Brine Shrimp Investigation

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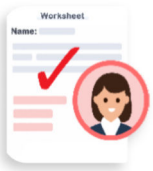
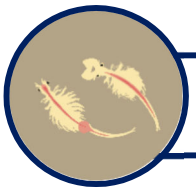


Notes for teachers

- Scan the QR code to get the electronic files.
- Teachers are strongly encouraged to adapt and modify these resources as necessary.

Innovations in Biology Investigations



Brine Shrimp Investigation

Overview

- This *Brine Shrimp Investigation* is about examining the behaviours of brine shrimps (Millar, et al., 1994).
- Students design experimental set-ups to investigate the preference of brine shrimps for light colours.
- Students are given the opportunity to design and carry out experiments in which they generate inquiry questions, establish sampling strategies, set up replicates, consider the importance of larger sample sizes, use multiple controls, and construct explanations.

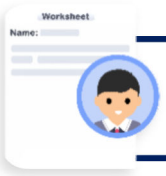
Teaching Plan & Key Features

Lesson	Lesson sequence	Duration (mins)	Resources
Stage ❶ Preparing for the investigation • Students observe and generate questions about brine shrimps to drive inquiry (*See-Think-Wonder thinking routine*, *Driving Question Board*). • Students read information about brine shrimps (*Reading Materials*).			
1	• The teacher allows students to observe adult brine shrimps and brine shrimp larvae. • The teacher invites students to ask questions about the brine shrimps. • Students read background information on brine shrimps. • The teacher introduces the investigation question based on the questions proposed by the students in the *Driving Question Board.*	40	*Worksheet 1*
Stage ❷ Designing the investigation • Students publish their experimental designs for peer feedback (*Mini Whiteboard*). • Students evaluate their experimental set-ups and those of their peers (*Gallery Walk*). • Students providing feedback to their peers (*Self & Peer Evaluation*).			
2	• Students are given the opportunity to see the materials and apparatuses and design their own experimental set-ups in the investigation. • Students share their experimental designs on *mini whiteboards*. • Students evaluate their experimental set-ups and those of their peers in a *gallery walk* activity. • The teacher provides feedback on students' experimental designs. • The teacher introduces the main investigation scenario and instructs students to design their set-ups.	40	*Worksheet 2*, Student Samples 1, *Worksheet 3*
3	• Students evaluate their experimental set-ups and those of their peers. • The teacher provides feedback on students' experimental designs.	40	Teacher Notes 1, Student Samples 2, *Worksheet 4*
Stage ❸ Carrying out the investigation • Students collect more complex data sets by setting up replicates (**Complex Data Set**). • Students use cameras to record data (*Digital Tool*).			
4	• The teacher provides students with the laboratory manual. • Teacher asks questions to help students connect their lab experience and related ideas/scientific inquiry skills • Students carry out the investigation.	40	Laboratory Manual

Stage ❹ Explaining and evaluating data • Students propose explanations to account for their data based on additional information about the brine shrimps (**Explanation Construction Task**). • Students reflect on their learning experiences using the reflection templates (*Reflection Cards*).			
Before Lesson 5	• Students complete data reporting and analysis at home. • The teacher collects and marks student responses.		Teacher Notes 2
5	• The teacher provides feedback on students' performance related to data reporting and analysis**.** • Students reflect on their learning and share their reflections.	40	Teacher Notes 2, *Worksheet 5*, Student Samples 3

Important Notes

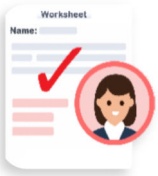
- This investigation involves the use of live organisms. Students should handle brine shrimps with care and respect their lives.



Instructional Materials

Stage 1 Preparing for the investigation

Student Worksheet 1



Notes for teachers

- Teachers distribute *Worksheet 1* and invite students to observe adult brine shrimps and brine shrimp larvae.
- The *Supplementary Resource* section contains the list of materials.
- Teachers use the *See-Think-Wonder* thinking routine to encourage students to make careful observations and propose scientific questions.
- More information about thinking routines can be found on the website: https://pz.harvard.edu/thinking-routines
- Teachers may project the microscope image of brine shrimp larvae. Scan the QR code below to see an example.
- Student questions may be posted on the *Driving Question Board*.
- After collecting student questions, teachers can distribute the reading material about brine shrimps and focus students on the inquiry question, 'Do brine shrimps prefer to live in the light or the dark?'

Task 1

- Examine the brine shrimps given. Answer the following questions:
  - What did you notice about the brine shrimps?
  - What do you want to know more about the brine shrimps?

⚠ *Brine shrimps are very delicate animals, and you must take care not to harm them when you handle them.*

See	Think	Wonder

"*See-Think-Wonder*" is a thinking routine that encourages careful observation and thoughtful interpretation. It helps stimulate curiosity and sets the stage for inquiry.

Information about Brine Shrimps

Directions
Read background information about brine shrimps.

Brine shrimps (*Artemiu*) are crustaceans and relatives of crayfish, lobsters, and hermit crabs. They are often referred to as 'sea monkeys' and are found worldwide in salt lakes. The salinity of salt lake water can exceed 280 g salt/L, whereas that of sea water is 35 g salt/L.

Brine shrimps begin their lives as tiny larva after hatching from tiny cysts. Young shrimp larvae are called *nauplii* (nor-plee-ee). In approximately 4–6 weeks, the shrimps reach their adult size of approximately 1 cm in length. See *Figure 1*.

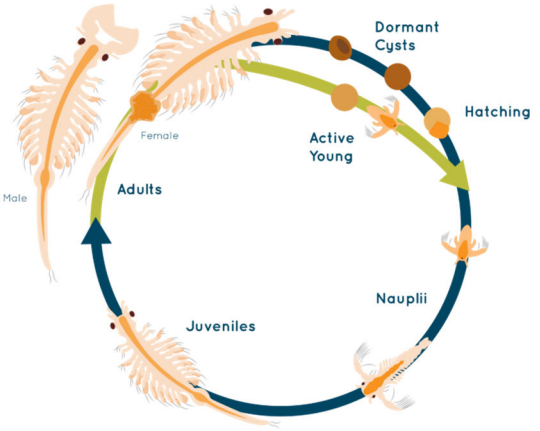


Figure 1

Brine shrimps have a head, middle (thorax), and tail (abdomen). On the front of the head are two little black eyes. There are also two small antennas that stick out forward. These are sensory structures for feeling the environment ahead. Brine shrimps usually move about on their backs, upside down with their leafy legs uppermost. The 11 pairs of leafy legs are used for swimming along in the water and as gills.

