Barrier Reef Anemonefish (*Amphiprion akindynos*) Image: Ian Banks.
**BIODISCOVERY**

*and the Great Barrier Reef*

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1.1 (a) Body Support

**Aim:** To examine some physical factors which affect the survival of organisms in aquatic habitats.

**Materials:**
- Aquatic plant or seaweed
- Gills of fish
- Balloon
- Spring Balance
- Large bucket of water

**Method:**
1. Place the aquatic plant and the gills of the fish in a beaker or jar of water.
2. Now remove them from the beaker and examine them and note your observations.
3. Fill the balloon approximately 2/3 full with water and tie a knot at the end.
4. Tie a piece of string to the end.
5. Attach a spring balance to the string and weigh the balloon. Record its weight.
6. Now suspend the balloon in the large bucket of water and weigh it now. Record its weight.

**Observations and Results:**
1. How do the aquatic plant and gills appear out of the water?

…………………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………………

2. What happened to the weight of the balloon when it was suspended in the bucket of water?

…………………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………………

**Interpretation:**
1. From the above investigation, what does water provide for aquatic organisms?

…………………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………………

2. Try to find out the name of this force i.e. what do we call this force? ……………………………………………

3. Does this force pose any problems for aquatic organisms? ……………………………………………

…………………………………………………………………………………………………………………………………

**Conclusion:**

In terms of body support, how does living in water differ from living on land?

…………………………………………………………………………………………………………………………………
1.1 (b) Temperature Changes

**Aim:** To examine some physical factors which affect the survival of organisms in aquatic habitats.

**Materials:**
- Small plastic yoghurt container
- 4-5L plastic bucket
- Large plastic garbage bin
- School pool (optional)

**Method:**

1. Fill each of the containers with water.
2. Place a thermometer in each and record the initial temperature. Leave one thermometer out for recording the air temperature.
3. Over the next two days, record the temperature at the start of the day (e.g. 8:30am) and at the end of the day (3pm), for each body of water and for the air temperature. Record your results in the data table provided. If you have a school pool, record the temperature of it at these times.

**Results:**

<table>
<thead>
<tr>
<th>Time</th>
<th>Temperature (°C)</th>
<th>Aquatic Habitat Simulations</th>
<th>Air (Land Habitat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td></td>
<td>Yoghurt container (small creek)</td>
<td>Bucket (pond)</td>
</tr>
<tr>
<td>(8:30am)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3pm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8:30am</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3pm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temp. difference *</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* To calculate this, subtract the lowest temperature recorded for each container from the highest temperature reached in that container.

**Interpretation:**

1. Which container had the greatest temperature change? …………………………………………………………
2. Which one had the smallest? ……………………………………………………………………………………………
3. Complete the following: ………………habitats heat up and cool down more quickly than ……………… habitats. In aquatic habitats, smaller water bodies have ………………… temperature changes than do larger water bodies.
4. How would you expect the temperature variations experienced by a tadpole in a roadside pool to compare with those it would experience in a lake?
   …………………………………………………………………………………………………………………………………………
   …………………………………………………………………………………………………………………………………………

* Queensland Museum | PO Box 3300 | South Bank | QLD Australia 4101
* Queensland Government
1.1 (c) Oxygen Concentration

Air contains approximately 21% oxygen; 78% nitrogen and 1% other gases. The temperature of water helps to determine the maximum amount of oxygen that can dissolve in the water. The solubility of oxygen at 0°C is about twice its solubility at 30°C i.e. as the water gets warmer, less oxygen will dissolve in it. (See graph below)

1. As water warms up, what do you think happens to the oxygen dissolved in the water? i.e. where does it go?
…………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………

2. For any given volume, there is less oxygen in water as compared to air. What problem does this pose for aquatic organisms?
…………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………

3. Explain how each of the following may help with this problem.
   (a) the many folds in the gills of fish
   …………………………………………………………………………………………………………………………
   …………………………………………………………………………………………………………………………
   …………………………………………………………………………………………………………………………

   (b) the constant movement by reef sharks
   …………………………………………………………………………………………………………………………
   …………………………………………………………………………………………………………………………

![Effect of Temperature on Dissolved Oxygen](image)
(c) the thin structure (one cell layer) of sponges

(d) the long, feathery tentacles of coral polyps

4. During low tide, shallow rock pools heat up quickly. As the temperature increases, what effect will this have on an organism’s ability to get oxygen? How do some organisms, such as molluscs, cope with this problem?

5. *Rheodytes leukops* is a special species of turtle that lives in the cool, fast-flowing Fitzroy and Dawson Rivers in Queensland. It has a bimodal way of breathing. As well as breathing through lungs like most reptiles, they can breathe underwater. They have a rear end (or cloaca) that can open to the size of a 10c piece. Water can be sucked in and out through here. This leads inside to two large bursae with branching papillae that are well-diffused with blood vessels. Here oxygen is extracted from the water.

Some turtles can hold their breath underwater for up to two hours, but these turtles can hold their breath for 3.8 days!

If a dam were to be constructed across one of these rivers, what impact could this have on the survival of these turtles? What effect would it have on the hatchlings?
Measuring Dissolved Oxygen

**Aim:** To investigate the amount of dissolved oxygen in different water samples.

**Materials:**
- 250 mL beaker
- 250 mL jar with a screw-top lid
- Stirring rod or spoon
- Methylene blue solution
- Oxygen-removing solution freshly prepared (50g/L sodium dithionite [hydrosulphite])

**Method:**
1. Fill a large bucket or saucepan with water and leave for three days. (Still sample)
2. Without stirring up the water, dip a beaker into the bucket of water and take out approximately 250 mL.
3. Pour off the excess water until there is exactly 200 ml in the beaker.
4. Add 3 drops of methylene blue to the water and stir gently.
5. Keep stirring gently and add a drop at a time of oxygen-removing solution until the colour *just* disappears.
6. Record the number of drops added in the data table. This is a measure of the amount of dissolved oxygen in the water.
7. Using a clean beaker, repeat this procedure twice and average the results.
8. Repeat steps 3 – 7 using water from the tap. (Tap sample)
9. Now pour the water from the bucket into a jar and screw the lid on tightly and shake vigorously for 20 seconds. (Shaken sample)
10. Pour the water back into the beaker and repeat steps 3-7.

**Results:**

<table>
<thead>
<tr>
<th>Water Sample</th>
<th>Number of drops of oxygen-removing solution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
</tr>
<tr>
<td>Still</td>
<td></td>
</tr>
<tr>
<td>Tap</td>
<td></td>
</tr>
<tr>
<td>Shaken</td>
<td></td>
</tr>
</tbody>
</table>

**Interpretation:**
1. Explain the difference in the three results: ..........................................................
   ..........................................................................................................................
   ..........................................................................................................................

**Conclusion:**
2. Why is there more dissolved oxygen in mountain streams than in shallow ponds and lakes?
   ..........................................................................................................................
   ..........................................................................................................................
3. Why are aquariums fitted with aerators?
   ..........................................................................................................................
   ..........................................................................................................................
1.1 (d) Salt Concentration

Organisms living in marine environments are surrounded by a liquid which is generally of higher salt concentration than liquids within their own bodies. That is, it is ‘saltier’ than their body fluids.

**Aim:** To investigate the effect on organisms of living in a ‘salty’ environment.

**Materials:**
- 2 Chicken eggs (you may need extra)
- Dilute hydrochloric acid (1M) or vinegar
- Rubber gloves
- Beaker or jar
- Distilled water
- Displacement can (optional)
- Measuring cylinder (or measuring cup)
- Salt

**Safety:** Gloves must be worn for this investigation.

**Method:**
1. Remove the hard shell of the eggs by dissolving it in the acid (or vinegar). Wear gloves and continually rub the surface of the eggs to remove the bubbles from it. This will help with dissolving the shell. This process takes some time so if it has to be left overnight, remove the eggs from the solution and place in a sealed container. Put in a piece of damp paper towel to keep the inside of the container moist.
2. After the shell has dissolved completely, the eggs will be left with a soft, rubbery membrane. Care must be taken when handling the soft egg.
3. Measure the initial volume of each egg using a displacement can. (If one is not available then place a jar filled to the brim with water inside a larger bowl. Gently drop the egg into the jar and collect the water that spills out in the bowl. Pour this water into a measuring cup and record the volume. This equals the volume of the egg. Try to be as accurate as possible.)
4. Take photographs of what the eggs look like initially.
5. Place one egg in a beaker or jar of distilled water and place the other egg in a beaker of water to which one heaped teaspoon of salt has been added.
6. Leave overnight or for a day or two and photograph again.
7. Measure the final volume of each egg by repeating step 3.

**Results:**

<table>
<thead>
<tr>
<th>External Solution</th>
<th>Initial Volume of Egg (ml)</th>
<th>Final Volume of Egg (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distilled Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water + Salt</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Interpretation:**
1. What has happened to the egg in the distilled water?

………………………………………………………………………………………………………………………..

………………………………………………………………………………………………………………………..

………………………………………………………………………………………………………………………..

2. What has happened to the egg in the salty water?

………………………………………………………………………………………………………………………..

………………………………………………………………………………………………………………………..

………………………………………………………………………………………………………………………..
3. The egg in the distilled water simulates organisms living in freshwater environments and the egg in salty water simulates those that live in salt water or marine habitats. Therefore, what problems are faced by marine organisms such as fish, corals, sea anemones, and sponges?

4. Research adaptations that fish and other marine organisms possess that help with the problem of living in a salty environment.

5. As the salinity of water increases, less oxygen can dissolve in it. Therefore, how would living in the sea differ from living in a freshwater environment?
1.1(e) Viscosity

Viscosity is defined at the resistance to movement of a medium. i.e. how easy is it to move through the substance.

