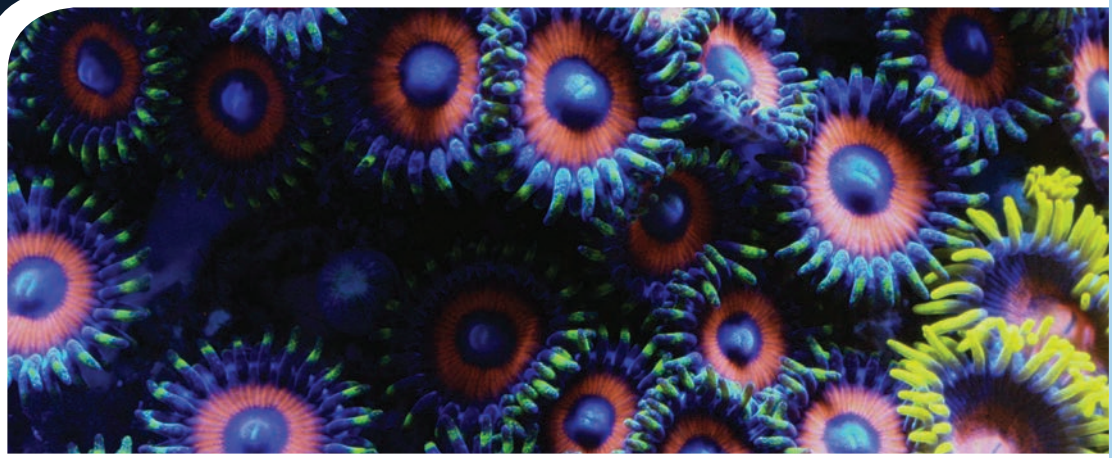
Coral Reefs



WOW!

Coral reefs make up less than 1% of the ocean yet they are home to over 25% of all marine life!

AQWA's Ultimate Coral Guide

Coral Reefs

Coral reefs are different. They are underwater cities of the sea. A bustling ecosystem made by animals, for animals. In a rainforest animals live amongst towering plants but on a reef, plants are microscopic and live inside the animals.
Corals aren't your standard animals though. They turn water into rock to build the home that they share and can live for hundreds of years!
As corals build their homes they also build the reef, creating an underwater world that covers 1% of the ocean floor but is home to over 25% of all marine animals.

To grow corals need warm, clear water with few nutrients.

Coral reefs have existed for more than 200 million years.

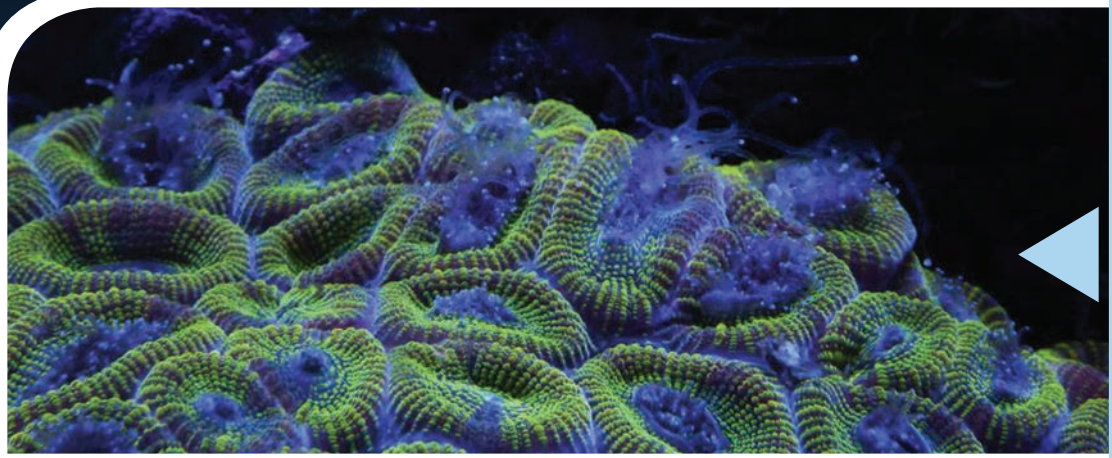
Western Australia's coral reefs are amazing and unique, because they grow much further south, in much colder waters, than reefs elsewhere in the world.

In this guide:

Called 'flower animals' corals have no defined head, eat sugar all day, eject their guts to devour anything that grows to close, ooze slime to clean themselves, all have sex at the same time and were worn to protect children from harm and boats from lightening!

Keep reading to discover more.....

Coral Reefs



A coral feeding at night. Corals can produce UV light by absorbing light at one wavelength and reflecting it at another.