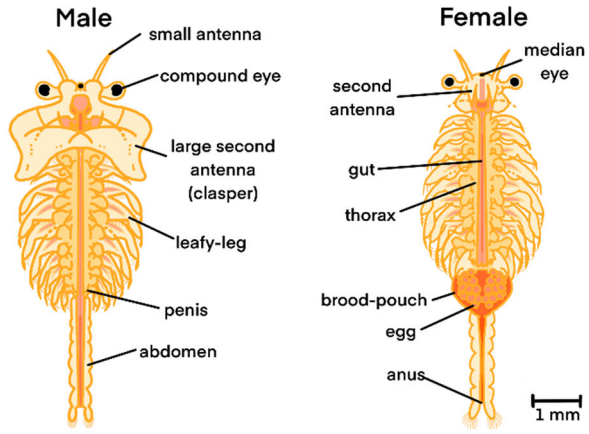


Figure 2

In males, the second antenna develops into large, hooked claspers. Males have a translucent body and are sometimes greenish-blue in colour.

The females are brown/red in colour and have a bundle of eggs in a brood-pouch halfway along their bodies.

See *Figure 2* for diagrams of brine shrimps.

Modified from Dockery and Tomkins (2000); Tomkins (2000).

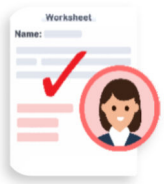
References

Dockery, M., & Tomkins, S. (2000). *Brine Shrimp Ecology*. British Ecological Society.

Tomkins, S. (2000). A review of the use of the brine shrimp, *Artemia* spp, for teaching practical biology in schools and colleges. *Journal of Biological Education*, *34*(3), 117–122.

Students are encouraged to find answers from the reading materials to the questions they have posed.

Student Worksheet 2



Notes for teachers

- Teachers distribute *Worksheet 2* and instruct students to design the experimental set-ups.
- Teachers can show students the materials and apparatuses to facilitate their design.
- Teachers can ask students to share their set-ups in small groups and instruct them to draw their experimental designs on *mini whiteboards*.
- Teachers can facilitate a *gallery walk* activity to give students an opportunity to evaluate the set-ups designed by their peers using the strategy *Two Stars and a Wish*.
- Some student work samples are shown below to illustrate possible student thinking.

Task 2(a)

- Imagine that you are working in a shop that sells brine shrimps. You would like to know more about the behaviours of brine shrimps. In particular, you wondered about the following question:

Do brine shrimps prefer to live in the light or in the dark?

- You found the following materials in the laboratory:

• 1 beaker of adult brine shrimps • Containers of various shapes (petri dish, measuring cylinder, and water tank) • Salt water • Aluminium foil	• Timer • Camera (mobile phone) • Light source • Dropper for transferring brine shrimps • Any other equipment you need (please specify)

- You may want to think about the following questions when designing your experiment:
  - What factor will you change?
  - What factor will you measure?
  - How will you collect the data?
  - How will you reduce the measurement errors?
  - What factors must be controlled?

- What is your experimental design? You may want to use a diagram to show your idea.

Task 2(b)

- Share your ideas with the person next to you.
- Draw your group's experimental set-up on the mini whiteboard.
  (*Note:* Please *annotate* your group's diagram to highlight any important design decisions.)

Students are allowed express their ideas either through drawings or in written words.

Mini Whiteboard Template

Investigation question:

- *Do brine shrimps prefer to live in the light or the dark?*

Our experimental set-up:

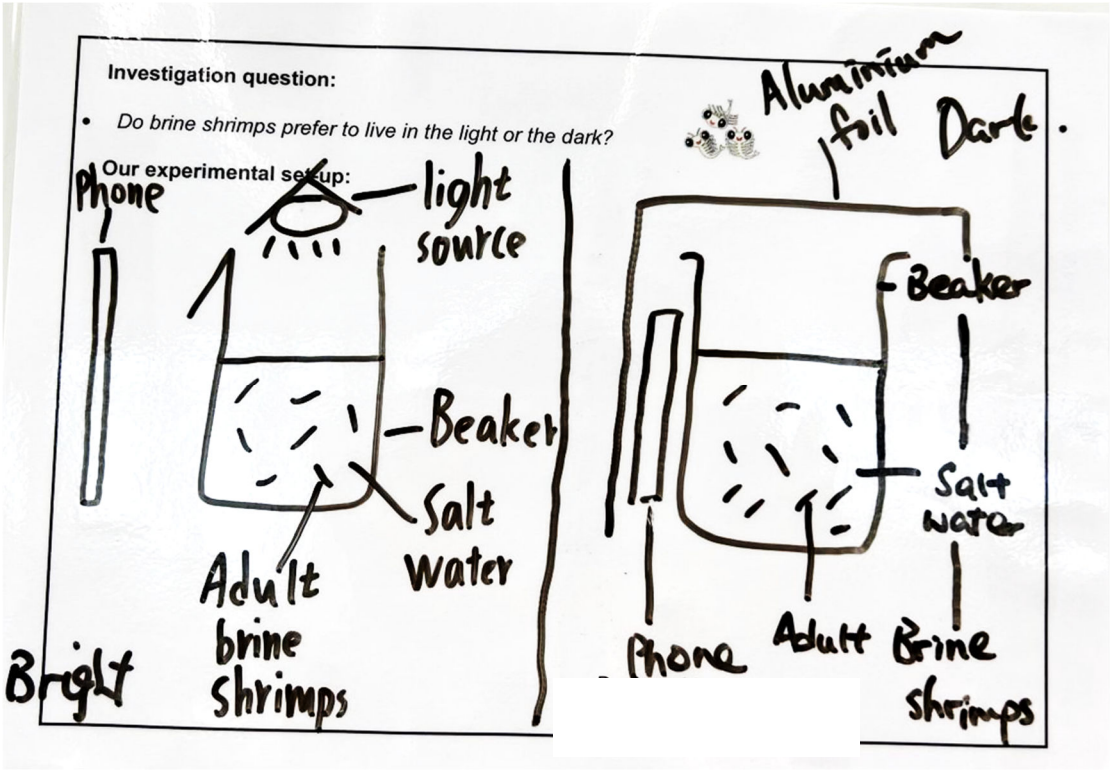
Designed by:

Students display their drawings, making their thinking visible.