**Aim:** To investigate the effect on movement of environments with different viscosity.

**Materials:**
- 4 paddle pop sticks
- 4 jars or beakers
- Honey
- Plaster of Paris
- Water

**Method:**
1. Label the beakers A - D.
2. Leave the first beaker, beaker A, with nothing (just air) in it.
3. In beaker B, pour 100 ml of water; into beaker C, pour 100 ml of honey; and into beaker D, mix a little Plaster of Paris with 100mls of water so that a very thick paste is formed.
4. Now pretend that the paddle pop stick is an organism and the beakers represent the habitat in which it lives. (A) Air (land habitat) (B) Water (aquatic habitat) (C) Honey (aquatic habitat, against a slight current) (D) Plaster of Paris (aquatic habitat, against a strong current).
5. Place a paddle pop stick in each of the four beakers.
6. Stir the ‘organism’ in the beaker of air; the one with water; the one in honey; and lastly the one in Plaster of Paris mix.

**Interpretation:**
1. In which beaker was it easiest for the ‘organism’ to move around? .................................................................
2. In which beaker was it the hardest? ......................................................................................................................
3. If you were an organism and had to live in an environment that had some resistance to movement, what adaptations would you need? (Hint: Discuss how Olympic swimmers and cyclists try to increase their speed.)
   ...........................................................................................................................................................................
   ...........................................................................................................................................................................
   ...........................................................................................................................................................................
   ...........................................................................................................................................................................

4. List and describe the adaptations that some marine organisms possess to assist them moving in aquatic habitats.
   ...........................................................................................................................................................................
   ...........................................................................................................................................................................
   ...........................................................................................................................................................................
   ...........................................................................................................................................................................
Most of the light that hits the surface of the ocean is absorbed in the first 10 metres. Red light can generally penetrate to a depth of 15m; yellow to 30m; orange to 50m; green, blue and violet can penetrate further.

Only about 45% of the surface light reaches a depth of 1 metre; only 22% reaches a depth of 10m; and only 0.5% of the surface light can reach a depth of 100m. Therefore beyond 150m, the ocean is completely dark.

The sea floor has a bluish colour because the shorter wavelengths of light (green, blue and violet) penetrate further.

Zooxanthellae algae live within the tissues of many species of coral and use light to make food for the coral in the process of photosynthesis.

If most of the light gets absorbed in the first 10m of the ocean, what effect does this have on the distribution of these corals? Why?

Red-coloured pigments reflect red light and absorb the other wavelengths (colours) of light such as green and blue. Green-coloured pigments reflect green light and absorb red and blue.

Red algae can be found at lower depths than other types of algae. Why would this be so?
1.2 Animal Adaptations

Observe and research each of the organisms in the table below and note any adaptations that they possess. Adaptations increase an organism’s chances of survival and can be structural (physical features); functional (how their body works); behavioural (what they do); or reproductive (how they reproduce).

<table>
<thead>
<tr>
<th>Organism</th>
<th>Adaptation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan Worm</td>
<td><em>Sabellastarte indica</em></td>
<td>(Image: QM)</td>
</tr>
<tr>
<td>Reef Stonefish</td>
<td><em>Synanceia horrida</em></td>
<td>(Image: QM)</td>
</tr>
<tr>
<td>Portuguese man o’ war or blue bottle</td>
<td><em>Physalia physalia</em></td>
<td>(Image: QM)</td>
</tr>
<tr>
<td>Organism</td>
<td>Adaptation</td>
<td>Explanation</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Smooth-handed Reef Crab</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Etisus laevimanus</em></td>
<td>(Image: QM)</td>
<td></td>
</tr>
<tr>
<td>Anemone Fish</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Premnas biaculeatus</em></td>
<td>(Image: Ian Banks)</td>
<td></td>
</tr>
<tr>
<td>Highfin Coastal Moray Eel</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Gymnothorax pseudothrysoidea</em></td>
<td>(Image: QM)</td>
<td></td>
</tr>
<tr>
<td>Green Turtle</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Chelonia mydas</em></td>
<td>(Image: Leonard Low, Creative Commons)</td>
<td></td>
</tr>
<tr>
<td>Organism</td>
<td>Adaptation</td>
<td>Explanation</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Steephead Parrotfish</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Chlorurus microrhinos</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image1" alt="Image: Richard Ling, Creative Commons" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern Shovelnose Ray</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Aptychotrema rostrate</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image2" alt="Image: QM" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Box Jellyfish</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Chironex fleckeri</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image3" alt="Image: Lisa Gershwin" /></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1.3 Marine Food Webs

A marine biologist observed the following organisms feeding around a coral outcrop and noted the following relationships.

1. Create a food web for this marine community, remembering that the direction of the arrows in a food web indicate the direction of energy flow. That is, from prey into predator.
Hint: start by placing the producers at the bottom of your page and make the next level above for the first order consumers, the next level for second order consumers and so on.

![Food Web Diagram]

<table>
<thead>
<tr>
<th>Organisms</th>
<th>Feeding Relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coralline algae</td>
<td>Like corals, coralline algae deposit calcium carbonate. By growing over coral rubble they act like a cement to bind the reef together. Algae are autotrophic. That is, they make their own food by photosynthesis.</td>
</tr>
<tr>
<td>Turf algae</td>
<td>Like other plants, algae obtain nourishment via the process of photosynthesis. This algae growing upon the bommie wall is the primary food source for many of the reef's herbivores. Many herbivorous species such as parrotfish, surgeonfish and damselfish can be seen feeding in this zone.</td>
</tr>
<tr>
<td>Phytoplankton &amp; Zooplankton</td>
<td>Phytoplankton are microscopic plants that make up part of the planktonic community. They are eaten by zooplankton. Planktonic species are found in the water column around coral bommies. In most marine ecosystems phytoplankton are the primary producers.</td>
</tr>
<tr>
<td>Staghorn coral</td>
<td>Symbiotic zooxanthellae photosynthesize using sunlight during the day and make food for the coral. At night coral polyps extend tentacles and feed on planktonic species.</td>
</tr>
<tr>
<td>Purple-encrusting Sponge Haliclona sp.</td>
<td>These filter planktonic food particles from the water.</td>
</tr>
<tr>
<td>Tubular sponge Clathria sp.</td>
<td>These filter planktonic food particles from the water.</td>
</tr>
<tr>
<td>Papuan jellyfish Mastigias papua</td>
<td>These use their tentacles covered in million of stinging cells to feed upon planktonic species.</td>
</tr>
<tr>
<td>Magnificent sea anemone Heteractis magnifica</td>
<td>These attach themselves firmly to the reef. Many contain zooxanthellae single-celled algae that photosynthesize using sunlight. They also use their tentacles to capture small fish such as damselfish and chromis.</td>
</tr>
<tr>
<td>Kuiter’s Nudibranch Chromodoris kuiteri</td>
<td>These feed on sponge mucus and collagen.</td>
</tr>
<tr>
<td>Sea cucumber Synaptula sp.</td>
<td>These feed on the mucus from branching and lamellate sponges such as Haliclona.</td>
</tr>
<tr>
<td>Organisms</td>
<td>Feeding Relationship</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Comb Jellies Beroe sp.</td>
<td>These are carnivorous, feeding on zooplankton.</td>
</tr>
<tr>
<td>Cuttlefish Sepia sp.</td>
<td>These nocturnal hunters feed on crustaceans and herbivorous reef fish.</td>
</tr>
<tr>
<td>Christmas Tree Worm Spirobranchus giganteus</td>
<td>Their Christmas tree-like gills filter and capture plankton and food particles from the water.</td>
</tr>
<tr>
<td>Crayfish</td>
<td>These are scavengers, feeding on dead matter and detritus.</td>
</tr>
<tr>
<td>Crown of thorns starfish Acanthaster planci</td>
<td>These are a coral-eating species. The crown of thorns favours the faster growing coral species such as staghorn.</td>
</tr>
<tr>
<td>Tiger shark Galeocerdo cuvier</td>
<td>These are aggressive and indiscriminate feeders that will eat just about anything: dolphins, seabirds, fish, stingrays, sea snakes and turtles.</td>
</tr>
<tr>
<td>Parrotfish</td>
<td>Their teeth are fused to form a strong beak that allows them to scrape turf algae off rocks.</td>
</tr>
<tr>
<td>Damselfish</td>
<td>These graze on turf algae growing on rocks.</td>
</tr>
<tr>
<td>Butterfly fish</td>
<td>These feed on turf algae and also bite the ends of anemone tentacles.</td>
</tr>
<tr>
<td>Beaked leatherjacket Oxymonacanthus longirostris</td>
<td>These feed exclusively on individual coral polyps.</td>
</tr>
<tr>
<td>Red emperor Lutjanus sebae</td>
<td>These are nocturnal predators feeding on small herbivorous fish, cuttlefish, crabs and shrimps.</td>
</tr>
<tr>
<td>Humphead maori wrasse Cheilinus undulatus</td>
<td>These are carnivorous, feeding on invertebrates, small reef fish and sometimes feeding on crown of thorns starfish.</td>
</tr>
<tr>
<td>Cleaner wrasse Labroides dimidiatus</td>
<td>These feed on the external parasites of reef fish.</td>
</tr>
<tr>
<td>Hawksbill turtle Eretmochelys imbricata</td>
<td>These feed on a wide range of food including algae, crustaceans, sponges and jellyfish.</td>
</tr>
</tbody>
</table>

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2. If all the zooxanthellae algae were to die due to the impact of global warming on coral polyps, outline the effects there would be on this community.

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______________________________________________________________________________________________________________________________________________________________
1.4 Investigating Invertebrates

You have a variety of invertebrates to investigate. Examine them carefully and complete the data table on the next page. Placing a ✓ or a ✗ in most squares is sufficient.

Some terms to revise:

**Exoskeleton:** a hard outer covering supporting and enclosing the animal.

**Bilateral Symmetry:** a body plan in which the body can be divided into two identical halves along one line of symmetry.

**Radial Symmetry:** a body plan in which the body can be divided into two identical halves along several lines that form the diameter of a circle.

**External Segmentation:** is present if the animal can be divided into a series of sections or ‘blocks’, usually shown by grooves on the surface of the body.

