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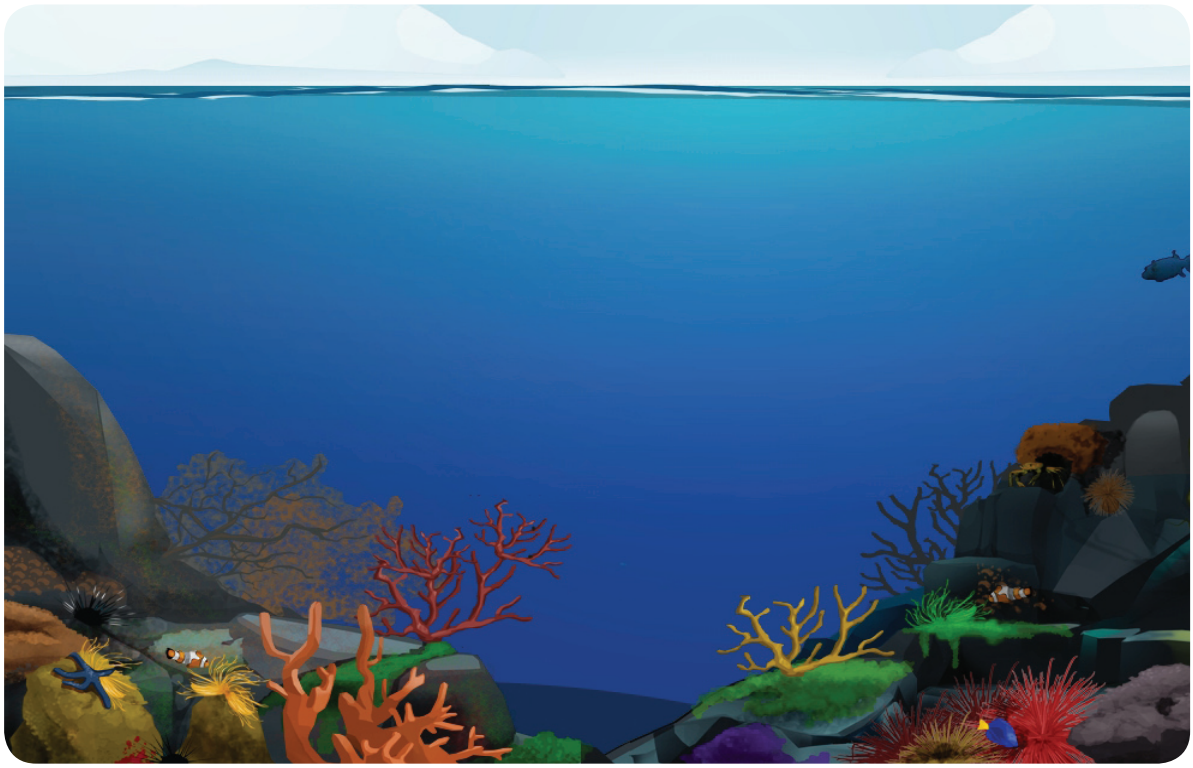
A / DESCRIPTION OF THE ANIMATION

A coral "head" is composed of a colony of animals (polyps) that live thanks to the presence of plant matter (algae) in their tissue. The collaboration between polyps and algae is one of true "symbiosis", each organism being able to draw benefits and sustenance from the other. This symbiosis is crucial to the survival of the animals, in that it enables the formation of coral reefs, home to a large number of species.

The rise in water temperature of our oceans, caused by climate change, causes this symbiosis to break down and usually leads to the coral death. With time, it's the entire ecosystem of the coral reefs that is threatened with extinction.



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B / LET'S TAKE A CLOSER LOOK...

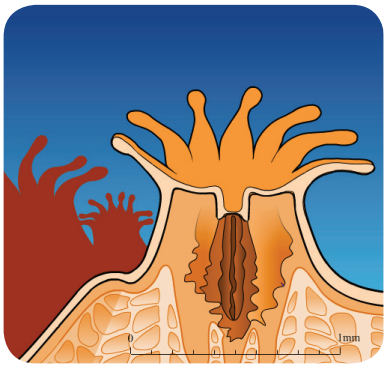
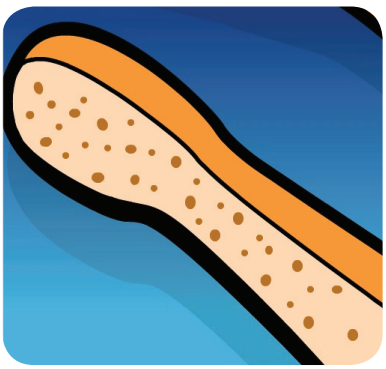
Coral reefs, like tropical rainforest, are one of the richest environments on the planet. They shelter an amazingly diverse amount of species that are interconnected by a number of complex links.