Slow change

Conflicting Corals - A coral reef may seem like a bright and peaceful place to live yet limited space causes colonies to compete with each other. This competition occasionally leads to all out war as neighbouring colonies extend their tentacles and eject their guts to devour their competitor.

Peace keeper corals - We've found that when 2 particular species of coral are placed together in an exhibit they will be aggressive yet if a third species joins them they will all get along!

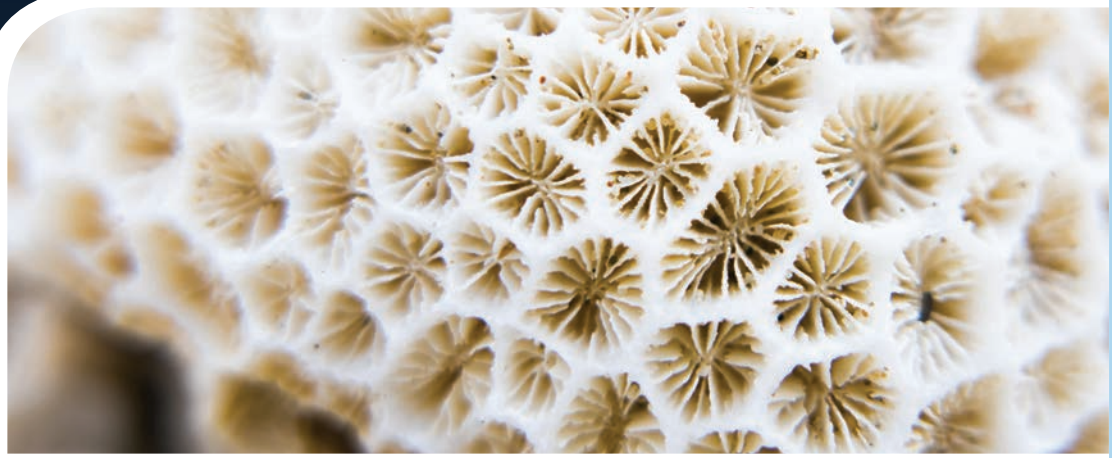
Check out BBC Blue Planet I - Epidoe 6 Coral Seas for amazing limelapse footage of corals growing and attacking!
Try these sections in particular:
0-4mins: A great introduction to coral reefs and then footage of coral growing.
11 -14.30mins: Day Vs Night on the reef; including corals feeding, attacking and defending.

Lesson Link: Time scales & Observable changes in the landscape,

Coral Reefs grow, move and attack at a slower rate than we can notice - A major breakthrough in our understanding of coral reefs came with the development of timelapse photography (not to mention underwater cameras too)
You tune clips such as: https://www.youtube.com/watch?v=_mijYXcSCS4 can explain this to your students. This also leads into a discussion about how new technology enhances our understanding of biological processes and how different types of data can be recorded and interpreted.

WOW!
There is a coral in Ningaloo that is thought to be more than 800 years old!

Building Blocks



What's inside?

The inside of a coral looks like a white rock as the living part is a thin layer over the top.

- A corals skeleton is calcium carbonate or limestone (so it is really a rock).
- 1 square metre of active coral reef manufactures 10-30 grams of limestone each day, by using the minerals found in sea water.

WOW!
Coral is used in bone transplants!
Their skeleton is make of calcium, alike ours, so it is not rejected by our bodies like synthetic materials are. Our blood vessels and muscles also love having all the little holes to attach too.

The living layer of coral is made up of polyps, separate animals that are all connected to each other. They share food, send messages to each other and have set jobs such as food production, construction or defence.

Polyps are alike a jellyfish with a cup shaped body, a mouth that is also its bottom and a rim of stinging tentacles.
Living inside coral polyps are single celled algae, called zooxanthellae, that use sunlight to make energy (photosynthesis).

The coral polyps provide the algae with a safe place to live and all the sunlight they need. In return the algae produce food for the coral, via photosynthesis. Not having to worry about catching all their food means that a coral has the energy to make their limestone skeleton and build a reef.

Lesson Links:
Living things depend on each other and the environment to survive (ACSSU073)
Living things live in different places where their needs are met (ACSSU211)

Corals get nearly all (98%) of the energy they need from eating sugar all the day.
For a balanced diet they do extend their stinging tentacles at night to capture their "meat and veg" (plankton) from the water.

Healthy eating?