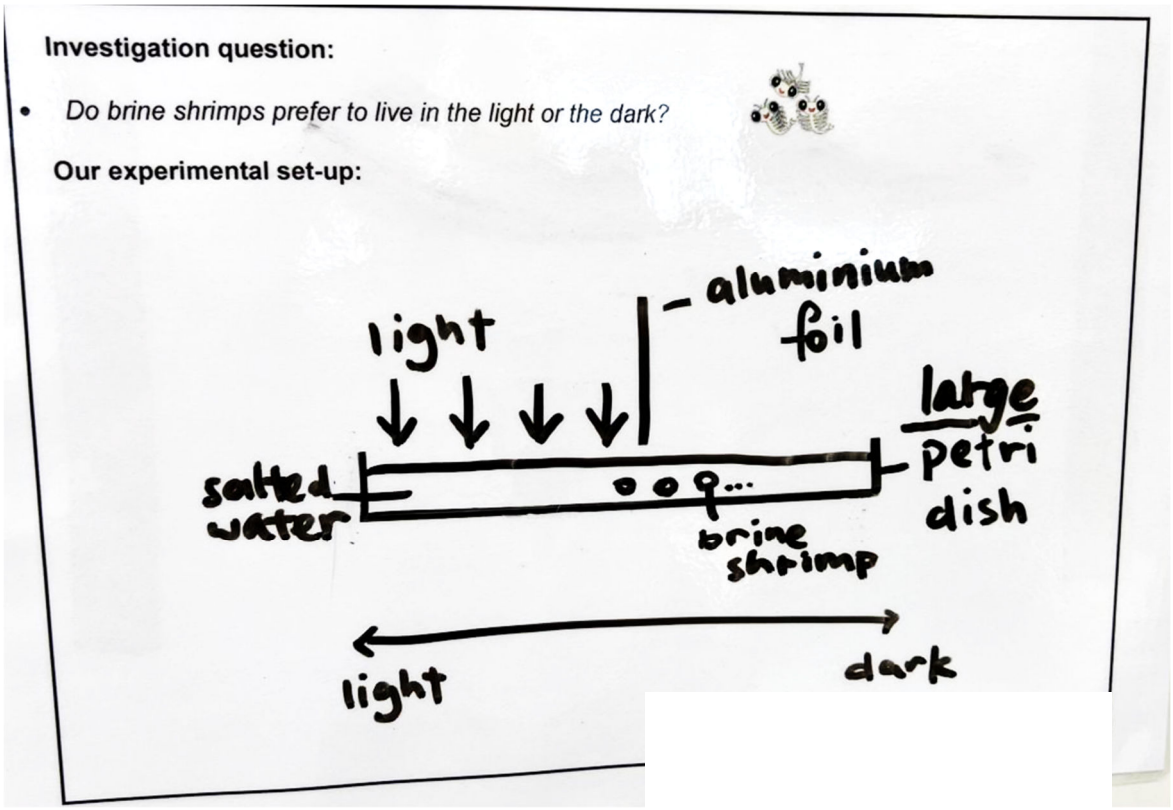
Scan the QR code to get a copy of the *Mini Whiteboard*.

Student Samples 1 (Worksheet 2)