**Digestive Sac:** only one digestive opening is present and this acts as the mouth as well as the anus.

**Digestive Tube:** two digestive openings are present: a separate mouth and anus.

Radial Symmetry

Bilateral Symmetry

Body Segmentation –
insect body divided into 3 sections: head, thorax, abdomen
<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Common Name</th>
<th>Skeleton</th>
<th>Body Symmetry</th>
<th>External Body Segmentation</th>
<th>Digestive Cavity</th>
<th>Paired Appendages for Locomotion</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Absent</td>
<td>Asymmetrical</td>
<td>Absent</td>
<td>Absent</td>
<td>Sac (one opening)</td>
<td>Phylum</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Exoskeleton</td>
<td>Bilateral</td>
<td>Present</td>
<td>Tube (two openings)</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Internal</td>
<td>Radial</td>
<td>Absent</td>
<td></td>
<td>Two pairs</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>Part Bilateral, Part Spiral</td>
<td>Present</td>
<td>More than 2 pairs</td>
<td>Aquatic (in water)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>None</td>
<td>Terrestrial (on land)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
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<td>9</td>
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<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Analysis:
1. The Phylum Chordata is a large group which includes the vertebrates. Is there any single characteristic you could use to distinguish the chordates from the other phyla studied in this investigation?


2. Is there any other characteristic that is found only in one phylum? If so, what is the characteristic and what is the phylum?


3. Sometimes organisms are classified into a phylum because they have a combination of two or more characteristics. Was there a phylum that you investigated that can be distinguished by a combination of two or more characteristics? What are the phyla concerned and what are their characteristics?


4. If any phyla have not yet been separated from the others, list these and determine what combination of characteristics identifies them.


Conclusions:
1. Are most of the animal groups distinguished by one characteristic only or a combination of characteristics?


2. There are many other phyla of animals not considered in this investigation. Would the characteristics listed in your answers to Q1 – 4 distinguish the groups in this investigation from other groups you have not observed? Explain.


For Further Investigation:
1. For the Chordates studied, observe the presence or absence of jaws, gill slits, teeth, and the type of appendages and skin coverings.


2. Try to determine the characteristics that distinguish each class of Arthropods.
1.5 Photosynthesis in Algae

Aim:  
(i) To determine the effect of increasing sediment on photosynthesis in algae.  
(ii) To determine the effect of increasing nutrients on photosynthesis in algae.

Hypotheses:  
Complete the following:  

(i) If the level of sediment in the water is increased, then photosynthesis will ………………….

(ii) If the nutrient level in the external water is increased, then photosynthesis will ………………….

Experimental Design: In your group, discuss the following questions for each experiment.

1.  
   (a) What is the independent (or experimental) variable? i.e. the variable you will change.  
   (b) How will you do this?

2.  
   (a) What is the dependent variable? i.e. the variable you will measure?  
   (b) How will you do this?

3.  
   What equipment will you need?

4.  
   What variables will need to be kept constant to make this a fair test?

5.  
   What will be the control set-up?

6.  
   How many experimental set-ups will you have? Why?

7.  
   Where will you perform the experiment?

8.  
   For how long will the experiment be conducted?

9.  
   How often will readings be taken?

10.  
    How will you display your results?

11.  
    (a) What results will support your hypothesis?  
    (b) What ones will disprove it?

After initial planning in your group, discuss your answers with other groups. Get feedback from your teacher and then begin conducting your investigation.

Your Investigation should be set out in the following format:

1.  
   Aim

2.  
   Hypothesis

3.  
   Materials (or Equipment)

4.  
   Method (or Procedure)

5.  
   Results

6.  
   Interpretation (or Analysis)

7.  
   Conclusion

8.  
   Bibliography

Include data tables and graphs to accurately and concisely display your Results.

Analyse your results in the Interpretation section and note any unusual findings. If time permits, repeat the experiment after suggesting ways to improve the experimental design.

Finally form a Conclusion and state whether the data supports or disproves your hypothesis.
Effect of Sedimentation:
Increasing sediment run-off from farms is having an impact on coral reef communities. Sediments in water reduce the amount of light that can filter through to deeper layers. This restricts photosynthesis to shallower regions. Therefore, sugars that zooxanthellae normally produce for coral polyps are also reduced.

To simulate this increase it will be necessary to ‘muddy-up’ the water surrounding the algae. One suggestion may be to start with normal creek water. This could act as the Control set-up.

In a second set-up, several heaped tablespoons of sand or vermiculite could be added and the students directed to swirl the contents every minute to keep the sediments in flotation and prevent them from settling on the bottom. This could be the high sedimentation set-up. (Soil or mud should be avoided as this would add nutrient ions to the solution and therefore with this added variable, it would not be a fair or valid test. In addition, all set-ups should be swirled to control variables.) This beaker would need to be swirled frequently to keep the level of suspended sediments high.

In a third set-up, the creek water could be filtered to remove small amounts of sediment. This could be the low sedimentation set-up. Filtering can be done using filter paper and a funnel, or using a piece of calico cloth.

Each set-up could be replicated to improve the validity of results. Species of algae that could be used include simple Spirogyra (or pond scum) but other varieties would be equally successful. All set-ups would need to be placed in sunlight (or artificial light), of the same intensity. e.g. in front of a lamp. In addition, the volume of creek water in each container would need to be the same; containers would need to be the same size; with the same volume/mass of algae in each; and same temperature etc.

To measure the level of photosynthesis, the algae could be placed under a small glass, inverted filter funnel and submerged in a large beaker of water. The beaker would need to be large enough so that when the filter funnel is weighted down, the tip of the funnel is still underwater. The set-up could be left for 10 minutes to allow bubbles of oxygen gas to form at the tip. It is then easy to count the number of gas bubbles given off per minute or per 5 minutes depending on the mass of algae that you have. Several readings could be taken over the next 30 minutes or so. As oxygen is a by-product of photosynthesis, a greater rate of oxygen production indicates a greater rate of photosynthesis. The oxygen bubbles will accumulate at the top of the filter funnel, move through to the end and emerge from the tip. It is important to have a glass filter funnel so light can still penetrate. An alternative experiment could be set up in which the oxygen gas displaces water from an inverted test tube or measuring cylinder. The volume of oxygen gas produced in a given time interval could then be measured.

Effect of Increased Nutrients:
Set-ups, similar to the ones listed above could be done, but instead of changing the level of suspended sediments, the level of nutrients in the surrounding liquid could be changed. Normal creek water would act as the control set-up and then small amounts of dissolved nitrogen or phosphorus fertilisers could be added. Commercially produced liquid fertilisers could be purchased and made up or diluted according to the instructions on the packet. A low, medium and high nutrient solution could be made up and algae added to these three experimental set-ups. Measuring the level of photosynthesis in each set-up could be done as above.
1.5 (b) GUIDELINES FOR WRITING A SCIENTIFIC REPORT

Use the following headings:

1. **Title** — a brief phrase relevant to the topic under investigation.

2. **Aim** — a brief statement about the purpose of the experiment or what the experiment attempts to demonstrate. e.g. “To demonstrate….” “To show ….”

3. **Introduction** — this is a paragraph or two explaining the theory on which the experiment is based. It explains the thinking behind the hypothesis.

4. **Hypothesis** — a brief statement that is a prediction or educated guess about what will happen in the experiment. It is only one sentence and is often worded in the format of “If …………, then …..” It shows the relationship between the manipulated/changed variable (independent variable) and the responding/measured variable (dependent variable). A hypothesis is concise and does NOT need to contain an explanation as to why you think it is correct.

5. **Equipment** — a list of all materials needed for the experiment.

6. **Procedure** — a list of steps that were followed to perform the experiment. It is written in the third person, past tense; the traditional genre for all scientific reports. e.g. Two plants were placed in…….. Diagrams of the set-up may be included here. These could be drawn in pencil and clearly labelled. The control set-up is clearly stated and all variables, apart from the manipulated variable, are kept constant. These variables must be mentioned in the experimental design for a valid experiment to be performed.

7. **Results** — Data tables, graphs and written observations.

8. **Interpretation** — a paragraph explaining the results and any discrepancies in the data is noted. i.e. if the observations support the theory and if not, then some alternative explanation may be relevant.

9. **Conclusion** — a brief statement answering the scientific problem under investigation. It also includes a statement about whether the hypothesis is supported or not supported by the data.

10. **Evaluation/Amendment to the experiment** — any sources or error can be identified here and suggestions made to improve the design of the experiment. If further investigation is required, then alternative experiments can be suggested.

A scientific journal can be kept. The justification for the hypothesis and the experimental design can be written in this. In the journal the manipulated (independent or experimental) variable and the measured (dependent) variable are stated; the control set-up and experimental set-ups are explained; all other variables that are kept constant are listed; and modifications to the experimental design are documented.

Senior school students should include an Abstract in their Experimental Investigations as an indented paragraph after the title. In the Abstract, the background to the study is clearly outlined in one or two sentences; the methods used in the study in no more that 3 or 4 sentences; the major findings (results) are summarised in no more than 2 or 3 sentences; the concluding sentence relates to the earlier statement of the hypothesis; and the entire abstract is a single paragraph.

11. **Bibliography** — a list of all references used.
1.6 Classification Challenge
Develop a Dichotomous Key to uniquely separate each of the following sea creatures into its own group.

