6. Supply students with magnifying glasses, microscopes, pH paper, and universal indicator to compare their water with a sample of drinking water and deduce how clean it is.

TIPS

- Coconut charcoal works well to adsorb microbes from the water. If coconut shell isn't available, charcoal can be used as a substitute.
- Use any leftover coconut shell to make a drinking bowl!

EXTENSION IDEAS

1. Ask students to research online what the parameters are for safe drinking water e.g. pH. Students could research what other tests they could conduct to check how safe their water is.
2. Students could investigate what a transpiration bag is and trial one out on a tree in the school grounds.

DIFFERENTIATION IDEAS

Support: direct the students by showing them the order in which layers must be placed.

Challenge: allow students to build the filter adding the layers in the order they think will work best. Before showing students the materials, encourage them to independently think about what would work best to filter water. Allow students to incorporate any feasible ideas that are not on the equipment list into their filter.

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

5 Coconut carbon filter

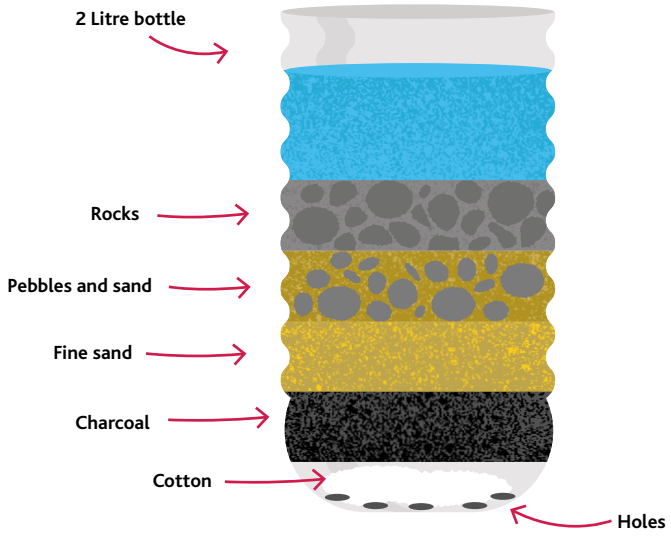
Briefing

This island has lots of fresh water – but if you drink it you may become unwell. You need to find a way to convert the ample supply of water you have into water that is fit for drinking.

YOUR TASK **Did you know coconut shell can be used to make coconut carbon and purify water? Use coconuts and other materials around you to create this nifty water filter so that you never go thirsty.**

WHAT YOU NEED TO DO

1. Start by making your coconut charcoal. Use a pair of tongs (or mounted needle) to hold a piece of coconut shell in the flame of a Bunsen burner until it goes black and sooty. (You could use a Bunsen gauze here).
2. Wait for the shell to cool and grind it up in a pestle and mortar.
3. Take your empty drinks bottle and cut it about a third of the way down from the top.



4. Put the top part of the bottle aside, keeping the larger, bottom half in front of you.
5. Use a sharp pair of scissors to carefully pierce five small holes into the bottom of the bottle.
6. Add a layer of cotton to the bottom of the bottle.
7. Sprinkle the coconut carbon on top.
8. Add a layer of fine sand.
9. Add a layer of thick sand.
10. Add a layer of gravel.
11. Place large pebbles on top.

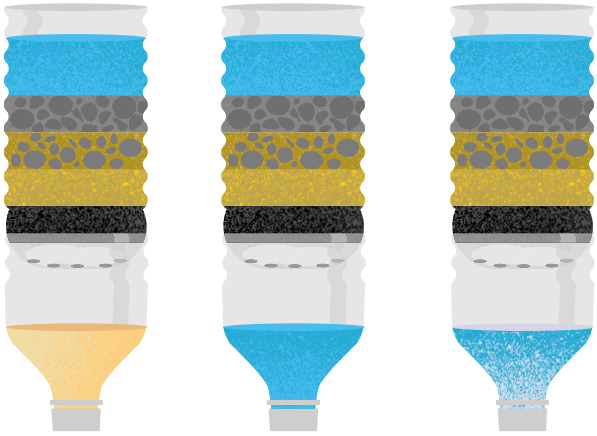
CAUTION: Under no circumstances should you taste the water.