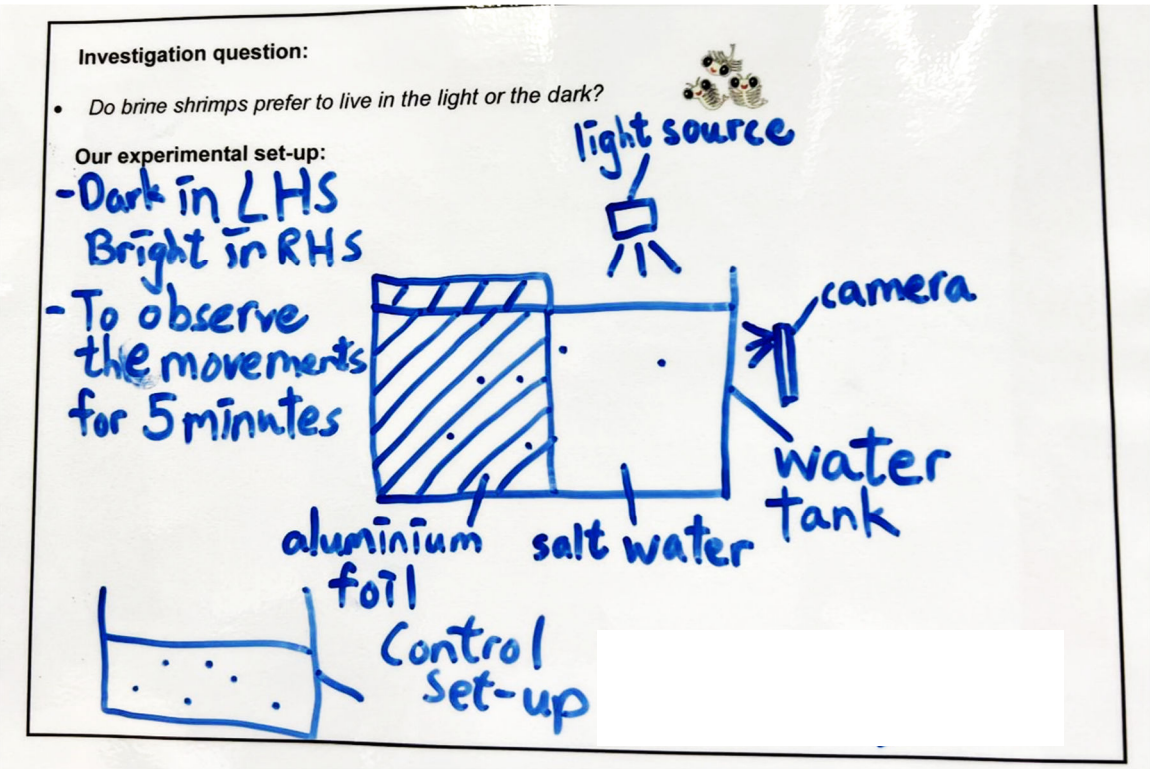
Sample 1



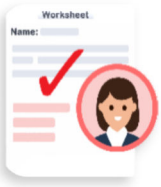
Sample 2



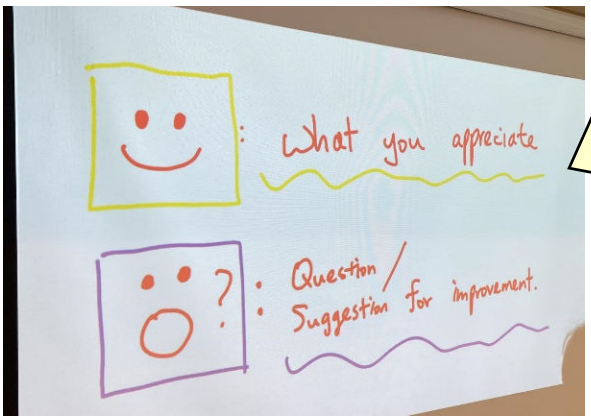
Sample 3



Notes for teachers



- Teachers can distribute *Worksheet 3* and do a *gallery walk* activity for students to evaluate their peers' set-ups.
- Some set-ups on the worksheet are similar to the typical student samples. For example, it is common for students to propose using two containers, one for a light condition and one for a dark condition (Sample 1, Design A on *Worksheet 3*).
- Students may also propose a set-up with light intensity as a continuous independent variable (Sample 2).
- Students may also propose control set-up (Sample 3, Design B on *Worksheet 3*).
- Teachers can press students for their reasoning for why the set-up they choose can produce the most accurate and reliable data.

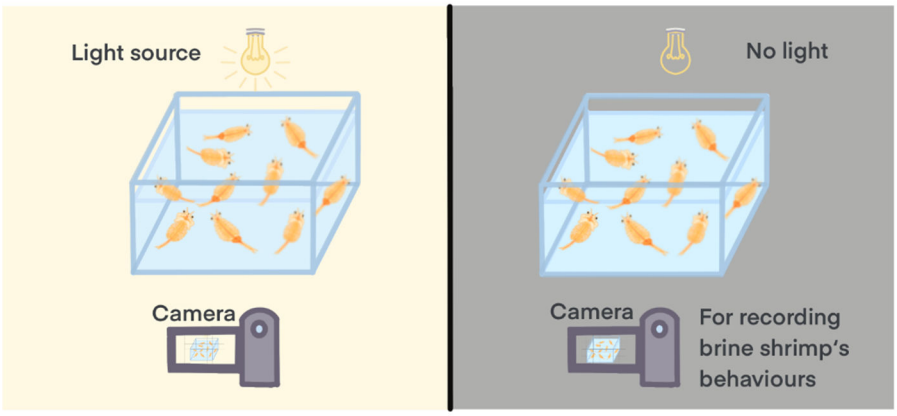


- Teachers can ask students to write comments on individual *Post-it* notes, which they can then post to share feedback on their classmates' experimental designs. Teachers may use the feedback strategy "*Two Stars and a Wish*" and ask students to provide two positive comments (the "stars") about each experimental design, along with one constructive suggestion for improvement (the "wish").

Task 3

- Examine the following experimental designs.

Design A



Design B

Aluminium foil
(To cover half of the dish to allow the brine shrimps to choose to stay in the side with light or that without light)

Control
(To see if the brine shrimps choose to stay in the particular side when no treatment is done)

1. Which set-up do you think can produce data that can answer the investigation question? Why do you think so?

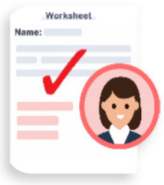
We think that

☐ Design A ☐ Design B

☐ My group's design ☐ My peers' design (_____)

can produce data that can answer the investigation question

because



Notes for teachers

- The following shows the main investigation context for students to work on.
- Some questions may be used by teachers to guide students in thinking about or assessing the scientific inquiry skills related to experimental designs.
- Student work samples are shown below to illustrate possible student thinking.
- Scan the QR code to get a copy of the *Google Form*.

Teachers can decide whether to give feedback to students and what type of feedback to provide based on their responses in the *Google Form*.

Task 4

Scenario

You would like to find out whether brine shrimp larvae would prefer to live in different light colours (i.e., red, green, yellow, and blue light). You find the following materials in the school laboratory for your investigation:

Brine shrimp	Camera	Timer
Light source (red, green, yellow, and blue)	Petri dish	Salt water
Plastic dropper (for transferring the brine shrimp larvae)	Aluminium foil	Measuring cylinder (for measuring salt water)

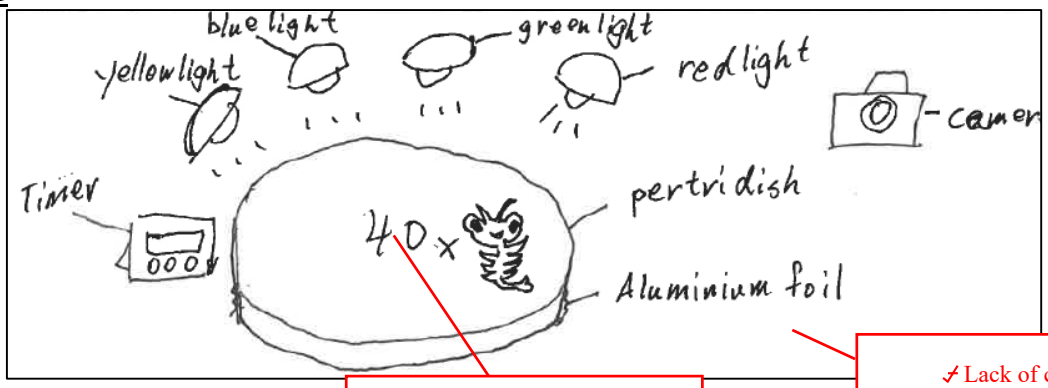
(a) Complete the following table to show your design:

Independent variable (*X*) (What is *X*? How to change and manipulate *X*?)	**Dependent variables (*Y*)** (What is *Y*? How to measure *Y*?)	**Controlled variables** (Anything else that likely affects *Y*?)
Sample (How many individuals?)	**Controls** (Do you need control? Why?)	**Errors** (How will you reduce errors?)