<table>
<thead>
<tr>
<th>Organism A</th>
<th>Organism B</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Starfish](Image: Paraflyer, Creative Commons)</td>
<td>![Brain Coral](Image: Pierre Poulquin, Creative Commons)</td>
</tr>
<tr>
<td>Starfish</td>
<td>Brain Coral</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Organism C</th>
<th>Organism D</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Nudibranch](Image: Doug Deep, Creative Commons)</td>
<td>![Sponge](Image: Dr. John Hooper, QM)</td>
</tr>
<tr>
<td>Nudibranch (shell-less mollusc)</td>
<td>Sponge</td>
</tr>
<tr>
<td>(Image: Doug Deep, Creative Commons)</td>
<td>(Image: Dr. John Hooper, QM)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Organism E</th>
<th>Organism F</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Sea Anemone](Image: Martin LaBar, Creative Commons)</td>
<td>![Parrot Fish](Image: Richard Ling, Creative Commons)</td>
</tr>
<tr>
<td>Sea Anemone</td>
<td>Parrot Fish</td>
</tr>
<tr>
<td>(Image: Martin LaBar, Creative Commons)</td>
<td>(Image: Richard Ling, Creative Commons)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Organism G</th>
<th>Organism H</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Manta Ray](Image: Thomas Hawk, Creative Commons)</td>
<td>![Blue-ringed Octopus](Image: CW Ye, Creative Commons)</td>
</tr>
<tr>
<td>Manta Ray</td>
<td>Blue-ringed Octopus</td>
</tr>
<tr>
<td>(Image: Thomas Hawk, Creative Commons)</td>
<td>(Image: CW Ye, Creative Commons)</td>
</tr>
</tbody>
</table>
1.7(a) Carbon dioxide release

**Aim:** To examine the effect of acidic liquids on coral skeletons.

**Materials:**
- Crushed chalk (made of calcium carbonate to simulate coral skeletons)
- Small stick of chalk
- Vinegar or acetic acid
- Glass jar or beaker

**Method:**
1. Add the chalk to the beaker.
2. Pour in a little vinegar
3. Record your observations.
4. Place a small stick of chalk in the vinegar and leave overnight. Examine in the morning.

**Results:**
Observations:

**Interpretation:**
1. What gas is being produced when vinegar is added to the chalk (calcium carbonate)?

2. What happened to the stick of chalk (calcium carbonate) that was left in the vinegar (acid) overnight?

3. Using the carbon cycle, explain how the carbon produced in this reaction could have once come from a dinosaur’s breath.

**Conclusion:**
What could happen to coral reefs, if marine sea water became more acidic?
1.7 (b) Ocean Warming

**Aim:** To investigate the effect of an increase in temperature on low lying islands and countries.

**Materials:**
- Small conical flask
- Glass Tube
- One-holed Rubber stopper
- Food colouring
- Large bowl
- Cold Water
- Hot water
- Permanent marker or felt pen

**Method:**
1. Fill the flask with cold water and add a few drops of food colouring.
2. Place the rubber stopper in the top of the flask. Push the glass tube through the hole in the stopper into the water. Make sure that the flask remains sealed.
3. With the felt pen, indicate the water level on the glass tubing.
4. Place the flask in a bowl of hot water. (Be careful not to splash hot water onto yourself.)
5. Observe what happens.

**Results:**
Describe what happened. Was there a change in the water level? If so, by how much?

………………………………………………………………………………………………………………………………………………

………………………………………………………………………………………………………………………………………………

**Interpretation:**

1. How does the experiment demonstrate the effects of climate change?
………………………………………………………………………………………………………………………………………………
………………………………………………………………………………………………………………………………………………
………………………………………………………………………………………………………………………………………………
………………………………………………………………………………………………………………………………………………

2. What effects could sea level rises have on low lying islands and countries?
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………………………………………………………………………………………………………………………………………………

(Adapted from the Queensland Sustainable Energy Industry Development Group 2004)
1.7(c) Ocean Acidification

Safety: Eye protection should be worn if using indicator solution. Blow gently and do not suck up the water. Dispose of the straws at the end of the activity. Do not share straws.

Aim: To investigate the effect of increased CO$_2$ levels on ocean acidification.

Materials:
- 2 beakers or glass jars
- pH meters or indicator solution (such as universal indicator or bromothymol blue or red cabbage water)
- Sea water - if not available, then a substitute can be made by dissolving approx 30 g of common salt (sodium chloride) in 1 dm$^3$ of water (1000ml or 1 litre)
- Tap water (fresh water)
- Drinking straws
- Stopwatch

Method:
1. Pour 100ml of sea water into one of the beakers and 100ml of fresh water into the other.
2. Measure the initial pH of each.
   If using an indicator solution, add several drops to each so that the colour is clearly visible.
3. Place the pH meter in the sea water sample and using the straw, blow gently and consistently into the water sample for 2 minutes. (If using an indicator solution, note any change in colour.)
4. Record the resulting pH.
5. Repeat this process for the fresh water sample.

Results:

<table>
<thead>
<tr>
<th>Beaker 1 – Sea Water Sample</th>
<th>Beaker 2 – Fresh Water Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial pH</td>
<td></td>
</tr>
<tr>
<td>Final pH</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td></td>
</tr>
</tbody>
</table>

Colour of Universal Indicator Paper

![Colour scale of red cabbage water]

Colour scale of red cabbage water
Interpretation:

1. What gas was being dissolved into the water when you were blowing through the straw?

2. Which beaker of water recorded the lowest pH?

3. As the pH decreases, the water is becoming more acidic. Why did the water become acidic?
   i.e. \[ \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 \]

4. Which water sample was able to absorb more carbon dioxide without its acidity changing greatly?

5. If carbon dioxide levels in the atmosphere continue to increase, what could be some of the implications for marine life, and corals in particular? (Remember that coral skeletons are made of calcium carbonate. Refer back to Experiment 1.7(a))
1.7 (d) CO₂ and the Greenhouse Effect

Aim: To investigate the effect of CO₂ on global warming and the greenhouse effect.

Materials:
2 × 1L jars with lids (these need to be the same)
2 thermometers
120 ml acetic acid (vinegar)
Measuring cylinder
Sodium bicarbonate (bicarbonate of soda or baking soda)
Spoon/spatula
Stopwatch

Method:
1. Pour 60ml of vinegar into each jar.
2. Add approximately 1 teaspoon of baking soda to one of the jars using a spatula.
3. Place a thermometer in each jar and put on the lids. (A hole may need to be made in the lids. If so, seal around the thermometer with plasticine. This should be done immediately after the baking soda is added to the jar.) Don’t allow the thermometer to stand directly in the vinegar. See the diagrams on the next page.
4. Allow the jars to stand for 5 minutes.
5. Place both jars in direct sunlight for 25 minutes and record the temperature inside the jars at 5 minute intervals.
6. At the end of this time, transfer the jars to the shade and record any temperature variations for a further 25 minutes. Again, record in 5 minute intervals.
7. Use the results to draw line graphs of the data. Two line graphs should be drawn on each set of axes. Select a different colour for each line graph and indicate this clearly on the legend.

Experimental Design:
1. Why is it important that the two jars are the same?
   ……………………………………………………………………………………………………………………………
   ……………………………………………………………………………………………………………………………
   ……………………………………………………………………………………………………………………………

2. Why did the lids need to be sealed?
   ……………………………………………………………………………………………………………………………
   ……………………………………………………………………………………………………………………………
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3. A criticism of this experimental design could be that it is not a truly fair test. It could be argued that for a valid test, there should be four jars, one with
   • baking soda and vinegar
   • just baking soda
   • just vinegar
   • nothing inside

   (a) What do we call this last jar? ………………………
   (b) Why should all experiments have one? i.e. this 3(a)
   ……………………………………………………………………………………………………………………………
   ……………………………………………………………………………………………………………………………
   ……………………………………………………………………………………………………………………………
(If time and resources permit, re-design this experiment, the data tables and graph to include these four set-ups.)

Diagrams:

Results:

<table>
<thead>
<tr>
<th>Jar Contents and Location</th>
<th>Temperature (°C) taken at 5 min Time Intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 mins</td>
</tr>
<tr>
<td>Jar 1 (Vinegar) in sun</td>
<td></td>
</tr>
<tr>
<td>Jar 2 (Vinegar &amp; baking soda) in sun</td>
<td></td>
</tr>
<tr>
<td>Jar 1 (Vinegar) in shade</td>
<td></td>
</tr>
<tr>
<td>Jar 2 (Vinegar &amp; baking soda) in shade</td>
<td></td>
</tr>
</tbody>
</table>
**Interpretation:**

1. In the experimental jar, (Jar 2), what gas did the vinegar (acetic acid) and the bicarbonate of soda (sodium bicarbonate) produce?

2. What happened to the jar with the vinegar and bicarbonate of soda (Jar 2) when it was placed in the sun? Compare it with the jar containing vinegar only (Jar 1)?

3. Was this pattern the same for the jars that were then placed into the shade?

4. If the jar represents the Earth and the vinegar and bicarbonate of soda simulates an atmosphere with increased carbon dioxide, what effect does this have on the planet?
5. This effect is called the greenhouse effect. Why is it important to life on the planet? (Link your answer with some of the results of the previous three experiments.)

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6. Research what is meant by the ‘enhanced greenhouse effect’?
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7. What might happen if the level of greenhouse gases in the atmosphere were to decrease/increase?
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(Adapted from the Queensland Sustainable Energy Industry Development Group 2004)
2.0 STRUCTURED DISCUSSIONS

FAQs (Frequently Asked Questions in Structured Discussion Format)

Several of these structured discussions are based on the web-seminars of the ARC Centre of Excellence for Coral Reef Studies and can be accessed at http://www.coralcoe.org.au/events/webseminar/iyorwebseminar.html

2.1 What is the effect of over-fishing on the GBR?

An experiment was performed to determine the effect of over-fishing of gropers, snapper and parrotfish along the Great Barrier Reef (GBR) i.e. whether over-fishing reduces reef resilience to climate change. (Resilience refers to the ability of the reef to recover from disturbances.)

After the 1998 bleaching episode, a large-scale Fish Exclusion Experiment was performed by Professor Terry Hughes (James Cook University) over a three year period in which several plots were set up at a site along the reef. Each plot consisted of a cage, 5m long by 5 m wide and 5 m high.

Some plots were completely closed to prevent large fish from entering (i.e. the full cages); some were partial cages, to allow some entry; and others had open cages that allowed large herbivorous fish to come and go freely.

After three years, the cages were examined. In the full cages, there was an increase in Sargassum algae forming large kelp beds that completely over-shadowed the coral. In these plots there was no, or limited, coral resilience. In the open cages, coral cover tripled over the three year study period.