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

5 Coconut carbon filter

12. Secure a clean cloth across the top with an elastic band.
13. Bring back the empty part of the drinks bottle you have kept aside. Hold it upside down so it creates a funnel shape. Now slide the part of the water bottle filled with filter material into the funnel. This now creates one larger filter that is tapered at the bottom to catch the clean water.
14. Filter away!
15. Now it's time to test your filtered water. Get a sample of drinking water and use some of the testing apparatus to compare your sample with the real deal – what do you find?



FUN FACTS

1. Modern day water filter cartridges use carbon – increasingly this is coconut carbon which has been steam-treated to activate it. There are tiny holes (pores) on coconut carbon that are the same size as the bacteria we want to remove from the water!
2. The first time you use a water filter, the water comes out black! This is because water is running through the carbon filter for the first time. Manufacturers suggest you run water through the filter four times initially before regular use.
3. Even though 71% of the Earth's surface is water, less than 1% of this water can be used for drinking. So, you can see how important these filters are!
4. Microbiologists are hired by the government to come up with methods of testing how clean water is. It's not just tap water that's tested – water for swimming pools and water used in factories is randomly tested too, making sure the public is kept as safe as possible!
5. Clean water isn't just something that stranded people need, it's necessary for everyone's survival. A chemist from Proctor and Gamble's Innovation Centre in Newcastle, Dr Phil Souter, was looking for a way to recycle soapy water from washing machines, and developed technology that can purify 10 litres of dirty water in 30 minutes. It has been proven to eliminate disease - causing microorganisms and reduce the risk of disease and death by 50%. Since his technology was developed more than 12 billion litres of clean water have been distributed around the globe!

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

5 Coconut carbon filter

Experiment results and observations

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

6 Sundial

Objective

In this activity, students design their own sundial. Students will select the best materials for their sundial, considering their properties. Their design should be based on their properties of the materials available to them, and how they can use changing shadows formed from the rotation of the Earth to tell the time.

HEALTH AND SAFETY:
A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

TOPIC LINKS

- Physics: space
- Design and technology: material properties
- Engineering: application of materials to solve a problem