(b) Draw your experimental design and annotate your diagram:

Student Samples 2 (Task 4)

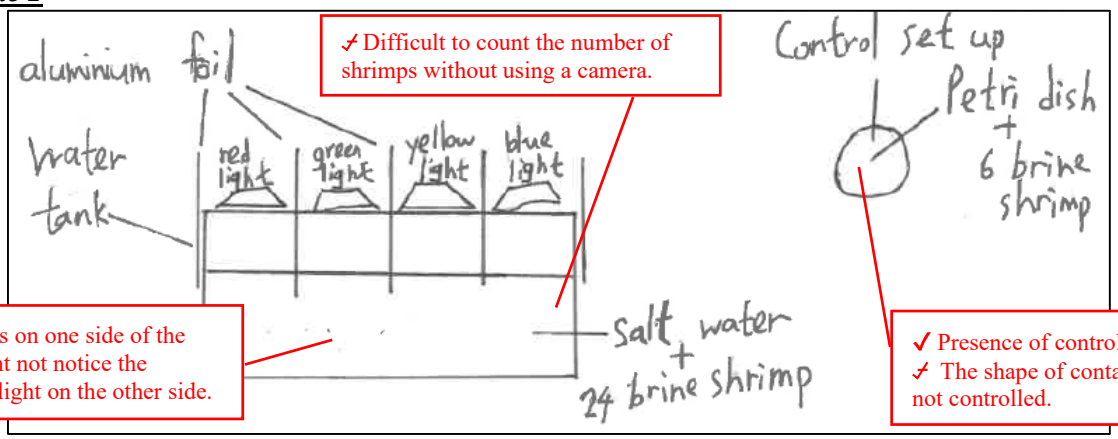
Sample 1



✓ Large sample size.

✗ Lack of controls.

Sample 2

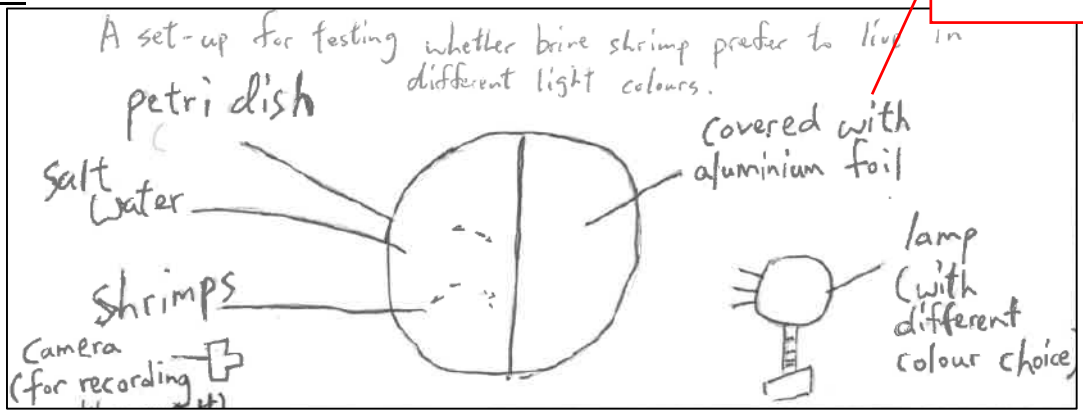


✗ Difficult to count the number of shrimps without using a camera.

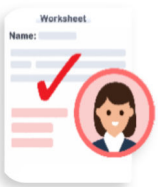
✗ Shrimps on one side of the tank might not notice the coloured light on the other side.

✓ Presence of control setup
✗ The shape of container is not controlled.

Sample 3



✗ Lack of controls



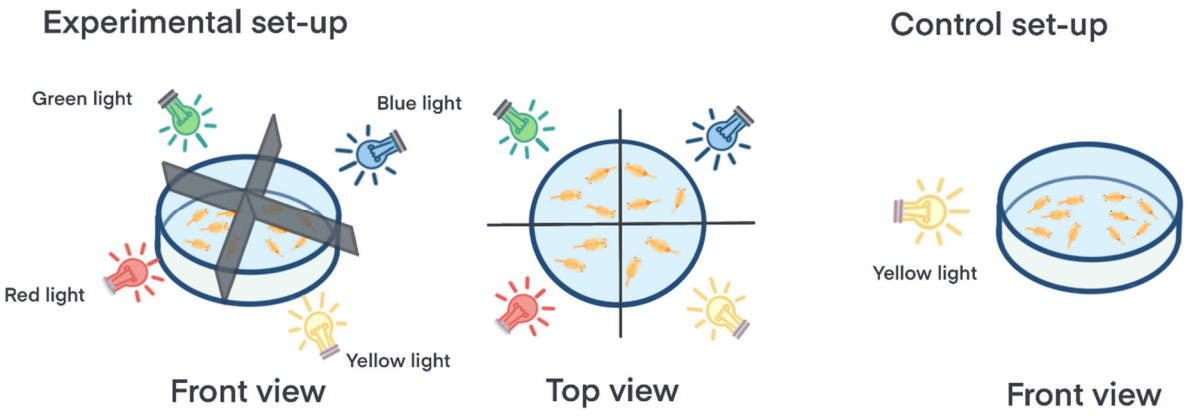
Notes for teachers

- Teachers can distribute *Worksheet 4* and ask students to evaluate their peers' set-ups and the set-ups on *Worksheet 4*.
- Some set-ups on the worksheet are similar to the typical student samples. For example, it is typical for students to propose Design A (Sample 1).
- Teachers can focus on several scientific inquiry skills such as how to sample the brine shrimps, the concept of controls, and alternative designs.
- Teachers can press students for their reasoning for why the set-up they choose can produce the most accurate and reliable data.

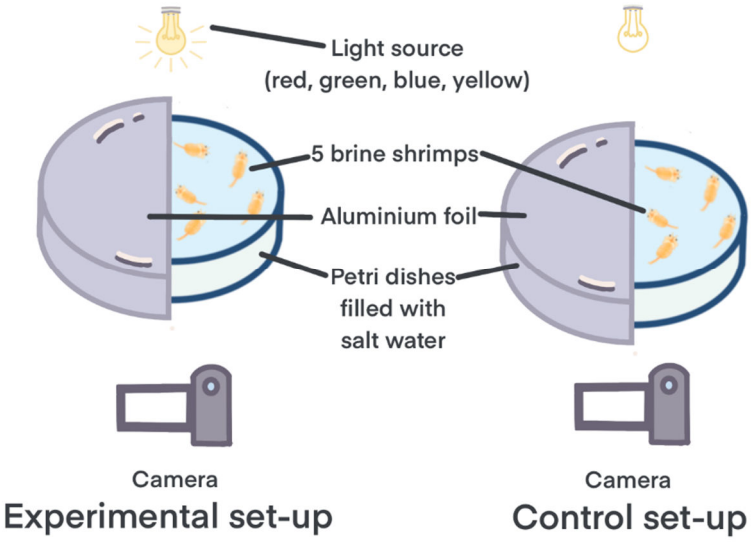
Task 5

- Examine the following experimental designs.

Design A



Design B



(a) Which one of the following set-ups can generate data that are more accurate and reliable? Why do you think so?