(a) Interpretation: Briefly explain why these results occurred.

(b) Which type of plot was the control set-up? Why?

(c) Conclusion: What conclusion can you make about the impact of over-fishing on the GBR and what recommendations can you make?
2.2 *Do all species of corals have the same susceptibility to bleaching?*

A study was performed to determine if all species of corals are equally susceptible to coral bleaching and the results were graphed and appear below. (These figures do not refer to actual experimental data.)

![Bar graph showing percentage of coral bleaching in different species.]

(a) What is your interpretation of the data shown in the above graph?

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(b) Ignoring any other factors, what is your long-term prediction for species diversity of corals along the GBR, if bleaching events become more common due to increased global warming?

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2.3 What is the effect of changes in temperature and CO$_2$ on coral reef communities?

Scientists have gathered information about changes in temperature and CO$_2$ levels over different time periods by sampling Ice Core data taken at Vostok, an outpost located near the South Geomagnetic Pole in Antarctica. Graphs can then be used to calculate the average rate of change over a 100 year period. A comparison between rates of change 420 000 years ago and the present day is shown in the table below.

<table>
<thead>
<tr>
<th>Average Rate of Change</th>
<th>Data from 420 000yrs ago</th>
<th>Present day data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>$0.009 \pm 0.013 \degree$C/100 years</td>
<td>$+0.7 \degree$C/100 years</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>$0.072 \pm 0.169$ppm/100 years</td>
<td>$+80$ppm/100 years (currently level is 380ppm)</td>
</tr>
</tbody>
</table>

(a) What conclusions can you draw from the above data?

(b) What impact is this having on coral reef communities today?
2.4 How does ocean acidification affect corals?

As pointed out by Professor Malcolm McCulloch from ANU (Australian National University), oceans don’t take up or release CO₂ uniformly. There is a major uptake when water is colder and a major release in warmer waters, such as those of the central Pacific. When CO₂ dissolves in water the following chemical reaction occurs:

\[
CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow H^+ + HCO_3^- \rightarrow CO_3^{2-} + 2H^+
\]

and then with more CO₂ dissolving in sea water the following reaction occurs:

\[
CO_2 + H_2O + CO_3^{2-} \rightarrow 2HCO_3^- \quad \text{(This reduces the levels of CO}_3^{2-} \text{ ions dissolved in the surrounding water.)}
\]

Corals need lots of CO₃²⁻ in sea water as they combine these ions with calcium ions (Ca²⁺) to form calcium carbonate (CaCO₃) which makes up their skeletons. That is, a calcification process occurs. [Most of the carbon in seawater is in the form of bicarbonate ions (HCO₃⁻) but corals need carbonate ions (CO₃²⁻) to build their skeletons.]

H₂CO₃ is a weak acid, called carbonic acid. Acidity is associated with the concentration of H⁺ ions in solution. The greater the concentration of H⁺ ions, the more acidic is the solution. An acidic solution has a low pH value of between 1 and 6.

(a) As more CO₂ dissolves in sea water, what happens to the pH of seawater? Why?

(b) What are the effects of this on corals and their ability to recover and reform coral skeletons after bleaching events?

(c) The CO₂ that dissolves in seawater forms carbonic acid (H₂CO₃) that erodes calcium carbonate as shown in the reaction below.

\[
CO_2 + H_2O + CaCO_3 \leftrightarrow 2HCO_3^- + Ca^{2+}
\]

What could happen to coral skeletons if this change in ocean acidity continues?

Recent studies of Flinders’ Reef off the GBR have shown no evidence to date for decreased calcification due to decreased CO₃²⁻. However, responses for coral reefs are non-uniform.
2.5 Are there any genetic differences in the zooxanthellae species living in corals?

Zooxanthellae algae that live in a symbiotic relationship with coral polyps have simple structures but complex genetics. As discovered by Dr. Line Bay from JCU (James Cook University), there are seven clades or genetic types of these algae, and three are found along the GBR. Clade C is the most common. However, Clade D performs better at higher temperatures but has a slower growth rate as compared with Clade C.

Studies have been carried out by Dr. Bay to determine if corals can change their symbioses. That is, change to a different type of clade (or symbiont) to give them greater thermo-tolerance, (an ability to survive increases in temperature).

A study performed by AIMS (Australian Institute of Marine Science) took some species of Acropora corals and moved them to Townsville. The ones with Clade C2 came from Davies Reef and Keppel Island and the ones with Clade D came from Magnetic Island. During a not especially hot summer, there was bleaching shown in the Davies Reef and Keppel Island corals but not the ones from Magnetic Island.

(a) Based on the above information, is this consistent with what was expected?

(b) How did the bleaching event affect the Keppel Island corals?

(c) Is this response to heat stress inheritable?

(d) Is this ability to change zooxanthellae symbionts likely to be a major evolutionary factor in how corals adapt to global warming? Why or why not?
2.6 Can we grow coral reefs?

Scientists have shown that when an electric current is passed through steel mesh in seawater, it is soon covered with a thick layer of limestone. Calcium carbonate is one of the components of limestone and makes up the skeletons of corals. These Electro Mineral Accretion Experiments have been performed at Reef HQ Aquarium on the GBR Marine Park and work according to the same principles as a battery.

The anode is the positive electrode and it attracts anions (negatively charged ions), while the cathode is the negative electrode and it attracts cations (positively charged ions).

Therefore in these experiments, chloride ions (Cl\(^-\)) and oxygen ions (O\(^2-\)) are attracted to the anode where they deliver some electrons and change into chlorine gas and oxygen gas. This can be seen as bubbles that float to the surface and diffuse into the air.

\[
2\text{Cl}^- \rightarrow \text{Cl}_2(g) + 2e^- \quad \text{and} \quad 2\text{O}^2- \rightarrow \text{O}_2(g) + 4e^- 
\]

Hydrogen ions are attracted to the cathode where they collect some electrons and form hydrogen gas.

\[
2\text{H}^+ + 2e^- \rightarrow \text{H}_2(g) 
\]

Minerals in the sea water are also attracted to the cathode and a precipitate of limestone is produced here.

In an experiment to determine the effectiveness of this process for growing coral reefs, PVC (polyvinyl chloride) frames were fitted with snake mesh to serve as the cathode. Coral colonies were fragmented into little pieces and fixed to the mesh. The frames were fitted with magnesium anodes underneath and connected to a 12-volt car battery.

(a) To be able to validly compare the effectiveness of this technique, another setup, the control setup, was added to the above experiment. How would this differ from the above setup?

(b) Therefore, what is the only variable that differs between these two setups? i.e. What is the manipulated or independent variable?

(c) What are the variables that should be kept the same in the control and experimental setups?

(d) What will be measured? That is, what is the dependent variable?

(e) What results would support the suggestion that ‘putting an electric current through seawater would significantly restore coral reefs damaged by ship groundings, blast fishing and related causes of reef destruction?’
2.7 How were bio-chemicals from sponges discovered?

*Biodiscovery Experiments: Biochemicals, Membrane Structure, and Pain Control*

(A study of the structure of membranes and the mechanisms by which substances move into and out of cells would be advisable before attempting this activity. Some background knowledge of the immune system would also be helpful.)

Once potential bio-active compounds are extracted from sources such as sponges, their molecular formula needs to be determined as well as the mechanism by which they exert their effects. Many of these compounds are chemicals that inhibit a biological or biochemical reaction.

To determine the effectiveness of some biochemicals, a measure called the IC\(_{50}\) is used. This is the concentration of the chemical that inhibits 50% of a parameter compared to the control. That is how much of a given drug is needed to inhibit a given biological process (or component of a process, such as an enzyme, cell, cell receptor or microbe), by half. It is commonly used as a measure of antagonist drug potency. That is, how potent a drug is.

(a) Therefore, the more potent or effective the drug, the …………………(higher/lower) the IC\(_{50}\).

   Explain:

   ……………………………………………………………………………………………………………………………

   ……………………………………………………………………………………………………………………………

   ……………………………………………………………………………………………………………………………

Cells such as macrophages and lymphocytes have special receptors on their membrane surface, known as P2X\(_7\) receptors. (P2X\(_7\) is expressed predominantly in cells with an immune origin.) These P2X\(_7\) receptors seem to have an important role in inflammation and immune responses. They are involved in the processing and release of interleukin-1\(\beta\), from their cells. Interleukins are types of cytokines; chemicals that stimulate immune and inflammatory responses. Chemicals or drugs that treat inflammation are known as P2X\(_7\) antagonists.

(b) What do you think this means?

……………………………………………………………………………………………………………………

……………………………………………………………………………………………………………………

(c) Mice, genetically modified to have the P2X\(_7\) receptor ‘knocked out’ have been reported to show a reduced severity of arthritis.

Why would this be so?

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Scientists at Eskitis Institute have been examining sponges and other sessile marine invertebrates collected by the Queensland Museum, specifically searching for bio-active chemicals. [Further details about the experimental procedure are at the end of this structured discussion.]

The P2X\(_7\) receptor is activated by ATP (adenosine tri-phosphate) and prolonged exposure to ATP opens large pores in the plasma membrane of these cells. This opening of the plasma membrane leads to a rapid influx of positive ions as well as hydrophilic molecules of small molecular mass. This leads to the release of cytokines from these cells and a subsequent inflammatory response.

(d) Suggest one way the P2X\(_7\) receptor could be made non-functional?
The study involved the use of a synthetic ATP analogue called benzoyl adenosine triphosphate, or BzATP for short. (This has the same effect on the P2X<sub>7</sub> receptor as extracellular ATP.)

Five possible compounds from the sponge *Stylissa flabellata*, were applied to human premonocytic cells (THP-1 cells) that express the P2X<sub>7</sub> receptor, together with a supply of BzATP. To determine any non-specific compound inhibition, an identical experiment was performed replacing the BzATP with the non-specific pore-forming compound, hemolysin.