TIME

40 minutes

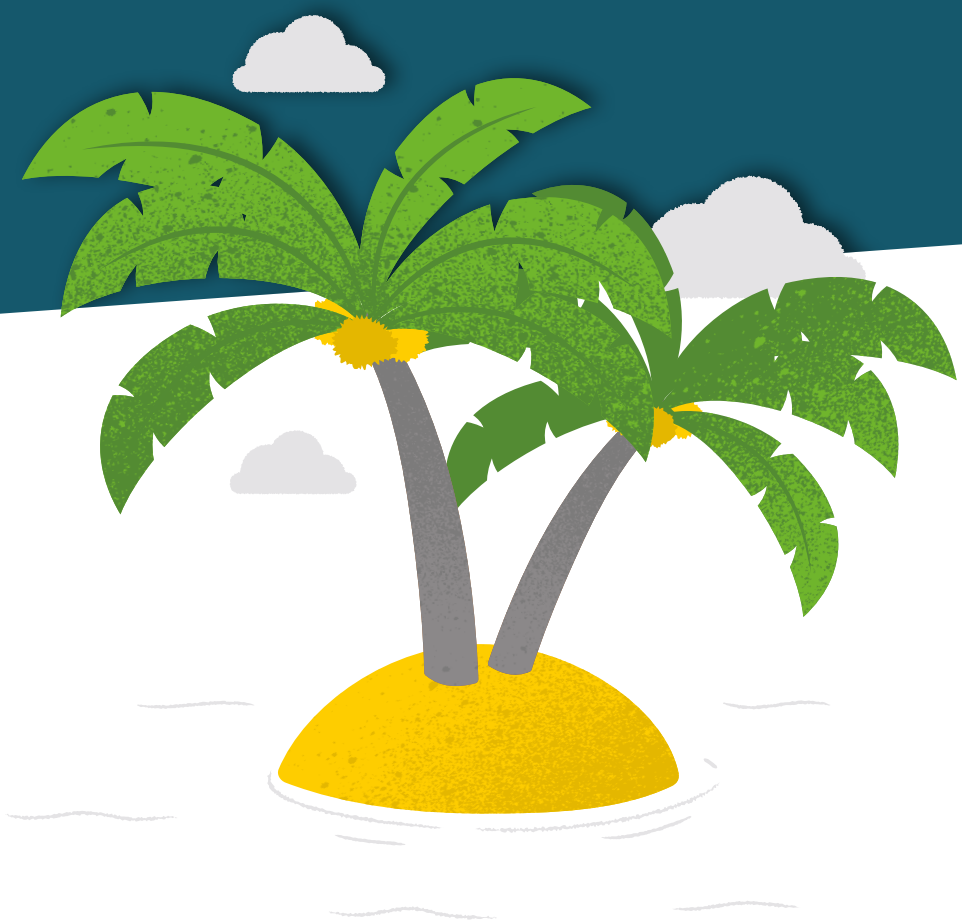
RESOURCES AND PREPARATION

Any materials that could be found on a desert island. For example:

- bamboo sticks
- large stones (about 5cm in diameter or bigger)
- carrier bags
- a watch
- shells
- rope
- coconuts
- plastic bottles

DELIVERY

1. Discuss why keeping track of time would be important if you found yourself stranded on a desert island.
2. Show students the clay, bamboo and stones and ask them how they could use these to tell the time.
3. Explain that they could make a sundial. Which materials would be best? Emphasize that they can only use the listed materials (as this is all that's available on the desert island).
4. Allow time for pupils to discuss their choices based on the properties of the different materials.
5. Using their chosen materials, get students to sketch a design for their sundial, labelling the different materials they would use.
6. Give students the tip that currently their watch is still working so they can use this to help them.
7. Ask students or groups to share their design for making the sundial and discuss their choices of materials. Encourage students to think critically about each other's' choices and provide constructive feedback.
8. Allow pupils time to improve their designs following the feedback session. At this point, they could translate their idea into a 3d model.
9. Ask pupils how they could test their design? What would be an effective way to identify its time keeping capabilities?



TIPS

How to make a sundial at home/school:

1. Place the stick in the clay so it stands upright.
2. Put the clay on the ground so the stick casts a shadow on the ground.
3. When the time reaches a set hour, place a rock where the stick forms a shadow.
4. Continue to do this for every hour during the day (you may need to assign times to people within your group) mapping out where the shadows fall each hour.
5. By the end of the day – you'll have your sundial!

Download and print a sundial template so pupils can build and trial one out immediately.

This needs to be done on a sunny day and requires an outside area at school that won't be disturbed!

EXTENSION IDEAS

Students could build the sundial using the materials provided. They could then test their sundial over the next week. Students will need to make sure they test their sundial at the same time every day (lunchtime) to measure its time keeping properties.

DIFFERENTIATION IDEAS

Support: explain to students how they would go about using rocks, bamboo and a watch to build a sundial.

Challenge: create a model to illustrate the difference between a solar day and a sidereal day.

USEFUL LINKS

BBC article about making sundials
http://www.bbc.co.uk/norfolk/kids/summer_activities/make_sundial.shtml

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

6 Sundial

Briefing

You need to be able to keep track of time on this island and your watch battery may soon run out. To help you on the island, create a design for a sundial to tell the time and come up with a way you could test its accuracy. Remember, there's plenty of sun on this desert island.