We think that

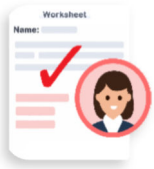
☐ Design A ☐ Design B

☐ Our group's design

can produce data that are more accurate and reliable *because*

(b) What else can be improved in the set-up in (a) to generate data that are more accurate and reliable? Why do you think so?

Laboratory Manual



Notes for teachers

- Teachers can distribute the manual for students to read and prepare before the investigation.
- Each group can be assigned to investigate the effect of two light colours. Data can be shared among the class.
- Teachers can ask questions to check if students fully understand the procedures.
- The *Supplementary Resource* section contains the list of materials.

Examples of questions include: How will you position the petri dishes, and why? How will you ensure that a similar number of brine shrimp are used in each petri dish?

Task 6

Procedure

1. Use a plastic dropper to transfer 3 mL of brine shrimp larvae into 3 petri dishes.
2. Gently swirl the petri dish to evenly distribute the brine shrimp larvae.
3. Cover each petri dish with a lid (half black in colour).
4. Position the table lamp 2 cm above the lid of the petri dishes.
5. Switch on the light (red/green colour).
6. Cover the set-up with a black cloth/plastic bag.
7. Wait for 5 minutes without disturbing the petri dishes.
8. Remove the black cloth/plastic bag. Be careful not to disturb the petri dishes.
9. Switch on the white light, and immediately record the distribution of the brine shrimp larvae.
10. Repeat *Steps 2–9* with blue/yellow light, white light (positive control), and without light (negative control).

⚠ *Brine shrimps are very delicate animals, and you must take care not to harm them when you handle them.*

Results

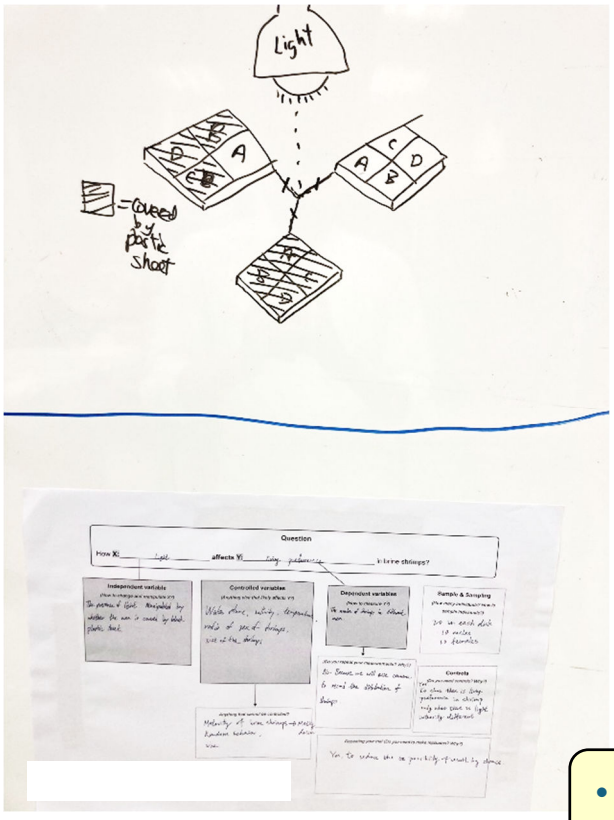
Light colour	Distribution of brine shrimp larvae			Preference for this light colour *(Strong attraction, weak attraction, no attraction)*
	Petri dish 1	Petri dish 2	Petri dish 3	
1	With light / No light	With light / No light	With light / No light	
2	With light / No light	With light / No light	With light / No light	
Control	**Distribution of brine shrimp larvae**			**Function of this control set-up**
3 Positive (white light)	With light / No light	With light / No light	With light / No light	
4 Negative (no light)	No light / No light	No light / No light	No light / No light	

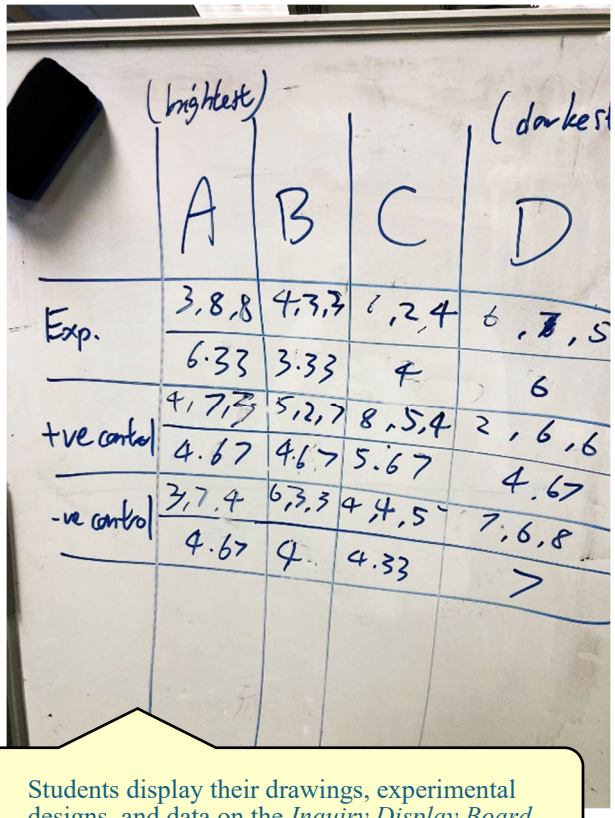
Notes for teachers

- Brine shrimp larvae are clearly phototaxis. However, teachers may use adult brine shrimps and ask students to use their data as evidence to support their claims about the preference of light/light colours of adult brine shrimps.
- Students may be allowed to design their own set-ups without following a manual. They can be provided with a *Reference Manual* as a basis for creating their own procedures.
- Students can be asked to display their experimental design, data collected, and claims on the *Inquiry Display Board*.

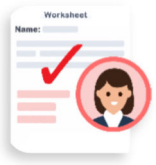
Scan the QR code to view the process of the experiment.

The petri dishes can be painted black by using spray paint.





- Students display their drawings, experimental designs, and data on the *Inquiry Display Board*.



Notes for teachers

- The following are possible questions that teachers can use to guide students in thinking about or assessing their scientific inquiry skills related to data analysis and interpretation.
- Student work samples are shown below to illustrate possible student thinking.