Coral Polyps

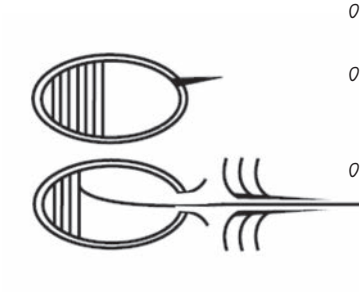
Coral polyps have a cylindrical body with a ring of tentacles around the mouth.

A corals mouth is also its' bottom!

Corals are related to jellyfish and share the same stinging cells, called nemtocysts.

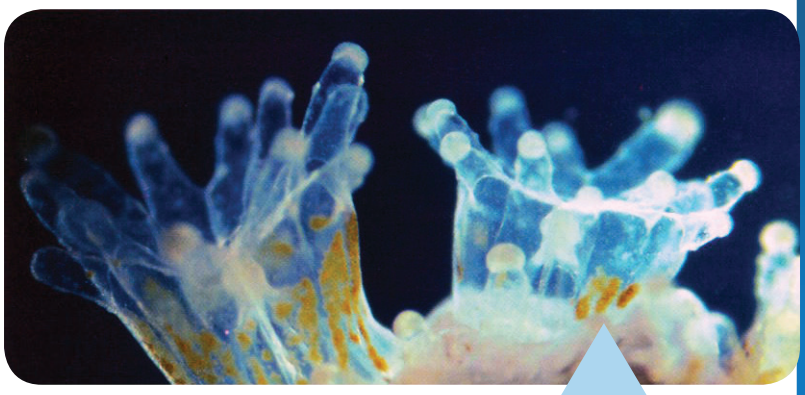
Corals up close

Night time nutrition.
Most corals only extend their tentacles at night. To catch their food corals use a combination of stinging power and slime. Stinging cells called nematocysts fire out of the tentacles to catch and stun prey which is then ensnared in slime and passed into the corals mouth.



Nematocyst before and after it is activated.

- Nematocysts are a combination of spear gun and syringe.
- A trigger extends from each nematocyst, when this is touched the harpoon fires and delivers an injection of poison.
- Nematocysts only work once (they can't be reloaded) it dies, is cast off and another nematocysts formed below moves up into its place.



Zooxanthallae inside a coral polyp

Learning Link:
Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

Ocean Architects

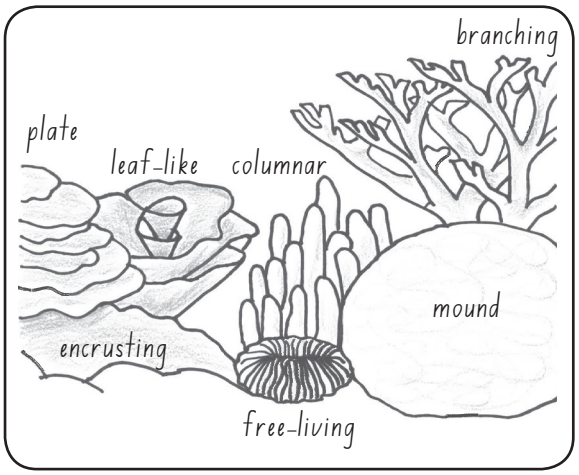
As corals are a colony they are free to create structures which vary in shape, size and design to meet the demands of life in different parts of the reef.

The same species of coral may have short thick branches and a solid skeleton on the upper reef slope, and a light skeleton with long fine branches in deeper water.

The skeletons of individual polyps within a colony are just as creative, adapting their structure to best compete with neighboring species.

All this variety creates a nightmare for scientists trying to classify corals, especially in the field. It is thus often easier to refer to corals by their shape: Plate; Branching; Mound / Massive; Vase; Encrusting; Free Living.

The shape of a coral can also tell us a lot about its ecology. Different shapes represent different strategies for growth and reproduction and are suited to different environmental conditions.



Coral Polyps

Coral polyps live together in a house that they build themselves.

Different polyps have different design styles for their floors and walls and the shape of the coral that they create varies with the stillness, clarity and depth of the ocean.

Lesson Link:
The growth and survival of living things are affected by physical conditions of their environment (ACSSU094)

Shape Shifters

This branching coral is Acropora sp.
This family of corals normally grows on the upper slope of a reef and can be easily identified by the different coloured polyp at the tip of the branch.

Environmental Design - Branching

This is the fastest to build as there is the least investment in skeleton. They can grow as much as 20cm a year

It is great for shallow water where there is lots of sun - The polyps grow on the side of the branches enabling them to get some shade.

This design is also perfect for water that has sand stirred up in it, as when the sand settles it doesn't cover all the polyps.

As they are fast growing branching corals can out compete slower growing corals initially, as they grow however they become more susceptible to wave action and borers.