(Hemolysin is a bacterial protein toxin that can form non-specific transmembrane channels which allow uncontrolled permeation of water, ions and small organic molecules across the membrane.)

A membrane-impermeable nucleic acid stain *Sytox Orange* was then supplied to both set-ups. This stain can bind to nucleic acids within cells, resulting in fluorescence. Compounds that disrupt pore formation should have an effect on the uptake of this dye.

(e) What should be this effect? That is, would there be an increased or decreased fluorescence? Why?

(f) Why was it important to use a nucleic acid dye that is membrane-impermeable?

(g) Which of the above set-ups would be the control set-up?

(h) The tests were performed in duplicate on three independent days. Why?

The results of the experiment are summarised in the following data table:
Compounds 1 – 5 Inhibition of P2X<sub>7</sub> and Non-specific Hemolysin.

<table>
<thead>
<tr>
<th>Compound</th>
<th>P2X&lt;sub&gt;7&lt;/sub&gt;</th>
<th>Hemolysin*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Stylissadine A</td>
<td>0.7 µM</td>
<td>None</td>
</tr>
<tr>
<td>2. Stylissadine B</td>
<td>1.8 µM</td>
<td>None</td>
</tr>
<tr>
<td>3. Konbu’acidin B</td>
<td>3.0 µM</td>
<td>107% @100 µM</td>
</tr>
<tr>
<td>4. 4,5-dibromopalau’amine</td>
<td>40% @100 µM</td>
<td>-46% @100 µM</td>
</tr>
<tr>
<td>5. Massadine</td>
<td>64% @ 100 µM</td>
<td>66% @100 µM</td>
</tr>
</tbody>
</table>

IC<sub>50</sub> of Stylissadine A and B was 0.7 and 1.8 µM respectively.

* Hemolysin activity only given if >± 30% at any concentration up to 100 µM

(i) The above figures show the IC<sub>50</sub> for each of the five compounds. Which of the compounds was the most effective in inhibiting the function of the P2X<sub>7</sub> receptor? Why?

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(j) Which compounds do you think should undergo further development into anti-inflammatory drugs?

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Experimental Details:

Dr. John Hooper and his team collected samples of the Indo-Pacific marine sponge, *Stylissa fabellata* from the Great Barrier Reef. Specimens were initially frozen and then freeze-dried. Scientists at Eskitis Institute then crushed these dried specimens to a fine powder. Solvents were then pumped through the powder to produce a liquid chemical extract. These extracts were then exposed to various technologies (natural product high-throughput screening or HTS) to discover any bio-active chemicals reacting to specific chemical and biological assays (or screens). In this case, an anti-inflammatory screen was used and they discovered some very interesting bio-active chemical compounds that were specific against the P2X<sub>7</sub> receptor. i.e. These chemicals were antagonist to the receptor (i.e. blocking it), such that the chemicals seemed to be useful in the development of anti-inflammatory drugs.
3.0 PROJECTS and ASSESSMENT TASKS

3.1 Middle School  CORAL COMMUNITIES

Background:

The biodiversity and health of the Great Barrier Reef is currently under threat for a number of different reasons. These threats include: tourism associated with coastal resort and marina development and over-harvesting; global warming and climate change, and freshwater and toxic runoff from floods and cyclones; agricultural run-off from farms, saltation, and pollution; population changes in the Crown of Thorns starfish, and diseases of corals.

Initial Research:

1. Investigate the characteristics of coral polyps and marine sponges.
   (a) Describe their physical characteristics.
   (b) How do they reproduce?
   (c) How do they eat?
   (d) How do they grow?

2. Concerning Coral Communities:
   (a) Where are they found and how are coral reefs formed?
   (b) What is the approximate percentage of the world’s species that live among coral reefs?
   (c) Why do some many animals live in and among coral reefs?
   (d) Name five species that depend on coral reefs and describe how each depends on the reef. Determine the Phylum name of each species.
   (e) Describe the symbiotic relationship between coral polyps and zooxanthellae algae.
   (f) Why are coral reefs referred to as ‘rainforests of the sea’?

3. Threats to Coral reefs:
   (a) List as many natural threats to coral reefs as you can.
   (b) Describe three threats to coral reefs due to human activity.
   (c) What is blast fishing or dynamite fishing?
   (d) How can people on land affect coral reefs?
   (e) How might a diver or someone in a boat affect a coral reef?
   (f) Think of ways that we can protect and conserve our coral reefs.

Task:

Each group of four students will be assigned ONE of the following threats to investigate.

Threats: (ONE of the following four.)

1. Tourism, coastal resort and marina development, and over-harvesting.
2. Global warming and climate change; freshwater and toxic runoff from floods and cyclones.
3. Agricultural run-off from farms (both fertilisers and pesticides); saltation; and pollution.
4. Population changes in the Crown of Thorns starfish; other organisms that affect the reef; and diseases of corals.
Your group has to prepare an environmental impact report on the effect of your threat on coral reef communities. The presentation should include an investigation into each of the following:

- The meaning of biodiversity and why it’s important
- A description of the threat and an explanation of how this threat has occurred
- The current impact of this threat on the Great Barrier Reef
- Future scenarios (or the long-term impact), if nothing is done to remove or reduce the threat
- Strategies that could be used to reduce or remove the threat

Presentation:

Each group should prepare a written report as well as a multi-media presentation, of approximately 5 minutes duration, that will be presented to the class.

The written report should be approximately 1000 words in length. It should include relevant facts and illustrations such as pictures, diagrams or charts and should address each of the five dot points above.

Results of any scientific studies into changes along the reef or human impact should be presented, as support for your statements and conclusions. These can include tables and graphs.

The report should be structured under the 5 headings as underlined above.

Organisational and alternative suggestions:

- Initial research could be done by each group member in a computer room for the first few lessons.
- Each group (or the teacher) could nominate a group captain that would be in charge of delegating tasks and producing a timeline of what needs to be done and when.

You may like to

- Purchase a three-sided folding poster board and on it have the problem, solution, action to be taken, drafted letter, pictures, illustrations, graphs etc
- Get other students in the school involved. Start up a public relations campaign to get students to come to a lunchtime activity such as making posters to display around the school to raise public awareness.
- Draft a letter to a Member of Parliament or a farmer or a business owner explaining your concerns and asking for his/her support and suggestions. Design a ‘signatures sheet’ to accompany this.
- Organise lunchtime presentations so that other students in the school are exposed to the findings of each group.
KNO WLEDGE AND UNDERSTANDING

Life and Living:
Year 7
- Systems of scientific classification can be applied to living things.
- Survival of organisms is dependent on their adaptation to their environment.
- Different feeding relationships exist within an ecosystem.
Year 9
- In ecosystems, organisms interact with each other and their surroundings.
- Changes in ecosystems have causes and consequences that may be predicted.

Science as a Human Endeavour:
Year 7
- Ethical considerations are involved in decisions made about applications of science.
- Scientific knowledge can help to make natural environments sustainable, at a scale ranging from local to global.
Year 9
- Immediate and long-term consequences of human activity can be predicted by considering past and present events.
- Responsible, ethical and informed decisions about social priorities often require the application of scientific understanding.

WAYS OF WORKING

Year 7 Students are able to:
- Identify problems and issues, and formulate testable scientific questions.
- Collect and analyse first and second-hand data, information and evidence.
- Select and use scientific tools and technologies suited to an investigation.
- Draw conclusions that summarise and explain patterns in the data.
- Communicate scientific ideas, data and evidence, using scientific terminology suited to the context and purpose.
- Reflect on different points of view and recognise and clarify people’s values relating to the applications and impacts of science.
- Reflect on learning, apply new understandings and identify future applications.

Year 9 Students are able to:
- Identify problems and issues, formulate testable scientific questions.
- Research and analyse data, information and evidence.
- Draw conclusions that are consistent with the data and respond to the question.
- Communicate scientific ideas, explanations, conclusions, decisions and data, using scientific argument and terminology, in appropriate formats.
- Reflect on different perspectives and evaluate the influence of people’s values and culture on the applications of science.
- Reflect on learning, apply new understandings and justify future applications.
SCIENCE UNDERSTANDING

**Biological Sciences**

Year 6
- The growth and survival of living things are affected by the physical conditions of their environment

Year 7
- There are differences within and between groups of organisms; classification helps to organise this diversity
- Interactions between organisms can be described in terms of food chains and food webs; human activity can affect these interactions

Year 9
- Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems

**Earth and Space Sciences**

Year 6
- Sudden geological changes or extreme weather conditions can affect Earth’s surface

Year 7
- Water is an important resource that cycles through the environment

SCIENCE AS A HUMAN ENDEAVOUR

**Nature and development of Science**

Year 6
- Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena

Year 7
- Science knowledge can develop through collaboration and connecting ideas across the disciplines of science

Year 9
- Scientific understanding, including models and theories are contestable and are refined over time through a process of review by the scientific community

**Use and influence of Science**

Year 6
- Scientific knowledge is used to inform personal and community decisions

Year 7
- Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations
- Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management

Year 9
- People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions
SCIENCE INQUIRY SKILLS

Questioning and predicting
Year 9
- Formulate questions or hypotheses that can be investigated scientifically

Planning and conducting
Year 6
- With guidance, select appropriate investigation methods to answer questions or solve problems
Year 7
- Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments
Year 9
- Plan, select and use appropriate investigation methods, including fieldwork and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods

Processing and analysing data and information
Year 6 & 7
- Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate
Year 7
- Summarise data, from students’ own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions
Year 9
- Use knowledge of scientific concepts to draw conclusions that are consistent with evidence
- Critically analyse the validity of information in secondary sources and evaluate the approaches used to solve problems

Communicating
Year 6
- Communicate ideas, explanations and processes in a variety of ways, including multi-modal texts
Year 7
- Communicate ideas, findings and solutions to problems using scientific language and representations using digital technologies as appropriate
Year 9
- Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations
<table>
<thead>
<tr>
<th>Knowledge and Understanding</th>
<th>Knowledge and Understanding</th>
<th>Investigating</th>
<th>Investigating</th>
<th>Communicating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understands the interactions between organisms and their surroundings</td>
<td>Understands the immediate and long-term environmental consequences of human activities</td>
<td>Researches and analyses data and draws informed conclusions</td>
<td>Reflects on different perspectives and applies understandings to justify future applications</td>
<td>Uses scientific language and conventions and presents the report in written and multi-media formats</td>
</tr>
</tbody>
</table>

**Feedback:**

Comprehensively describes the concept and importance of biodiversity and explains how the Reef has changed due to human impact; and describes several valid relationships between: environmental factors; adaptations of relevant marine species; and their distribution.