YOUR TASK **Work together to design your own sundial.**

WHAT YOU NEED TO DO

1. Look at the materials given to you. How could you use these (and a working watch) to create a contraption so you can tell the time once your watch runs out of batteries?
2. In your groups, discuss which materials would work best – consider the different properties of the materials available.
3. Create a sketch of your design ready to share with the rest of the group.
4. Listen to one another's ideas and explain your choices to your peers. Are all the ideas the same? Do you need to change your design based on what you have heard?
5. Download and print a sundial template (check out the web links or find your own online –there are lots) to make your own which you can then compare to your rock version.
6. Research what a 'sidereal day' is. What is more accurate, a sundial or a smartphone? Which is more precise? Why is this? Present your conclusion to the class.

If you'd like to make a paper sundial, print and download the template in the links section!

FUN FACTS

1. The part of a sundial that stands upright and casts the shadow is called the 'gnomon'. This is a word that comes from ancient Greek and means indicator.
2. Sundials started out as huge objects but gradually became smaller so they could be carried around, similar to watches!
3. The length of the shadow cast by the gnomon from the sundial varies throughout the day. It is longest when the sun is lower in the sky at the beginning and end of the day.

STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

7 Organic toothpaste

Objective

In this activity, students formulate their own toothpaste. Students will explore the cleansing power of eggshell and charcoal.

TOPIC LINKS

Chemistry: synthesis, practical skills

TIME

40 minutes

RESOURCES AND PREPARATION

- eggs (3 per group)
- coconut oil (15 ml)
- fresh mint
- charcoal (1 stick per group)
- scissors
- a Bunsen burner
- 2 x pestles and mortars
- coffee
- berries (e.g. blueberries/ raspberries/blackberries)
- food colouring
- condiments (e.g. tomato sauce, jam, BBQ sauce, black tea, black coffee)
- a white tile
- cotton buds
- shop-bought toothpaste (for comparative testing)
- disposable gloves

DELIVERY

1. Discuss with students what creature comforts they would miss most if they found themselves stranded on a desert island.
2. Explore the concept of prevention vs. cure. If we look after ourselves correctly now, then we are more likely to avoid the need for treatment in the future. Bring up the idea of dental hygiene if it hasn't already come up.
3. Allow students time to discuss what ingredients might go into toothpaste.
4. Assist students as they plan and make an organic toothpaste, following the instructions on the student guide.
5. Instruct students to test the toothpaste having prepared the tiles before making the toothpaste.

TIPS

- Students can use any oil in making the paste.

EXTENSION IDEAS

1. Ask students to research what goes into toothpaste. What key ingredients are they missing?
2. Ask students to design their own desert island toothbrush to get their teeth clean. What resources could they find on the island to help them make this?

DIFFERENTIATION IDEAS

Support: give students step by step instructions on how to formulate the toothpaste, assisting them where necessary.

Challenge: give students the materials and apparatus but do not tell them how to make the paste. Allow students to experiment to make their own version. Add red herring ingredients and equipment to challenge students further.

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

7 Organic toothpaste

Briefing

Teeth easily decay if we neglect them. You need to find a way to clean your teeth and keep them healthy using the limited resources you have on the island. You won't be able to get your hands on any fluoride!

YOUR TASK **Use egg shells and charcoal to make your own toothpaste! Compare it to everyday toothpaste and decide which is best at combatting teeth stains!**

WHAT YOU NEED TO DO

Testing preparation

1. Use a cotton bud to smear two white tiles with common teeth stains (e.g. coffee, food colouring, tomato sauce). One will be for your toothpaste, one for the shop-bought toothpaste.
2. Try to smear on equal amounts of stain onto each tile.
3. Allow the stains to dry while you make your toothpaste.