The branches are quite thin so they can break easily - but because they are thin they can grow again quickly.

Some branching corals have "weak points" at secific locations along their branch. If they break they will break at this point. This ensures that the piece that is broken off has the best chance to re-establish itself and continue growing, alike a plant cutting.

Damselfish can live for over 40 years and may spend most of that time living within $1m^2$ of their home coral.

Some damsel fish farm their favourite type of algae in the area surrounding their coral. They will even get rid of the types they don't like just like we weed our garden!

This can also save their coral from having to defend its territory.

Corals don't just compete with each other for space on the reef, they also compete with algae in an ongoing race against time. Algae grows very quickly and can take over spaces were coral is trying to grow - once a coral is established however it can shade the alge preventing it from getting enough sunlight to grow.

Shape Shifters

Lesson Link

Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044)

Environmental Designs

- Mound

The slowest but sturdiest of the corals is a mound coral.

These take a long time to grow as there is so much skeleton to build on the inside. One it has grown though it can't be easily broken or knocked over by waves.

These corals often reproduce later as all their initial energy goes into building.

These are the major contributors to the long term structure of the reef and can live to be hundreds of years old.

- Encrusting

Growing flat and wide this growth form stretches along the surface of the reef. It can spread out quickly into new areas that may have better access to sunlight and food but has an extensive border to defend.

This design can also be easily covered with sand

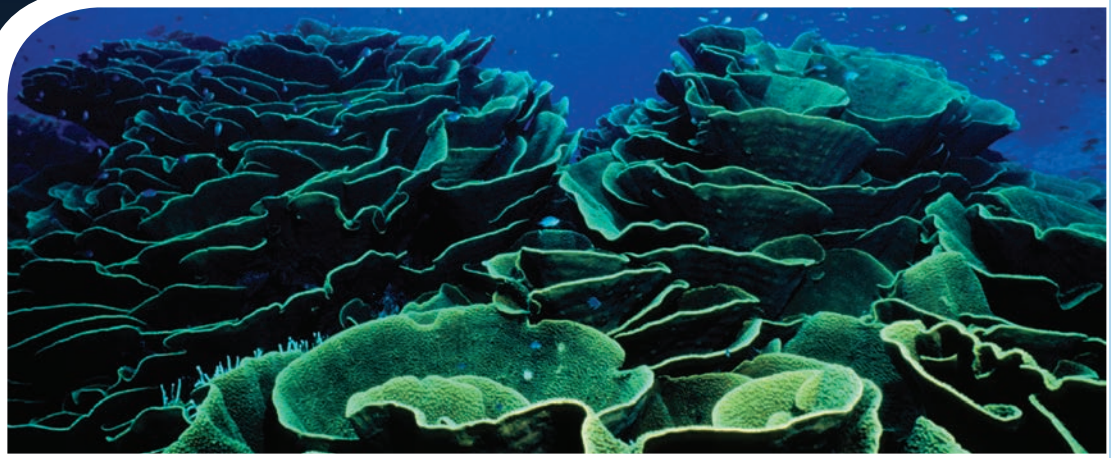
- Plate

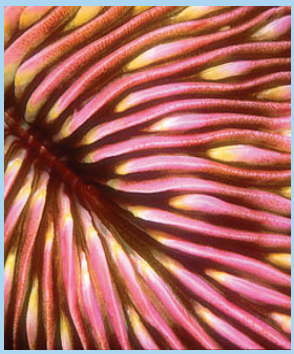
This design is great for sunbaking as everyone gets lots of sunshine. It is a popular style a little bit deeper in the water, as near the surface there is just too much light.

This design also blocks out light underneath - that means no other coral will grow there. With out neighbours plate corals can spend less time and energy defending themselves.

A disadvantage of this design is the narrow base which makes them fragile, sand can also collect on the flat surface.

Shape Shifters





Environmental Designs

- Foliaceous (Leaf- like)

This design is simular to the plate but less likely to be covered in sand as sand will be funnelled to the centre, rather than over all the polyps.

The narrow base makes this design susceptible to being knocked over - it normally grows in deep water away from crashing waves.

- Columnar

Simular to the branching design style, these colonies have stubby column and grow out by adding more olumns rather than growing up and splitting alike branches.

Their columns are less likely to be snapped and are favourite hiding places for juvenile fish.