Task 7

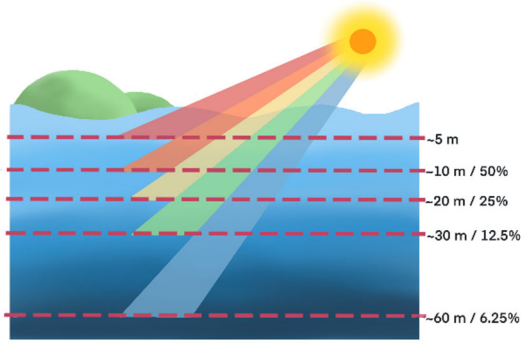
Possible questions

1. Complete the following table to show what deduction about the light colour preference of brine shrimps can be made by comparing the results of the following set-ups:

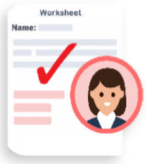
Set-ups	Deduction
1 versus 4	
2 versus 4	

2. You read the following information on a website:

Sunlight is a mixture of all colours of light. However, as sunlight travels through water, red and yellow light are absorbed, leaving only blue and green to be transmitted. In other words, blue light passes through water best, followed by green, yellow, and red lights. Red light is quickly filtered from water as the depth increases and effectively never reaches the deep ocean.



Based on the above information, propose a possible explanation for your experimental results.

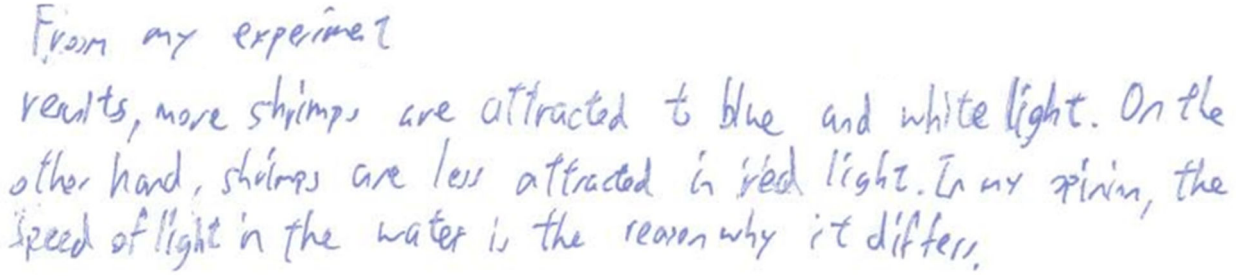


Notes for teachers

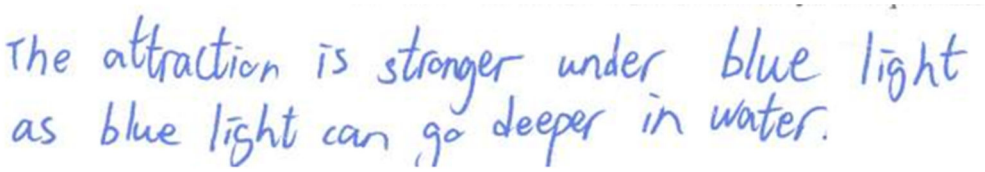
- Q.1 assesses students' ability to make claims based on the data by logical deduction.
- Q.2 assesses students' ability to propose possible explanations based on given information and data.

The following shows some students' responses to Q.2:

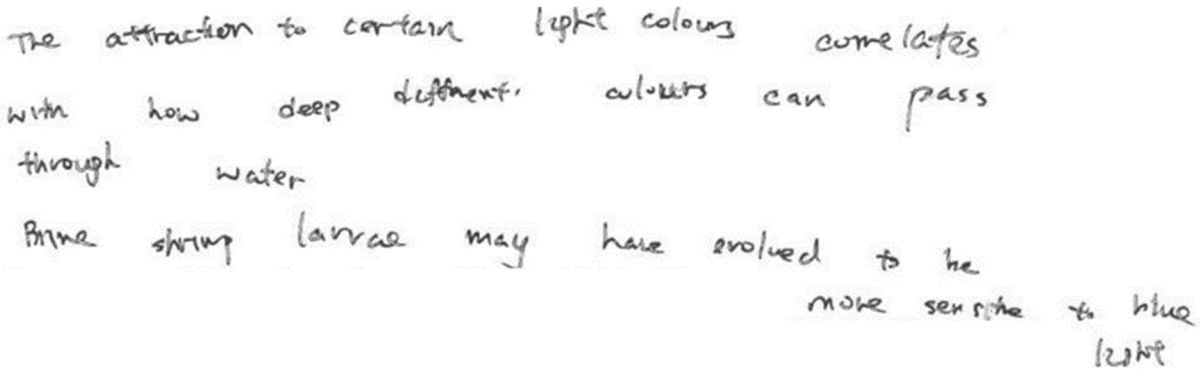
Sample 1

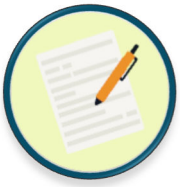


Sample 2:



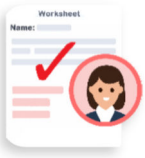
Sample 3:





About the samples

- Sample 1 could not relate the experimental results with the information given. There is a lack of biological explanation.
- Sample 2 could relate the brine shrimp preference for blue light with greater transmittance of light in water but could not give a biological explanation.
- Sample 3 could relate the brine shrimp preference for blue light with greater transmittance of light in water and provide a biological explanation.



Notes for teachers

- Teachers can distribute the mini whiteboards and invite students to reflect on their learning from the whole investigation.
- Teachers can ask students to read other reflections and compare their learning with others.
- Teachers may also ask students to elaborate on their reflections.

Task 8

- Reflect on your learning from the *Brine Shrimp Investigation*. What is your most important/impressive learning? Write down your thoughts on the mini whiteboards.

Reflection Card Template

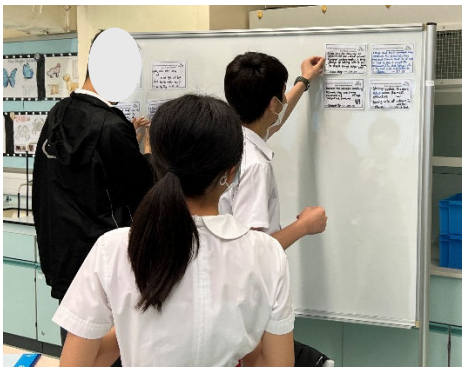
My most important/impressive learning from the ***Brine Shrimp Investigation***:

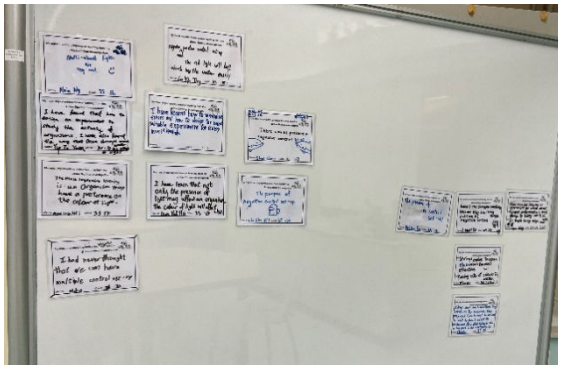
Students share their reflections with their peers.