Toothpaste preparation

4. Crack the eggs, keeping the pieces of shell as large as possible.
5. Wash the shells under cold running water.
6. Use the tongs to gently heat the shell in a Bunsen burner, ensuring all the shells are completely dry.
7. Crush the shells to a fine powder using a pestle and mortar.
8. Add some coconut oil a little at a time to the egg shells, continuing to grind.
9. Keep adding oil until you are happy with the consistency of your paste.
10. Finely cut some mint and add this to your paste.
11. Crush some charcoal in another pestle and mortar.
12. Add a sprinkling of charcoal to your toothpaste
13. Your toothpaste is ready for testing!
14. Use a cotton bud or gloved finger to compare how good each toothpaste is at removing the different stains from your white tiles.
15. Which ingredient is most vital? Experiment to see what happens when you make the toothpaste without one of the ingredients.
16. Record your results in the space below. What impact does the removed ingredient have on its cleaning power?

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

7 Organic toothpaste

Experiment results and observations

FUN FACTS

1. Fluoride was added to toothpaste in 1956 and is now an essential ingredient that helps to prevent tooth decay and gum disease. In many parts of the UK, it's also an ingredient in our water supplies.
2. Your toothpaste can be used to polish your silver jewellery as it helps in removing its tarnish! It shouldn't be used on pearls though.
3. Toothpaste also contains detergent! It helps in foaming the paste when you brush!
4. Product researchers are scientists who are able to talk to the public and get a clear understanding of what people want. For example, in the toothpaste industry, hundreds of people are given different flavour toothpastes until there is a clear favourite. Different countries have different taste buds – that's why in America, toothpaste is normally flavoured with 'wintergreen' and in China, you can find 'green tea' flavoured toothpaste!

STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

8 Fish dissection

Objective

In this activity, students explore the anatomy of a fish, making comparisons between the organs of a fish and those of a human.

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity. Safety glasses should be worn.

If students have not carried out a dissection before, introduce them to the tools used and highlight the importance of thorough hand washing using soap after dissection.

Ensure you count out and count back in the dissection tools, and take care with their disposal.

TOPIC LINKS

Biology: anatomy

TIME

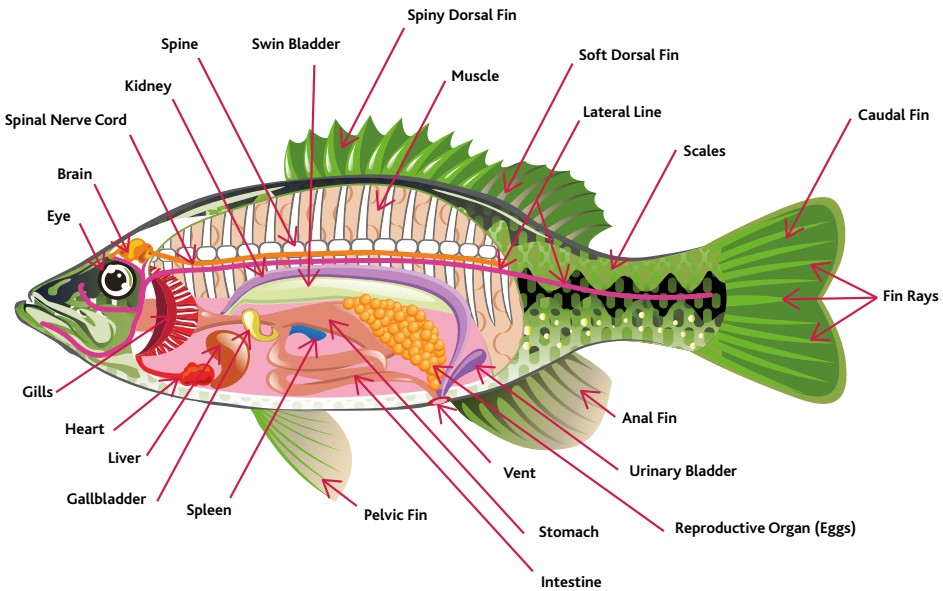
50 minutes

RESOURCES AND PREPARATION

- any medium-sized fresh fish (e.g. mullet, trout, mackerel,) CAUTION: source from a food-safe source e.g. dissection provider or supermarket/ fishmonger
- disposable gloves
- dissection scalpel or scissors
- dissection point-ended scissors (CAUTION: make sure you count out the scissors or scalpels and count them back in)
- dissection tweezers
- dissection tray
- safety goggles
- apron or lab coat
- hand sanitizer

