teacher guide

Carbon cycle 1: Carbon ocean

Components

NAME	DESCRIPTION	AUDIENCE
Carbon ocean teacher guide	This guide provides background information and outlines preparation required to complete activities in the workbook.	teachers
Investigating carbon workbook	The workbook presents procedures for activities exploring ocean biology and chemistry, as they relate to the carbon cycle.	students
SeaWIFS data video	Two animations represent data collected by the SeaWIFS instrument monitoring the colour of reflected light from Earth and chlorophyll concentration at Earth’s surface.	students
Phytoplankton rap video	An animated rap explains the importance of phytoplankton to life on Earth.	students
Seagrass services video	A short documentary describes a seagrass replanting experiment featuring South Fremantle Senior High School students.	students
Carbon cycle diagrams worksheet	Diagrams of the carbon cycle for teachers to print for activity 10.	teachers
Investigating carbon workbook answers	suggested answers to questions in the workbook, *Investigating carbon*	teachers

Purpose

Students **Explore** important elements of the carbon cycle that are ocean based: including phytoplankton, seagrass and ocean chemistry.

Outcomes

Students:

- appreciate the extent and importance of ocean plants and their part in the carbon cycle;
- understand ocean chemistry relating to water mixing and moving (currents); and
- recognise the role of oceans in the carbon cycle.

Activity summary

ACTIVITY	POSSIBLE STRATEGY
Prepare for students to rotate through 10, 5 – 7 minute activities, in small groups. Print out the required number of student workbooks.	teacher
Students rotate through activities. They may be done in any order.	small groups
Students answer questions in the workbook as they complete the activities.	each student or one workbook per group
Activity 8 may be conducted over a week. This requires students to complete planning and set up their investigation.	individual or group

Teacher notes

One way to work through activities in the workbook is to hold a caucus race. Materials required are listed with each activity; some activities require out-of-school preparation, e g collecting seawater samples, and making coloured ice cubes. Activity 8 is best completed over a week.

Classroom planning

What to do:

- Move students in small groups through activities, allowing 5 – 7 minutes for each.
- Ask students to complete answers to questions in the workbook, as they go.

You may like to split the activities into two sessions:

- all wet (physical property) activities (see table below), and
- remaining activities (see table below).

Alternatively, you may like to separate physical property activities (see table below), or split activity sessions according to equipment used:

- Activities 1 – 4 require a range of equipment and involve water and setting up again after each group completes the activity.
- Activities 5, 7 and 9 involve media viewing.
- Activity 6 requires a microscope and water samples from the ocean or fishpond.
- Activity 10 is paper-based and you may like to make laminated printouts (optional).

Activities in brief

ACTIVITY	ACTIVITY NAME	ACTIVITY TYPE
1	Water density A	physical property
2	Water density B	physical property
3	Water temperature	physical property
4	Water acidity	physical property
5	Phytoplankton from space	observing and interpreting
6	Phytoplankton under the microscope	observing and recording
7	Phytoplankton rap	observing and identifying functions
8	Plan a phytoplankton investigation	planning investigation
9	Sea grass services	observing and interpreting
10	Carbon cycle diagram interrogation	interpreting diagrams

Activity 8 requires students to plan an experiment that investigates what phytoplankton need to grow and how they respond to changes in their environment.

It's preferable for students (or one group that reports back) to undertake the experiment over the course of a week. Phytoplankton (algae) need a least a week to see noticeable changes and differences.

- Phytoplankton in the form of algae can be scraped out of a fish tank or fishpond.
- One straightforward experiment is to place some algae in three different locations: sunlight, darkness and something in between.
- Take photos at the start and finish to compare colour and density of phytoplankton.
- Phytoplankton also need nutrients. If students put algae in tap water they'll find they don't flourish, however if they use water from the source of the algae (e g fish tank) they'll do better. Either let your students discover this or tell them at the start.
- Students may devise a way to remove carbon dioxide from the algae's environment.
- Alternatively, they may experiment with how water temperature affects growth.
- If fresh-water algae are used students won't be able to undertake a salinity challenge but they could consider this in their experiment planning.

Activity 10 may require extra time and be completed outside the classroom.

Science background

When we think of carbon and climate change we often think about the atmosphere and importance of trees. Indeed, plants do take carbon dioxide out of the atmosphere and are important in reducing effects of extra carbon dioxide humans produce by burning fossil fuels. However, we seldom think about ocean plants, which are as important. This Explore section looks at ocean plants, the oceanic environment, and how it deals with carbon dioxide.

Phytoplankton is the collective term for tiny floating plants. They exist in large numbers in the ocean, so much so they can be viewed from space, although you need a microscope to examine a single plant. As they're plants they photosynthesise and need sunlight, carbon dioxide and nutrients to live.

Surprisingly, phytoplankton are responsible for half the oxygen on Earth. Without them Earth wouldn't be liveable. Phytoplankton have removed carbon dioxide from the atmosphere for an extremely long time.

Ocean plants such as seagrass and mangroves are closer to shore. We now realise these shore-fringing plants also play an important part in the carbon cycle and storing of carbon dioxide. Seagrass remains are buried in sediments and, because sediments are low in oxygen, seagrass remains don't decompose and release bound carbon, effectively locking it away for centuries if not disturbed. Human activities around the globe have destroyed seagrass (e g fertiliser run-off, dredging and coastal development). Re-establishing it may be a useful step in mitigating climate change. The mat of seagrass remains in the sediments is spelt matte.

Ocean currents are generated by wind, differences in temperature, and salinity (the latter two both affect water density.) Ocean currents occur near the surface and also deep in the ocean. The thermohaline current is a deep ocean current that circulates around the globe taking hundreds of years to complete a circuit. The currents mix and move water and also vital nutrients including carbon.

More carbon dioxide in the atmosphere also increases levels in the ocean through gas exchange taking place at the sea surface. Increased levels also affect the ocean's pH.

Carbon dioxide and other gases in the atmosphere are responsible for enhancing the greenhouse effect. The result of increased CO_2 is a warmer Earth, this includes both atmosphere and oceans. In addition, warming may cause sea ice and permafrost to melt, resulting in an influx of freshwater into the surface ocean.

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Technical requirements

The teachers guide and worksheet require Adobe Reader (version 5 or later), which is a free download from www.adobe.com. The worksheet is also available in Microsoft Word format.

A modern browser (e g Internet Explorer 9 or later, Google Chrome, Safari 5.0+, Opera or Firefox) is required to view the videos.

SPICE resources and copyright

All SPICE resources are available from the Centre for Learning Technology at The University of Western Australia ("UWA"). Selected SPICE resources are available through the websites of Australian State and Territory Education Authorities.

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Associated SPICE resources

Carbon cycle 1: Carbon ocean may be used in conjunction with related SPICE resources to address the broader topic of the carbon cycle.

DESCRIPTION	LEARNING PURPOSE
Carbon ocean (overview) This learning pathway shows how a number of SPICE resources can be used in teaching students about the carbon cycle and the significance of the oceans in the carbon cycle.	
Carbon cycle 1: Carbon ocean Students do a variety of hands-on and media watching activities that focus on phytoplankton, seagrass and ocean chemistry.	**Explore**
Carbon cycle 2: Feedback loops Students undertake an activity, with board and cards, involving small group discussion. Students identify positive feedback cycles that link human-induced climate change to the carbon cycle in oceans.	**Explain**
Carbon cycle 3: Carbon neutral Students watch a short video, then undertake a classroom or school audit to consider how a school can move towards carbon neutrality.	**Elaborate**