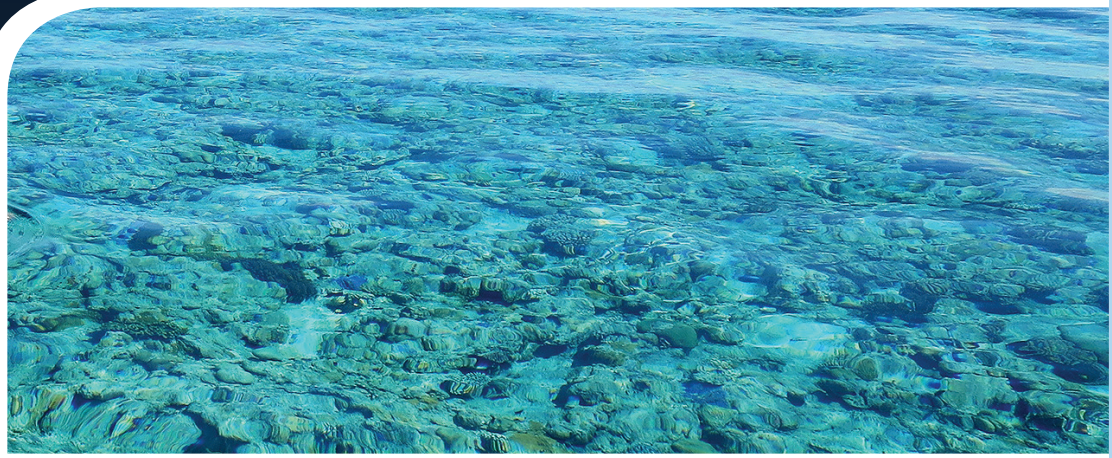
- Free - living (mushroom corals)

Each coral is a single polyp and it is not attached to the reef.

To move they will turn upside down, use their tentacles to 'walk" then suck in water to inflate one side and flip themselves over.

Mushroom corals are most common on the slopes fringing reefs, where they are not wept about by waves.

In 2007 researchers in Ningaloo detected "a mass of little brown dots" in waters 40m deep. It turned out to be a field of more than 12 million mushroom corals! Scientist think that the density was so great because they had found the perfect environemnt inwhich to prosper.



Coral Reef Food Chains & Web

Primary Producers - Algae, Seaweed, Zooxanthallae, Phytoplankton

First order consumers:

Zooplankton (eats phytoplankton)
Coral (eats sugars made by zooxanthallae and catches plankton)
Fish (herbiverous and omnivores that eat plankton, algae or seaweed)
Western Rock lobsters (molluscs, worms, detritus, small crustaceans, algae)
Crabs (eat algae and also sea cucumbers, worms, detritus, bacteria)
Jellyfish (eat plankton)
Whale sharks (eat plankton)
Sponges (eat plankton)
Sea urchins (eat seaweed and algae)
Prawns (eat plankton)
Giant clams (eat plankton)
Seahorses (eat plankton)

Consumers:

Turtles (eat jellyfish, sea cucumbers and sponges),
Butterflyfish and parrotfish (eat corals)
Fish - general (eat other fish)
Tiger shark (eats turtles)
Port Jackson shark (sea urchins, crabs, prawns, fish)
Sea snakes (eats fish)
Sharks - general (eat fish)
Octopus (eats crabs, mussels, western rock lobsters)
Starfish (mussels, fish, algae, seaweed, worms, sea cucumbers, detritus)

Detrivores & Decomposers- Crabs, Starfish, Seacucumbers, Bacteria

Ocean Day link -

Marine Phytoplankton may be microscopic but hey are a vital component of life on Earth.