DELIVERY

1. Discuss with students what their main source of food would be on a desert island.
2. How would students go about eating the fish? Are there parts to the fish that could come in handy outside of eating? How could we find out?
3. Show students a labelled diagram of fish anatomy (readily available online).
4. Elicit from students what parts they recognise from human biology. Are they surprised by the number of similar organs a fish has compared to the number a human has?
5. Show students a fish dissection video (see Useful links).



6. Demonstrate how to use dissection equipment e.g. holding blade away from you, and how to safely remove gloves. Please refer to CLEAPSS Dissection: A starter guide to health and safety.
7. Assist students as they complete their dissection.
8. Ask students to look out for parts of the fish that could be useful for them outside of eating.
9. Ensure students dispose of gloves in a waste bin and wash their hands with sanitising soap after dissecting.

TIPS

- If you have never done a fish dissection, refer to the videos and instructions in the Useful links prior to completing the dissection.
- Count out scalpels/scissors/tweezers so you can ensure all are returned.
- Ensure all students know to first cut along the underside of the fish from head to tail, then up towards the top of the fish from the two ends of the first incision as in the diagram. This will give easy access to the internal organs (see photo).

DIFFERENTIATION IDEAS

Support: select a fish dissection video to watch with the class and then demonstrate dissecting to the class, showcasing the easier to locate organs (eyes, heart and liver). Show students how to locate and explore the structure of the gills before allowing them to dissect their own fish.

Challenge: allow students to independently select four organs they will aim to locate. Students should use their research to give them an idea as to what size the organ is, whereabouts in the fish it is and what colour the organ will be to help them locate it.

EXTENSION IDEAS

1. Ask students to showcase the similarities and differences between the organs of a fish and those of a human. This can be aided by taking measurements, photographs and sketches of their dissection.

USEFUL LINKS

- http://cswnetwork.org/projects/pdf/197.pdf
- www.instructables.com/id/Fish-Dissection/
- www.youtube.com/watch?v=Im73uJVBowc
- www.cleapss.org.uk

STUDENT GUIDE: SUITABLE FOR AGE 11-14

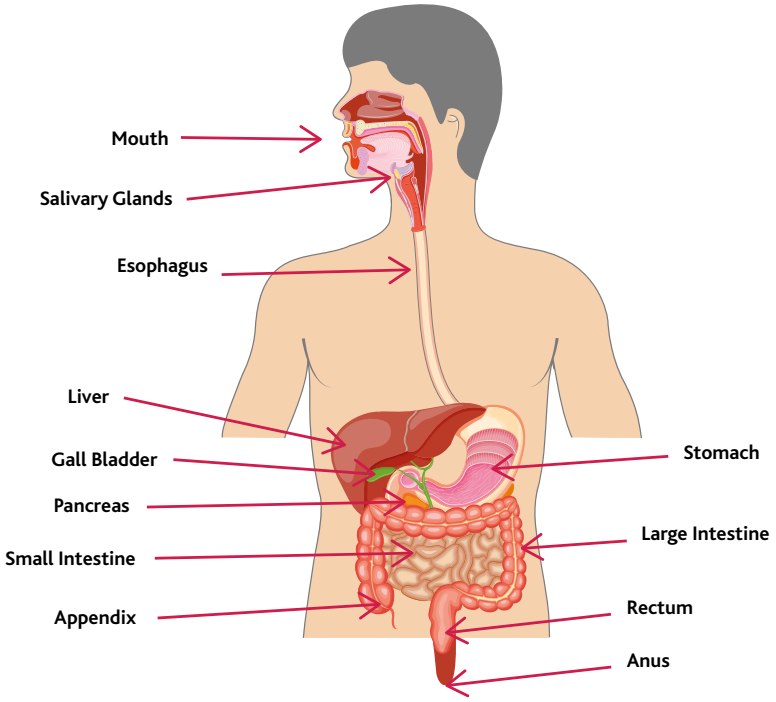
Could you survive on a desert island?