1/ SYMBIOSIS

Une symbiose est une association intime et durable qui unit deux organismes différents. La réciprocité est le principe clé de leur union : les deux organismes s'échangent des éléments essentiels à leur survie.

Symbiosis in coral

The symbiosis between polyps and algae (zooxanthella) is the basis from which hard coral is able to form coral reefs.

POLYPE	ZOOXANTHELLA (ALGAE)
Kingdom :	**Kingdom :**
Animal	Végétal (algue)
Outward appearance :	**Outward appearance :**
Mini jellyfish (a few mm in size)	Single-cell ovoid shape invisible to the naked eye (0.01 mm)
	
– Lives in colonies. A colony may contain up to several million polyps. – Is linked to other polyps by living tissue. – The whole collection of polyps forms the coral reef. – Makes its calcareous skeleton (shown in grey) under its living tissue (red).	– Lives in the cells of the external tissue of the polyp. – There are approximately 2 million algae for every 1 cm^2 of polyp. – Contains pigments that give colour to the polyp (but not to its grey-white skeleton).
Conditions required for living :	**Conditions required for living :**
Warm, salty water, form base.	Sunlight
What it provides in symbiosis to the other organismtre :	**What it provides in symbiosis to the other organismtre :**
Carbon dioxide + Nutrients	Sugar + Oxygen

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Another example of symbiosis

Another example of symbiosis ca, be found in the clown fish and sea anemone. The clown fish is a highly vulnerable species. To protect itself from its many predators, it hides inside the venomous tentacles of the sea anemone to which it is immune. In return, the clown fish defends the sea anemone against some of its predators, such as the butterfly fish, and rids it of the parasite shellfish which feed on its tissue.

Important: Not everything is symbiotic in a coral reef. Some other species that live within the confines of the reef have a "normal" prey/predator relationship.

2/ THE THREAT POSED BY CLIMATE CHANGE TO CORAL REEFS

Coral bleaching

Water temperatures have been increasing due to climate warming. This rise in temperature is responsible for the disappearance of 60% of coral reefs. In response to the stress caused by the increase in temperature, the polyp expels the algae. But, without the algae, the coral head looses its colour and turns white just like its calcareous skeleton: this is called coral bleaching. The polyp then quickly dies if it does not find more algae with which to live in symbiosis. Reasons other than rises in water temperature can also lead to coral bleaching, such as disease, too much shade or a change in salinity levels.

LIncrease in seawater acidity

The carbon dioxide (CO2) content of the air has risen dramatically, which is one of the causes for current climate warming. A change in atmosphere composition also has an effect on the oceans since the two systems constantly interact and exchange components. As carbon dioxide comes into contact with water, it is converted into carbonic acid.
As a result, the rise in CO2 concentration of the atmosphere makes the oceans turn more acid. The lower the pH level of a liquid, the higher its acidity. The pH level of the oceans has already begun to fall and scientists expect it to continue to do so between now and 2100 (from 8.1 to 7.9 or 7.8).

This increase in acidity in marine environments is extremely harmful to marine animals with shells or calcareous skeletons. It also has negative repercussions on the entire food chain.

Close-up on the effects of acidity for coral heads

This rising acidity disrupts and slows down the coral's growing process. This is because its skeleton, like many other shells, is made up of calcium carbonate (CaCO3) and because the number of carbonate ions (CO3) present in the water, which polyps need to build their skeleton, diminishes the more acidity rises. This means that polyps are no longer able to find the carbonates they need to develop their skeleton.

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What will happen tomorrow?

Experiments conducted by scientists to analyse the reaction of coral heads to rising acidity show that coral grows at half its normal speed when it is exposed to the level of acidity expected to prevail by 2050. If we add rising temperatures to the equation, coral could totally disappear by the end of the century as a result of being insufficiently able to adapt.

Other organisms that play a central role in the food chain of our oceans are already affected, or will be soon, by the acidification of the oceans: the growth of plankton, which is the staple food of the oceans, will slow down and numerous other marine animals will be affected as they find it harder to build their shells. These include the gastropods (family of sea snails) and the bivalves (oysters and mussels). The important issue here is that all of these tiny animals (plankton, sea snails, etc.) play a vital role in feeding other species, such as the salmon, mackerel and whale.