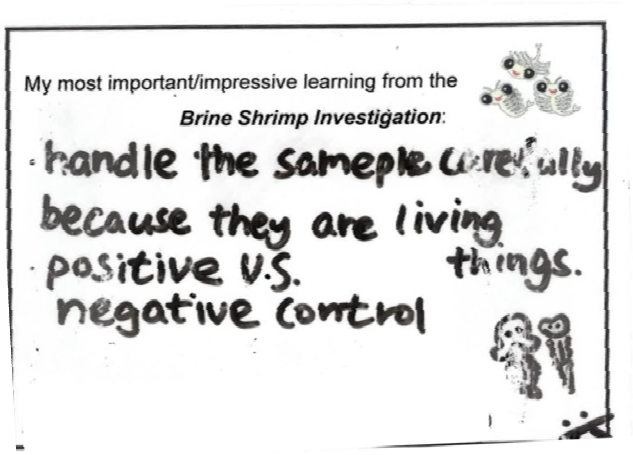
Name: *Class:* *( )*

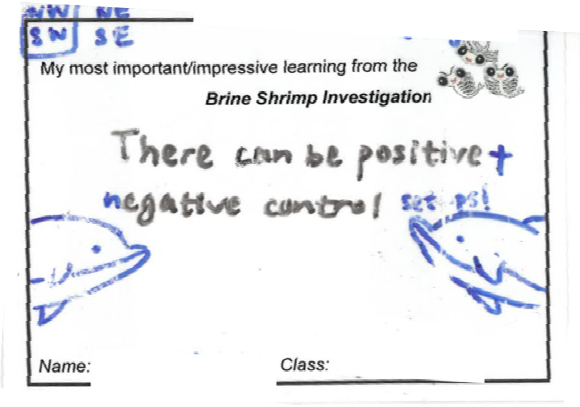
Scan the QR code to get a copy of the *Mini Whiteboard*.

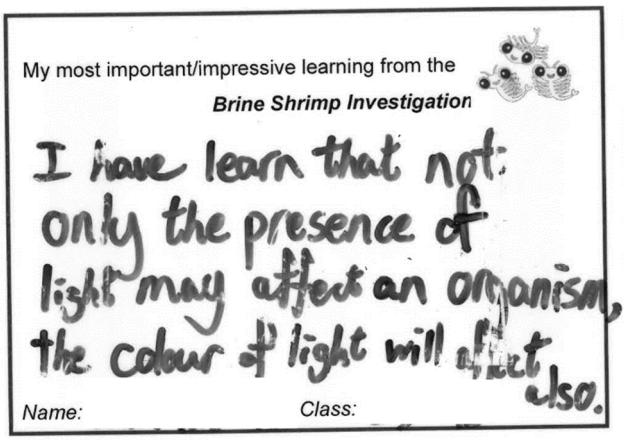
Student Samples 3 (Worksheet 5)

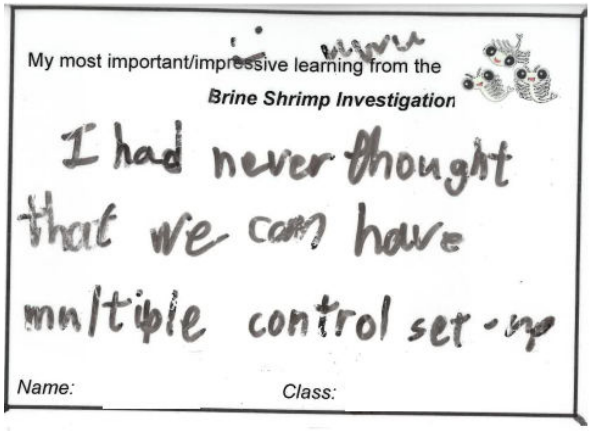












About the samples

- As shown above, typically students not only identified the learning of scientific inquiry skills (e.g., concepts of controls) as important learning outcomes but they would also develop affective outcomes related to handling living organisms.

Supplementary Resources

Possible Modifications

1. 'Plankton rainbow' demonstration

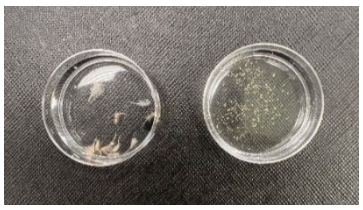
- The plankton rainbow demonstration can be set up using several glow sticks in multiple colours (blue, green, and red) and/or light sources with different colours.

- Details can be found in Exploratorium (2024).
- Scan the QR code for a video of the plankton rainbow demonstration.

Technician Notes

1. Materials for Task 1

- Adult brine shrimp in a petri dish
- Juvenile brine shrimp in a petri dish



2. Materials for Task 2

• 1 beaker of brine shrimps • Containers of various shapes (petri dish, measuring cylinder, water tank) • Salt water • Aluminium foil	• Timer • Camera (mobile phone) • Light source • Plastic dropper for transferring brine shrimps

3. Materials for Task 6

Materials for each group

• Petri dish (with half of the lid painted black) X 6	• Plastic dropper	• Black cloth/plastic bag
• Brine shrimp larvae in a beaker	• LED light bulb of different colours (Red, Green, Blue, White)	• Timer
• Ruler	• Table lamp	• Camera

References

Dockery, M. & Tomkins, S. (2000). *Brine Shrimp Ecology*. British Ecological Society.

Exploratorium. (2024). Plankton rainbow: Biology & perception science activity. https://www.exploratorium.edu/snacks/plankton-rainbow

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Tomkins, S. (2000). A review of the use of the brine shrimp, *Artemia* spp, for teaching practical biology in schools and colleges. *Journal of Biological Education*, *34*(3), 117–122.

This project is supported by Quality Education Fund (Project No. 2019/0283)

此計劃由優質教育基金贊助 (計劃編號 2019/0283)

nnovations in Biology Investigatior

Faculty of Education
The University of Hong Kong
香港大學教育學院

優質教育基金
Quality Education Fund