8 Fish dissection

Briefing

Fish make up a significant part of the island diet, but which part is which in a fish? Are all parts safe to eat? Would you want to eat all parts? Can any parts be used to help us on the island in some way other than as food?

YOUR TASK Complete the dissection so you're ready to tackle any fish! Compare the anatomy of a fish to that of a human – it might surprise you!



WHAT YOU NEED TO DO

1. Have a look at the labelled diagram of a fish that your Club leader shows you. Start to think about what you will expect to see inside the fish.
2. Use the links your Club leader gives to find out what organs a fish has. What will you be looking for?
3. Select some organs you are going to look out for in your dissection. Where do you expect to find them? What colour are they? What shape are they?
4. Put on your safety goggles, lab coat and disposable gloves. Collect a tray with one fish and your dissection tools.

FUN FACTS

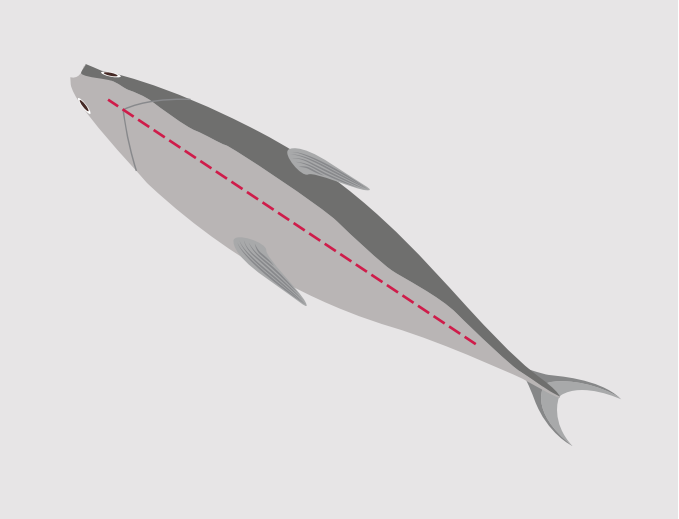
1. Fish have a heart, stomach, liver, intestine and kidneys but they don't have lungs. They breathe by taking oxygen from the water in through their mouths, where it passes over the gills. The gills then absorb oxygen from the water and send it throughout the body.
2. Fish don't grow new scales as they grow – the scales that they have just grow bigger. This means that you can estimate the age of a fish from the rings that are formed over time, which is similar to how you would guess the age of a tree.

STUDENT GUIDE: SUITABLE FOR AGE 11-14

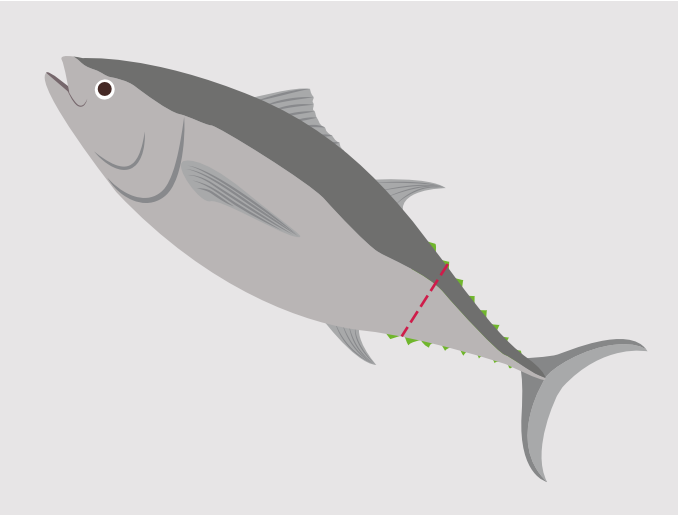
Could you survive on a desert island?