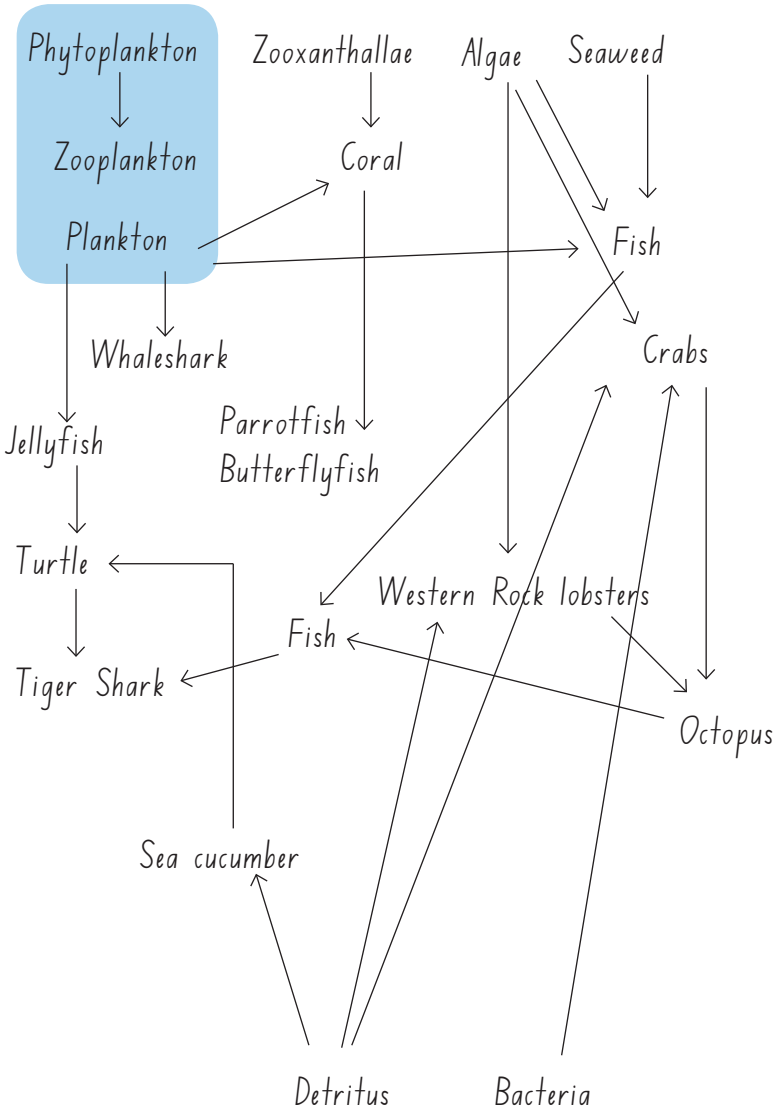
Using energy from the sun, they absorb as much carbon as all the trees and other plants on land, and produce half of all the oxygen that we breathe.

Learning Link:

Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems (ACSSU176)

Food Web

Example Coral Reef Food Web:



Learning Links:

Interactions between organisms can be described in terms of food chains and food webs; human activity can affect these interactions (ACSSU112)

Crunching Corals

Parrotfish 4 hugely powerful teeth that work like bolt cutters breaking of huge chunks of coral, that are then ground up - the polyps are eaten while the limestone is crushed into sand,

Scientists estimate that up to 70% of the sand on white sandy beaches in the Caribbean and Hawai'i has passed through a parrotfish!

WOW! Some sea cucumbers process more than 130kg of sand per year!

Sea cucumbers feed on the tiny particles amongst the sand (algae, small sea creatures and waste) breaking it down into smaller pieces that become food for bacteria.

Detritus that settles on a coral is wiped off by oozing out a layer of slime. When corals release their slime layer they also let go of all the 'rubbish' that has settled on them.

This slime and the nutrients stuck in it are then eaten by other fish!

Ocean Treasure

The word coral comes from a word meaning "red" as it was named after a coral found in the Mediterranean, that has a red skeleton

Corals & Culture

Intercultural Understanding

Red coral has been collected for over 22,000 years. Ancient Egyptians, Romans and Greeks used it in jewellery while in the middle ages people carried a piece of coral to ward off witches.

It was also believed to defend ships from lightening, calm evil spirits, protect harvests and give fertility to the soil.

Found in dark holes and crevices of the western Mediterranean red coral grows around 10 times slower than tropical corals. Local divers venture into to depths of 35 - 100 meters to collect this treasure from the sea.

Poseidon, the Greek god of the ocean, is said to live in a palace made of coral and gems.

Romans would place coral around the necks of children to protect them from harm.

Coral is mentioned in the bible 'and a parcel of wisdom fetches more than red coral'

Coral is one of the 7 treasures listed in Buddhist scriptures

In Chinese culture coral is one of the "Eight Treasures" and symbolises longevity and official promotion. Red coral is particularly auspicious as red signifies good luck, good fortune and happiness.

Cnidaria

Pagoda coral showing a plate growth form.

Learning Link:
Classification helps organise the diverse group of organisms (ACSSU111)

Classification

Corals belong to the Phylum Cnidaria which also includes anemones and jellyfish. They are all classed together as they share a simular body plan and all have stinging cells called cnidoblasts.