Clearly and accurately describes the threat and the environmental consequences from a range of viewpoints and a long-term perspective.

Provides well-justified reasons and makes informed conclusions supported by valid research.

Accurately interprets diagrams and scientific findings to suggest several valid, well-justified strategies for reducing the impact of the threat.

Diagrams, tables, explanations, conclusions and justifications use a sound level of scientific terminology in both formats. Diagrams and tables are clear.

Uses everyday language, orally and in writing. Superficial communication in one or both formats is shown. Diagrams and tables are used minimally.
3.2 Senior School  
EXTENDED RESPONSE TASK
Coral Communities
Pre-Task Activities

Investigate/revise each of the following:

1. Key terms relevant to marine ecosystems:
   (a) Zones of the ocean – photic, pelagic, abyssal.
   (b) Organisms and their habitats – plankton, nekton, benthos.
   (c) Ecological concepts – producer-consumer, food web.
2. Associations and interactions among and between organisms. e.g.
   (a) Territoriality.
   (b) Predator-prey.
   (c) Mutualism, symbiosis, commensalisms, parasitism.
3. Classification
   (a) Biological system of naming organisms.
   (b) Biological classification keys to identify marine species.
   (c) Anatomical structure, life cycle and significant features of relevant marine phyla.
   (d) Structural, functional and behavioural adaptations of marine organisms.
4. Ecology
   (a) Relationships between marine organisms and their habitat.
   (b) The significance of biodiversity within the marine environment.

Initial Research/ Background Reading:

4. Reefs and Resorts
   (a) How does coastal development threaten coral communities?
   (b) Can Tourism harm coral reefs?
   (c) What are the arguments for development versus diversity?
6. Global Warming
   (a) What is causing it?
   (b) What are its effects? What symbioses are affected?
7. Coral Bleaching
   (a) Is coral bleaching affected by temperature?
   (b) Can corals adapt to global warming?
8. Ocean Acidification
   (a) What is causing it?
   (b) What are its effects on corals?
9. Coral Reef Protection
   (a) What are some reasons advocated for why we should protect our coral reef?
   (b) What are the consequences if we don’t?
10. Bio-chemicals
    (a) What GBR organisms are being investigated for a source of bioactive chemicals?
    (b) How do some of these chemicals exert their effects?
    (c) What are the benefits for humankind?
EXTENDED RESPONSE TASK
Coral Communities

Background to the Task:
The Environmental Protection Agency’s (EPA) 2006 Water Quality report was released in October 2008. It confirms scientists’ concerns about the health of the Great Barrier Reef (GBR) and that it is in grave danger from contamination and climate change. It warns that the measures put in place by governments over recent years are not working.

The area from Bundaberg to Mossman covers the Great Barrier Reef’s catchment area. More than 40 percent of the state’s agricultural products from more than 10,000 farms end up here. It is suggested that tough, new laws may be enacted to prevent further nutrient and pesticide runoff. From 2009 – 2014, the Federal Government aims to provide a $200 million package to assist producers to change their farming methods and the Queensland Government promises to contribute an additional $25 million per year.

The Scenario:
There is a controversial plan to build a marina, the Shute Harbour Marina, at the entrance to the Whitsunday Islands. The project manager for the Port Binnili development is very confident the marina will go ahead and states that, “the scientific studies show there’s a clear net benefit for the community in terms of social, economic and, indeed, the environmental aspects.”

However, opponents of the project are concerned because the site is within the Great Barrier Reef World Heritage area. Over recent years, the Port of Airlie and Abel Point marinas have been built. This new marina at Shute Harbour would have 669 berths and Port Binnili also plans a five-storey, 109-suite and 117 unit resort hotel.

Task:
You have been called in to write an environmental impact report to send to the Federal Minister for the Environment, on the planned Shute Harbour marina and Port Binnili development. You have to answer the question: “Should the proposed development go ahead?”

Your report will be in the format of an analytical essay.

Length: 1000 – 1500 words (Year 11) 1500 – 2000 words (Year 12)

Biology Key Concepts:

2. Multi-cellular organisms are functioning sets of interrelated systems.
3. Organisms live an interdependent existence in environments to which they are adapted.
4. A variety of mechanisms results in continual change at all levels of the natural world.

Key Ideas:

6. The set of systems comprising an organism enables it to function in its environments
7. All systems are interrelated and interdependent.
9. Different types of multi-cellular organisms have different roles in an environment.
11. The external features and internal functioning of organisms together enable an organism to obtain its needs.
12. Abiotic and biotic factors in an environment influence the size of populations and the composition of communities.
14. Human actions have significant impacts on interactions within an environment
15. Different organisms perform different interdependent roles in an ecosystem.
16. An organism has adaptations specific to its environment.
20. The activity of organisms changes the environment.
Criteria Assessed: Understanding Biology (UB)
Investigating Biology (IB)
Evaluating Biological Issues (EBI)

Critical Literacy Framework:

When reading any journal or newspaper article, keep in mind the critical literacy aspects of Evaluating Biological Issues. That is, gathering, critically analysing, and evaluating information from valid and reliable sources.

- Who wrote the article? Are they giving an impartial perspective or have they a hidden agenda?
- What are their qualifications?
- Are their claims supported by other scientists/research? i.e. are they reputable?
- Do their experiments and data collection methods incorporate a valid scientific model?
- Are the results reported in a reputable journal?

In your report you must

- Gather, interpret and analyse data from a variety of valid sources, demonstrating appropriate in-text referencing. (IB)
- Analyse data gathered from non-experimental investigations. (IB)
- Support your response with appropriate tables, flow charts, tables etc. (IB)
- Apply knowledge and understanding of the anatomy, physiology, distribution and ecology of relevant marine species. (UB)
- Compare and explore the complex interrelationships between human activities, natural processes, marine species and the Great Barrier Reef (GBR) ecosystem. (UB)
- Synthesise information and data to make justified conclusions and develop future scenarios about human and natural impacts on the Reef. (EBI)
- Evaluate information and make responsible decisions regarding the issue under investigation supporting this with logical, justified arguments. (EBI)

Your report should be written under the following headings:

1. Abstract
2. Existing Biology and Interactions in this Coral Reef community
3. Natural factors impacting on the Reef
4. Human Impact on the Reef
5. Benefits from the Shute Harbour Development
6. Risks from the Shute Harbour Reef
7. My Recommendation
8. Bibliography

Conditions:

Class lessons over a two-week period as well as time at home will be devoted to research. Conferencing with your teacher will occur throughout this time to validate student ownership of the task. A draft may be submitted for feedback.

Date task handed out: ..........................
Due date for Draft: ............................
Due date for Report: ...........................
<table>
<thead>
<tr>
<th>NAME : ..................................................</th>
<th>OVERALL GRADES:</th>
<th>UB : ...............</th>
<th>IB: ...............</th>
<th>EBI: ...............</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Understanding Biology</strong></td>
<td>A</td>
<td>Makes links between the anatomy and physiology of relevant marine species.</td>
<td>B</td>
<td>Explains the anatomy and physiology of relevant marine species.</td>
</tr>
<tr>
<td><strong>Link ideas, concepts &amp; theories to explain phenomena</strong></td>
<td></td>
<td>Provides extensive &amp; valid links to reveal interrelationships between</td>
<td></td>
<td>Describes interrelationships between</td>
</tr>
<tr>
<td></td>
<td></td>
<td>environmental factors, and distribution of relevant marine species; and</td>
<td></td>
<td>environmental factors, and distribution of relevant marine species; and</td>
</tr>
<tr>
<td><strong>Investigating Biology</strong></td>
<td></td>
<td>Organises data provided into appropriate tables and graphs and uses these to identify trends and interrelationships between human activities and marine ecosystems.</td>
<td></td>
<td>Organises data provided into appropriate tables and graphs and uses these to identify trends in the marine factors investigated.</td>
</tr>
<tr>
<td>Collect, organise, interpret &amp; present secondary data</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Analyse data</strong></td>
<td></td>
<td>Interprets and critically analyses the results presented by comparing and contrasting risks and benefits of the proposal and links them to theoretical concepts of marine ecology to draw a conclusion about human impacts.</td>
<td></td>
<td>Interprets the results presented by comparing risks and benefits and uses them to draw a conclusion about human impacts on marine ecosystems.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gathers, critically analyses and evaluates researched information on marine ecosystems from a variety of valid and reliable sources which is referenced using appropriate in-text format and a bibliography.</td>
<td></td>
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</tr>
<tr>
<td><strong>Evaluating Biological Issues</strong></td>
<td></td>
<td>Integrates researched information and data presented to make justified and responsible decisions about the effects of human activities on reef systems.</td>
<td></td>
<td>Integrates researched information and data presented to make supported decisions about the effects of human activities on reef systems.</td>
</tr>
<tr>
<td>Select &amp; use information from a variety of sources</td>
<td></td>
<td>Valid viewpoints from different sectors of society are considered.</td>
<td></td>
<td>Viewpoints from different sectors of society are stated.</td>
</tr>
<tr>
<td><strong>Analyse current scientific &amp; societal issues</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Justify decisions &amp; develop future scenarios</strong></td>
<td></td>
<td>Considers comprehensive, realistic future scenarios to provide a fully-justified recommendation for future management of marine ecosystems.</td>
<td></td>
<td>Recognises relevant alternative predictions for the marine ecosystem.</td>
</tr>
</tbody>
</table>
### 3.3 Worksheet - Who or What Am I?
Match the description on the left with the correct organism or process below. (Hint: Your answer should be the same colour as your question.)