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C) GROUP ACTIVITY TO BE CONDUCTED IN THE CLASSROOM

« ACIDITY »

Aims

– Identifying what an acid and base are by using practical examples
– Showing the harmful effects that too much acid can have on the marine environment

Timing : 1 hour 25 minutes / group of 4 pupils

Equipment

– 1 packet of acid drops
– 1 container of red cabbage juice* + 4 pipettes
– 3 small transparent glasses
– 1 container of water + 4 pipettes
– 2 empty snail shells
– 1 bottle of vinegar + 1 pipette
– 1 glass of lemon juice
– 1 tub of baking soda + 1 teaspoon
– a glass of water

*To prepare the red cabbage juice before the activity, boil some pieces of red cabbage in water and strain off the coloured water.

Step 1:
Introduction
(5 minutes)

– Hand out the acid drops. How can the taste be described?
– *After having sampled a few acid drops, how can we identify a substance without tasting it? Not all of the products can be eaten, so how should we go about it?*

Step 2:
Procedure A
(15 minutes)

– Create control liquids by filling each glass up halfway
    – glass n° 1: water + baking soda
    – glass n° 2: water
    – glass n° 3: vinegar
– Use a pipette to add a few drops of red cabbage juice to glasses n° 1, 2 and 3 and stir the liquid gently with a spoon. **Be careful not to shake it up!**

!!! Make sure you use a different pipette for each product to avoid contamination!!!!

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Step 3:
Observation A
(10 minutes)

Write on the blackboard:

Baking Soda	Water	Vinegar
Blue-green	Blue-violet	Red-pink
Alkaline	Neutral	Acid

Fill in the gaps:

Vinegar is an……acid…… because it turns the red cabbage to……Red-pink…… .
Baking soda is a ……base…… because it turns the red cabbage to ……Blue-green……
Water is neutral because the red cabbage juice stays…blue-violet…

Step 4:
Explanation A
(10 minutes)

When we eat or drink, our tongue is sensitive to certain basic tastes: sweet, salty, bitter and sour.
➡ What foods contain these tastes?
– We find an **acid taste** in fruits like oranges and lemons.
– This taste corresponds to a chemical property detected by the tongue that can be measured on a scale called pH. The pH is a level having no specific unit that describes the acidic nature of a product containing water. Depending on the pH level, the product is acid, neutral or basic (alkaline).

There are three types of pH levels:
– If the pH is lower then 7, the solution is acid.
– If the pH is 7, the solution is neutral.
– If the pH is higher than 7, the solution alkaline.

Step 5:
Other substances to test
(20 minutes)

Following the same procedure, the children then test other substances with the red cabbage juice:
– orange juice
– can of orangeade

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– apple juice
– water + 1 tablespoon of salt
– water + 1 squeezed orange
– bottle of milk
– bottle of lemon juice
– water + 1 teaspoon of dishwasher powder
– can of cola
– water + 1 teaspoon of washing powder
– water + 1 teaspoon of sugar
– bottle of shower gel for babies

Step 6:
Explanations
(10 minutes)

Products that come into direct contact with the body are generally **neutral**, whereas washing and dishwasher powders are more alkaline.

Not only can acids be harmful to humans – alkalis can be, too!!!

Step 7:
Procedure B
(5 minutes)

- Fill one glass up with lemon juice (very acidic substance) and another with just water.
- Place a shell in each glass.
- Come and observe what has happened at regular intervals during the day.

Step 2:
Observation B
(5 minutes)

➡ The shell immersed in the lemon juice is damaged, whereas the shell in the glass of water is intact.

Step 3:
Explanation B
(5 minutes)

Because the lemon juice is highly acidic, it "eats away" the snail's calcareous shell.
The rising acidity of our marine environment is a problem. Coral heads produce their skeletons from calcium. But the increase in CO2 levels absorbed by seawater is causing the ocean's acidity to rise and preventing the ideal formation of coral skeletons. The same applies to the shells of other species, such as sea snails.

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D) REFERENCES/ RESOURCES

- Explanations on coral heads:
  http://vieoceane.free.fr/paf/ficheb32.htmlhttp://www.com.univmrs.fr/IRD/atollpol/ecorecat/recifs.htm
- Presentation of the various threats posed to coral (rise in temperature, acidification, diseases, etc.):
  http://it.mongabay.com/news/2007/0507-coral.html
- The WWF report "The climate is us!"
- Activity from the "CAP SCIENCES" website,
  http://www.cap-sciences.net