- Body Plan: Cup shaped with tentacles around rim and a single central opening
  This body plan comes in 2 forms:Polyp (attached to a surface) & Medusae (free swimming)
- Cnidoblasts:
  Contains nematocysts which enclose a harpoon like stinging mechanism.
  Each tentacle contains thousands of stinging cells but whether or not we feel pain is dependant upon the venom penetrating our skin. Anemones feel sticky because they fire their stinging cells but do not sting us while the box jellyfish has 3 million nematocysts and only needs 4 to cause pain in humans.
- They also have:
  - Radial symmetry
  - A nerve net
  - No respiratory system
  - Two body layers
  - Some sensory organs
  - No definite head!
  - No excretory system

The Phylum Cnidaria is divided into 4 classes:

- Anthozoa: All the members of this class are marine and have no free living medusa stage.
  Hard Corals, Soft Corals , Gorgonians (sea fans), Black Corals, Sea anemones, zoanthids
- Hydroza: Hydroids, Fire Corals, Portuguese Man O'War
- Scyphozoa: Jellyfish
- Cubozoa: Box Jellyfish

Translations:
Anthoza = Flower animals
Cnidaria = Nettle-like.
Referring to the flowering plant; stinging nettle

Cnidaria

Gorgonian Coral

This wierd relation has a skeleton of 'gorgin' which is a hard horn-like substance.

They are also known as fan corals as they grow in a flat fan-like shape that can reach over 1m in width!

Home Delivery:

Fan corals grow at right angles to the current so that they can catch as much plankton as possible from the water as it passes by.

Wierd Relations

Hard Corals:

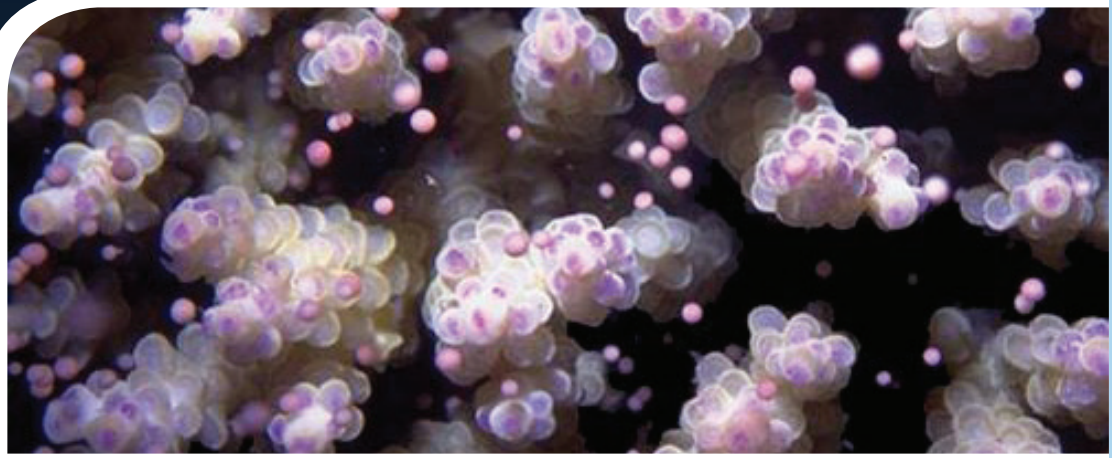
- Have tentacles arranged in multiples of 6.
- Build coral reefs by continuously depositing their limestone skeleton.
- Are a wierd relation to other Cnidarians as they have no free swimming stage to their life cycle

Soft Corals

- Have small calcareous structures (sclerites) embedded in their tissues instead of a solid skeleton. Sclerites and water pressure support the main body of the colony.
- Sclerites come in elaborate shapes and used to classify soft corals.
- Are slightly flexible.
- Some feel leathery/rubbery others are prickly with sclerites poking out between polyps.
- Generally have 8 feathery tentacles and 8 internal partitions
- Soft corals release chemicals which kill predators and deter algae
- Soft corals are more common in waters deeper than 10 metres astheir soft form is not able to withstand the powerful forces of waves and surge.

Zooanthids - eg. Daisy Corals

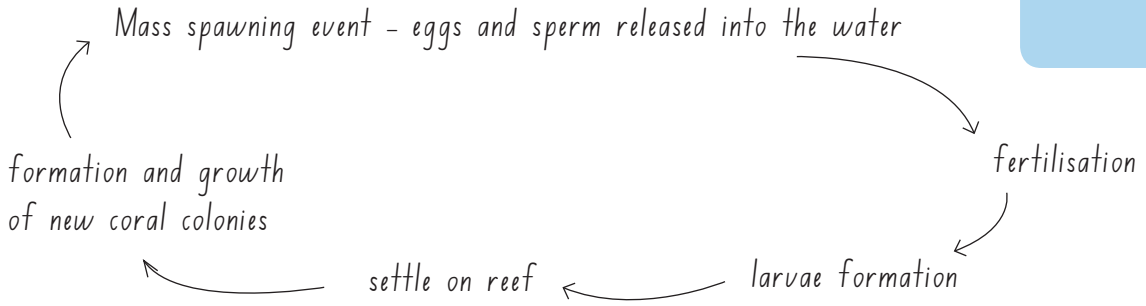
- These corals don't have zooxanthallae in their tissues - they need to catch all their own food but are free to grow in shaded areas such as caves where other corals can't grow.
- These corals secrete a small cup shaped limestone base under their body. This is an exoskeleton as it in below their living tissue



Coral Life-cycle

On the move!