<table>
<thead>
<tr>
<th>Description</th>
<th>Organism/Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I am an organism that lives within coral and I make food for the coral.</td>
<td>Zoochlorella</td>
</tr>
<tr>
<td>2. This process refers to the increase in nutrient level in rivers and seas due to fertiliser runoff from farms and industry.</td>
<td>Parastism</td>
</tr>
<tr>
<td>3. One of the effects on increased CO₂ dissolving in seawater.</td>
<td>Clionaid</td>
</tr>
<tr>
<td>4. The relationship that occurs when two organisms live together and one benefits and the other is unaffected.</td>
<td>Cuttlefish</td>
</tr>
<tr>
<td>5. I am a type of sponge that produces enzymes that dissolve the organic matter of corals.</td>
<td>Ocean Acidification</td>
</tr>
<tr>
<td>6. These organisms produce more bioactive chemicals than any animal on Earth.</td>
<td>Beaked Leatherjacket</td>
</tr>
<tr>
<td>7. This is the ability of cells to change function as required.</td>
<td>Coralline algae</td>
</tr>
<tr>
<td>8. This is the process in which water moves from a lower concentrated solution into one of higher concentration.</td>
<td>Osmosis</td>
</tr>
<tr>
<td>9. The branch of biology involved with the identification and classification of organisms.</td>
<td>Taxidermy</td>
</tr>
<tr>
<td>10. I have teeth fused into a beak that I use to shave algae that grows over coral.</td>
<td>Symbiosis</td>
</tr>
</tbody>
</table>

- **Zoochlorella**
- **Parasitism**
- **Clionaid**
- **Cuttlefish**
- **Corals**
- **Ocean Acidification**
- **Beaked Leatherjacket**
- **Coralline algae**
- **Osmosis**
- **Taxidermy**
- **Symbiosis**
- **Sponges**
- **Hermatypic**
- **Zooxanthellae**
- **Sea Anemones**
- **Diffusion**
- **Parrotfish**
- **Taxonomy**
- **Global Warming**
- **Sargassum algae**
- **Commensalism**
- **Choanocytes**
- **Eutrophication**
- **Totipotency**
3.4 Multiple Choice Quiz

A. Easier Multiple Choice
(Hint: Read over all the information first; perform the activities; go through the Frequently Asked Questions; become engaged in the Project work; and then attempt the Quiz.)

Multiple Choice Questions: Select the most appropriate answer from the four options provided.

1. There are three Domains of Life. They are
   (a) Archaea, Bacteria, Eukarya
   (b) Archaebacteria, Eubacteria, Eukaryotes
   (c) Plants, Animals, Bacteria
   (d) Bacteria, Invertebrates, Vertebrates

2. How many Kingdoms are there?
   (a) Three
   (b) Four
   (c) Five
   (d) Six

3. A tiny crab lives inside the shell of a large mussel. It eats food remains rejected by the mussel. This is an example of
   (a) mutualism
   (b) commensalism
   (c) parasitism
   (d) predation

4. When food for the mussel is scarce, the crab described above may attack the tissues of the mussel. This is an example of
   (a) mutualism
   (b) commensalism
   (c) parasitism
   (d) predation

5. What is the name of the symbiotic algae that grow within the tissues of many coral polyps?
   (a) choanocytes
   (b) zoochlorella
   (c) trikentrins
   (d) zooxanthellae

6. During the past century the earth has warmed by
   (a) 0.3°C
   (b) 0.6°C
   (c) 1.3°C
   (d) 1.9°C
7. Between 1990 to 2100 sea levels are predicted to rise by
   (a) 2-3cm  
   (b) 9 – 88cm  
   (c) 88-130cm  
   (d) 2-3m

8. There are five predominant greenhouse gases. They are
   (a) water vapour, carbon dioxide, methane, nitrous oxide, halocarbons  
   (b) carbon dioxide, methane, nitrous oxide, ammonia, chlorine  
   (c) carbon dioxide, methane, sulphur dioxide, halocarbons, chlorine  
   (d) methane, carbon dioxide, argon, halocarbons and helium

9. Which wavelength of light has the greatest energy and so can penetrate the deepest?
   (a) red  
   (b) yellow  
   (c) green  
   (d) blue

10. Threats to coral reefs include
    (a) global warming, leading to coral bleaching events  
    (b) over-fishing, leading to changed food webs and increased algal growth  
    (c) increased agricultural run-off and eutrophication  
    (d) tourism and coastal resort development, leading to increased sedimentation  
    (e) all of the above

RESULTS:

8 - 10 Einstein Equivalent
6 – 7 Getting Great
4 – 5 So-So
< 4 Re-Read the Resources
B. Harder Multiple Choice

(Hint: Read over all the information first; perform the activities; go through the Frequently Asked Questions; become engaged in the Project work; and then attempt the Quiz.)

Multiple Choice Questions: Select the most appropriate answer from the four options provided.

1. Within the cells of one species of the coelenterate Hydra there exist many unicellular green algae of the genus Zoochlorella. They are present in such large numbers that they give a green colour to the hydra. The algae obtain carbon dioxide and nitrogen compounds from the hydra. The hydra has waste products removed, is supplied with oxygen, and can also draw on the food (carbohydrates) manufactured by the algae. This relationship most closely resembles

   (a) mutualism.
   (b) commensalism.
   (c) parasitism.
   (d) predation.

2. Sponges and Corals are classified into the phyla

   (a) Protozoa and Coelenterata, respectively
   (b) Porifera and Cnidaria, respectively
   (c) Protista and Anthozoa, respectively
   (d) Platyhelminthes and Cnidaria, respectively

3. Which of the following statements about corals is correct?

   (a) Hexacorals are hard corals such as sea pens, blue corals, and sea fans
   (b) Ahermatypic corals contain zooxanthellae.
   (c) Octocorals are soft corals such as sea pens, blue corals, and sea fans.
   (d) Corals contain cyanobacteria that produce food for the coral.

4. Chemicals from different sponges have been shown to have the following properties.

   (a) antibiotic
   (b) anti-inflammatory
   (c) anti-thrombotic
   (d) anti-cancer
   (e) all of the above

5. The force or upthrust that helps to support an aquatic organism’s weight is called

   (a) Newton’s force
   (b) surface tension
   (c) buoyancy
   (d) viscosity

6. Which of the following water bodies would have the greatest amount of dissolved oxygen?

   (a) hot springs
   (b) warm, tropical seas
   (c) cold, deep lakes
   (d) cold, alpine stream
7. Organisms living in marine environments are faced with which of the following problems?
   (a) salts passing out of them and water moving in
   (b) water moving out of them and salts moving in
   (c) both water and salts moving out
   (d) both water and salts moving in

8. When CO₂ dissolves in water, it
   (a) decreases the availability of carbonate ions.
   (b) decreases the availability of bicarbonate ions.
   (c) expands and causes sea levels to rise.
   (d) forms acetic acid.

9. In Electro Mineral Accretions experiments
   (a) hydrogen ions are attracted to the anode where hydrogen gas is formed.
   (b) chloride ions are attracted to the cathode where chlorine gas is formed.
   (c) a limestone precipitate is formed at the anode
   (d) an electrical current is passed through sea water to form limestone.

10. Research on the sponge *Stylissa* has shown that it produces an inhibitor of the P2X₇ receptor. The P2X₇ receptor normally works by
    (a) releasing ATP which causes inflammation.
    (b) causing macrophages and lymphocytes to release ATP.
    (c) being activated by ATP to open pore channels and release interleukins.
    (d) absorbing ATP to stimulate the production of immunosuppressants.

**RESULTS:**

8 - 10  Einstein Equivalent
6 – 7   Getting Great
4 – 5   So-So
< 4     Re-Read the Resources
### 4.0 OTHER USEFUL WEBLINKS AND RESOURCES

<table>
<thead>
<tr>
<th>Site</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Coral Reef Society</td>
<td><a href="http://www.australiancoralreefsociety.org/links.html">http://www.australiancoralreefsociety.org/links.html</a></td>
</tr>
<tr>
<td>CRC Reef Research Centre</td>
<td><a href="http://www.reef.crc.org.au/about/achieve.html">http://www.reef.crc.org.au/about/achieve.html</a></td>
</tr>
<tr>
<td>CSIRO Climate Change Impacts</td>
<td><a href="http://www.csiro.au/science/ClimateChangeImpacts.html">http://www.csiro.au/science/ClimateChangeImpacts.html</a></td>
</tr>
<tr>
<td>Diving the Gold Coast with Ian Banks</td>
<td><a href="http://www.divingthegoldcoast.com.au/">http://www.divingthegoldcoast.com.au/</a></td>
</tr>
<tr>
<td>Green Nature</td>
<td><a href="http://www.greennature.ca">http://www.greennature.ca</a></td>
</tr>
<tr>
<td>History of Life Through Time (University of California Museum of Palaeontology)</td>
<td><a href="http://www.ucmp.berkeley.edu/exhibits/historyoflife.php">http://www.ucmp.berkeley.edu/exhibits/historyoflife.php</a></td>
</tr>
<tr>
<td>Queensland Murray Darling Committee</td>
<td><a href="http://www.qmdc.org.au/">http://www.qmdc.org.au/</a></td>
</tr>
<tr>
<td>School of Marine and Tropical Biology, James Cook University</td>
<td><a href="http://www.jcu.edu.au/mtb/">http://www.jcu.edu.au/mtb/</a></td>
</tr>
<tr>
<td>Scientists in Schools Programs</td>
<td><a href="http://www.scientistsinschools.edu.au/">http://www.scientistsinschools.edu.au/</a></td>
</tr>
<tr>
<td>Tree of Life Web Project</td>
<td><a href="http://tolweb.org/tree/">http://tolweb.org/tree/</a></td>
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