8 Fish dissection

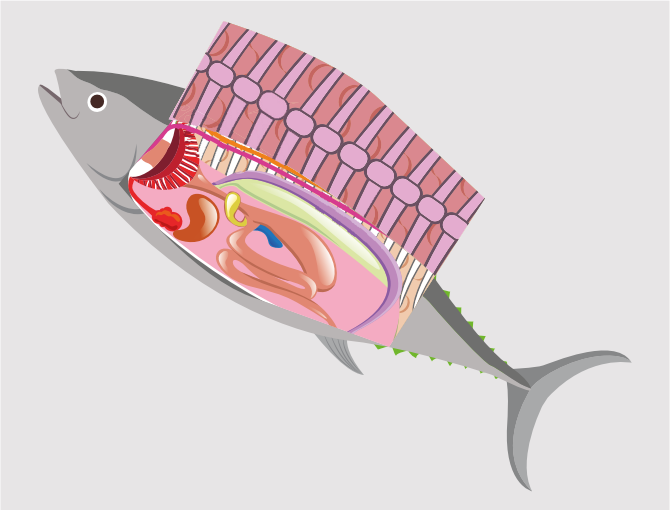
5 Carefully use the scalpel or dissection scissors to make an incision along the bottom of the fish.



6 From one end of the incision, use the dissection scissors to cut up towards the top of the fish. You will now have created a 'flap' on one side of the fish.



7 Do the same at the other end of the original incision. Cut up from the end of the incision towards the top of the fish. You should now have a large flap that you can fold up or cut away completely, revealing the internal organs of the fish. Ask your Club leader to show you a picture if you are unsure.



8 Use your research to locate the organs on your list!

9 How many of these organs do you recognise from human anatomy? How are they different? What adaptations does a fish have that a human doesn't? What do you find surprising about the anatomy of a fish?

10 What parts of the fish would be useful outside of eating? Could any parts be used in other ways?

REMEMBER: be very careful with the equipment you are using, do not wave any of the tools around and put them back on the table when not using them.

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

8 Fish dissection

Experiment results and observations

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Could you survive on a desert island?

9 Get CREST Discovery Awards

By completing all nine activities in this resource pack, your STEM Club members can get a CREST Discovery Award.

ABOUT CREST

CREST is a scheme that inspires young people to think and behave like scientists and engineers. It is student-led, flexible and trusted. CREST helps young people become independent and reflective learners. With no set timetable, projects can start whenever you want, and take as long as you need.

HOW TO GET YOUR CREST DISCOVERY AWARDS

It's easy to get your members' Discovery Awards, simply:

1. Sign-up for a free account - https://my.crestawards.org/
2. Have each member complete a CREST Awards Discovery Passport
3. Create a project eg. "Asteroid Impact", "Desert Island" or "Zombie Apocalypse"
4. Upload names
5. Upload two or three passports and any accompanying work
6. Assess individuals, have they:
   a. Completed around five hours of work on the project?
   b. Participated fully in the project?
   c. Reflected on their learning?
7. Type in your delivery and payment details.

TAKING THEIR WORK FURTHER

If members want to take activities further, they can work towards a CREST Bronze or Silver Award.

CREST Bronze Awards require around ten hours of enquiry, project-based work, and Silver Awards require thirty hours of work at GCSE or equivalent standard. Using one of the activities for inspiration, they choose a question or topic to investigate.

Guidance on how to run CREST Bronze and Silver Award projects is available on the CREST Awards website www.crestawards.org.

Notes

Notes

STEM CLUBS

NUMBER 1 FOR STEM

STEM Clubs Programme, led by STEM Learning

Achieving world-leading STEM education for all young people across the UK.

For more information on the programmes and publications available from STEM Learning, visit our website www.stem.org.uk