At 2km per hour tropical fish and coral larvae cruise our coast on the world longest coastal current – the Leeuwin Current.



Learning Links:

Living things have life cycles (ACSSU072)

Living things grow, change and have offspring similar to themselves (ACSSU030)

Reproduction: Corals can reproduce sexually and asexually

Asexual – budding

- Coral polyps may divide to form individuals.

Sexual

- Polyps can be male, female or both
- Coral polyps release eggs/sperm into the water but what's interesting here is that all corals will normally spawn at the same time releasing millions and millions of eggs into the water at once to provide safety in numbers and ensure that as many as possible survive. This is called: Mass spawning.

Mass Spawning

When corals spawn they release so many eggs that they produce a slick that can be meters wide and kilometres long, this attracts animals such as the Whale Shark!

Mass Spawning

- Mass Spawning occurs on the Great Barrier Reef 1-2 days after the full moon in November and at Ningaloo Reef 8-9 days after the full moon in March or it may be split and occur after consecutive full moons in March and April (Easter). This timing coincides approximately with the beginning of the flow of the Leeuwin Current, and planulae may be swept southward to supply reefs further south with new corals.

The fact that all corals spawn at once instantly raises the question of how do they know when to do it? Scientists have pinned it down to three triggers.

1. A gradual rise in sea temperature. Corals need water temperature to be around 27°C. Here on the west coast it reaches that temperature in March. On the Great Barrier Reef it reaches 27°C in October explaining why there are different mass spawning dates on either side of Australia. The gradual rise in sea temperature getting to that 27 degrees is what triggers the production of eggs and sperm inside the coral.
   Most corals are both male and female and can develop both eggs and sperm. In branching corals eggs take about 9 months to develop, and sperm about 3-4 months.
   The sperm are free swimming while the eggs are filled with lipids (fats) to help them float.

Learning Link:

The growth and survival of living things are affected by physical conditions of their environment (ACSSU094)

Mass Spawning

"This shows the different types of Coral. When they lay their eggs the water is milky. The eggs are laid before the rainy season. Sometimes coral is crushed and used to make different colours for paint"

Agnes Yanawana

2. The lunar cycle (Tidal phase). When the moon is full there is a big difference between high and low tides. A few days after a full moon you get what is known as a neap tide – this is when there's hardly any difference between high and low tides.

   Here in WA during March and April a neap tide happens 9 days after a full moon. On the east coast in October it's 5 day after. The advantage of a neap tide is that a small difference in tides means less water flow which means weak currents, weak currents mean calm waters and calm waters enable eggs and sperm to hang around together, giving them time to mix and more fertilisations to occur.

3. Day / night cycle – Corals spawn at night.

General Capability:

Intercultural Understanding

Learning Link:

Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon (ACSSU115)

WA Reefs

Pocillopora Reef, Rottnest Island

In WA coral reefs can grow so far from the tropics because of the Leeuwin Current which flows south between autumn and spring carrying warm water as far as Esperance.

Pocillopora reef is named after pocillora coral – this corals branches are stunted on shallow reef fronts where there is lots of wave action while in deep water branches are thin and open.

Local Legends

- Houtman Abrolhos Islands, off Geraldton

  In theory coral reefs should not extend this far south however 70% of WAs corals do and a thrid of these extend even further south!

  Here the lower sea temperature (which slows algal growth) means that extensive beds of algae can actually coexist with extensive coral communities. Normally get either Kelp and algae beds (Temperate) or coral reefs (Tropical).

- Shark Bay – Australia's Largest enclosed Bay
- Ningaloo Reef – The largest fringing reef in Australia
- The Marmion Marine Park – WA's first marine park (1987)
- Rowley Shoals Marine Park

  One of the most remote and pristine marine areas in the world and the most perfect example of shelf-edge atolls in Australian waters

  Inhabited by at least 233 species of coral and 688 species of fish

  Has a unique composition and relative abundance of species – the marine community is morecharacteristic of south-east Asia than any other WA reefs.

Rottnest Island was once connected to the mainland. Legend has it that they were separated through a fight between a giant crocodile and a giant shark, creating the shallow sandy areas dotted with reefs that we have today.

Intercultural Understanding