

Week 4 Lesson 2

Mussel adhesive

Aim: To investigate the properties of glue through an example of biomimicry. Research into this is still on-going.

Keywords: adhesive, mussel threads, mussel

Starter activities

1. Types of glue

Students write down as many types/brands of adhesive as they can in 30 seconds. Other than 'stickiness', ask them to list one or two different properties for each type.

2. How do mussels stay attached to rocks?

Show an image of mussels attached to a rock. Give students the statements to organise into a sensible order (resource 'How do mussels stick?').

Main activities

1. Making glue

Carry out the practical investigation (resource 'Making a glue') in which students make glue and then test its strength. This investigation can be extended into finding the best recipe for the strongest glue.

2. Comparing mussel strength

A graph drawing and interpretation exercise.

Differentiation

Provide the axes pre-drawn to students who need some support. Reduce the number of points they need to plot and only do one set of data. They can compare their graph with a friend or partner who has plotted points for the other set of data.

Assessment opportunity

The activity will allow you to assess students graph drawing skills and ability to interpret graphs.

Plenary activity

1. Taboo

Students choose a word from a bag. They have to describe it to the class without saying the word itself.

The person who gives the correct answer explains how the taboo word is connected to the lesson.

Suggested words:

byssus thread	calcium	base
mussel	bay	solution
shell	rocks	ethanoic acid
valve	adhesive	indicator
mollusc	glue	Newton
invertebrate	polymer	investigation
intertidal	property	comparison
shore	force	compare
		research

Starter 2

How do mussels stick?

Photocopy and cut up the statements. Give each group a set and ask them to put them into a sensible order.

You may have seen mussels attached to rocks at the sea side.

They are firmly attached by **bysuss threads** which glue the shell to the rocks.

The forces which are experienced by mussels as they are pounded by the waves are much larger than the strength of the bysuss threads which scientists measured in the lab.

This mystery was solved by further research which revealed that the threads are made of both stiff and soft materials.

This special combination of materials means that when the threads are moved by the crashing waves, they become 900% stronger than when the thread is not moving.

Scientists would like to copy the mussels' ability to glue themselves to rocks and for the glue to set under water.

This new glue would be great for fixing internal, surgical wounds.

Main 1

Making a glue – Teaching notes

Students could make up the glue in the lesson or a range could be prepared beforehand and then each group could test three or four glues.

Apparatus and chemicals for making glue

- skimmed milk
- dilute solution of ethanoic acid
- bases e.g. magnesium carbonate, sodium hydrogen carbonate, calcium carbonate
- measuring cylinders 100cm³ and 25 cm³
- beakers 100cm³ and 250 cm³
- spatula
- stirring rod
- filter funnel and paper
- indicator paper

Apparatus for testing glue

- lolly sticks
- Bunsen burner and apparatus for heating liquid in a beaker
- clamp and clamp stand (2 per group)
- elastic bands
- 10 N weights to test strength of glue plus hook
- something to absorb impact e.g. sand box

NB: A risk assessment needs to be carried out before doing the experiment with students, please refer to CLEAPPs Hazcards. Students should wear eye protection throughout.

Method:

1. Put 100 cm³ of milk and 20 cm³ of ethanoic acid into a beaker.
2. Heat on medium flame and stir until small lumps begin to form.
3. Stop heating but continue to stir until no more lumps form.
4. Stop stirring and let the lumps sink.
5. Decant the liquid from the top and filter the remaining mixture.
6. Rinse the beaker thoroughly.
7. Gently squeeze the solid lumps to remove excess liquid.

8. Return the lumps to the beaker. Add 15 cm³ water and mix until smooth.
9. Add half a spatula of the base and use indicator paper to check the mixture is neutral.
10. If still acidic add a little more of the base.
11. Cut sticks into 4cm lengths.
12. Take two lengths and overlap by 2cm. Apply your glue and stick them together.
13. Stand clamps on the floor or on two stools, with the glued sticks between them.
14. Attach the weight hook from the lower of the two sticks and add weights 10N at a time.
15. Record the force required to break the join between the sticks.

Further investigation

Different groups of students can make glues with different bases. They can swap and test another groups' glue to find out which base makes the strongest glue.

Different milks i.e. skimmed, semi-skimmed, full fat, goats milk can be tested.

Different materials can be tested - does the glue adhere to plastics, metals, paper?
Does it work under water?

Notes

Skimmed milk produces the best glue. Proteins (predominately casein) are precipitated from the milk by ethanoic acid. The protein molecules undergo polymerisation forming the glue. The fat in milk acts like a lubricant preventing the protein molecules from sticking together as effectively.

The insoluble casein in the solid curds is hydrophobic and fairly insoluble in water.

The adhesive produced by mussels will work both in and out of water.

Main 2

Comparing mussel strength

Sea mussels		Bay mussels	
Area of one shell valve cm ³	Force needed to dislodge mussel from rock (N)	Area of one shell valve cm ³	Force needed to dislodge mussel from rock (N)
3	4	5	3
5	5	7	4
5	10	10	5
7	7	11	3
7	10	15	5
9	14	16	4
10	10	17	13
10	15	20	5
10	20	20	6
13	17	22	8
13	20	25	5
13	23	25	7
15	23	27	6
15	25	30	10
17	25	32	10
18	30	33	14

Table 1: Showing the size of a mussel and the force required to dislodge it.

1. Plot the points for both species of mussel and draw a line of best fit for each.
2. Describe the relationship between shell size and force for each species.
3. Compare the shell size and force. What differences can you see between the two species?
4. Sea mussels are attached to rocks on exposed shores and experience the full force of the ocean's waves. Bay mussels are found in sheltered coves and harbours. Use this information to explain the differences.