

# BioTECH

## The coelacanth and biotechnology

Biotechnology plays a big role in the study of the coelacanth. All the information which coelacanths inherit from one generation to another is stored in their DNA as genes. Biotechnology is the tool to measure all these genetic differences of the coelacanth DNA.

The more genetic differences there are, the better, as it means the coelacanth is more likely to survive changing conditions and new diseases. If there is little genetic variation, the coelacanth could possibly be wiped out by a new disease as it is less likely to have the gene needed to fight the disease.

Studying the genetics of coelacanth populations will answer many of our questions regarding this fascinating fish. It will tell us if the South African population is unique or similar to those found in other parts of the world; if the individuals in South Africa are all members of one family; and if the population is large enough to breed and survive.

Members of the research team are collecting scales from coelacanths without disturbing or harming them. Scales grow back rapidly to replace those that had been removed. Scale samples have been collected from six individuals to date to study the genetics of the coelacanth. The scales have so far shown that the South African group is closely related to populations elsewhere off Africa.

### Four-limbed animals

The coelacanth is very important to biologists studying the evolution of four-limbed animals (tetrapods). Learning more about the genome (sets of chromosomes containing genes) structure and biology of the coelacanth will tell scientists lots about the evolution of modern day vertebrates. The coelacanth genome may offer a glimpse of the genomes of creatures that evolved into modern day tetrapods over 400 million years ago.

Sources: African Coelacanth Ecosystem Programme; Public Understanding of Biotechnology Programme



### Biodiversity and the health of planet Earth

We need biodiversity (many different forms of life) on Earth if we want to continue to live here. Biodiversity shows how sick or healthy our planet is.

There are three types of diversity that indicate our planet's health:

- **Ecosystem diversity:**  
The variety of environments on Earth, made up of different habitats. The Greater St Lucia Wetland Park is an example of a habitat.
- **Differences between species:**  
A species is a particular kind of organism. There are about one million known animal species and over 350 000 known plant species. All members of a species have the same general appearance and behaviour. The coelacanth is an example of a species. The members of a species breed among themselves and, because the same mixture of chromosomes and genes is passed to the new generation, the offspring are of the same kind.
- **Differences within species:**  
In a species, there can be lots of variation between individuals' genetics. If you look at your friends, they are all slightly different though they are all members of the human species. Coelacanths will all also differ from one another.

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### PUBLIC UNDERSTANDING OF BIOTECHNOLOGY

The Department of Science and Technology has launched a Public Understanding of Biotechnology programme to make sure South Africans understand the scientific principles, related issues and potential of biotechnology. Biotechnology is the part of science that uses the DNA building blocks of life to make useful products from living things. If you have opinions, questions or concerns about any area of biotechnology, let's hear from you at [speakup@pub.ac.za](mailto:speakup@pub.ac.za) or fax 012 320 7803 or visit [www.pub.ac.za](http://www.pub.ac.za) for more information.



DEPARTMENT OF SCIENCE AND TECHNOLOGY



A coelacanth swimming off the KwaZulu-Natal coast.

## Discover our oceans and seas

Oceans and seas are great areas of salt water that cover more than two-thirds of the total surface of planet Earth. Seas are much smaller and shallower than oceans and are usually partly surrounded by land.

There are five large oceans on Earth: the Atlantic, the Pacific, the Indian, the Arctic and the Southern (or Antarctic) Oceans. They are really one "world ocean" – a continuous expanse of water – with the continents of the world like big islands of land.

We use and exploit the oceans extensively for food, energy and materials, and they have a major role in controlling our climate.

### What lies beneath the surface?

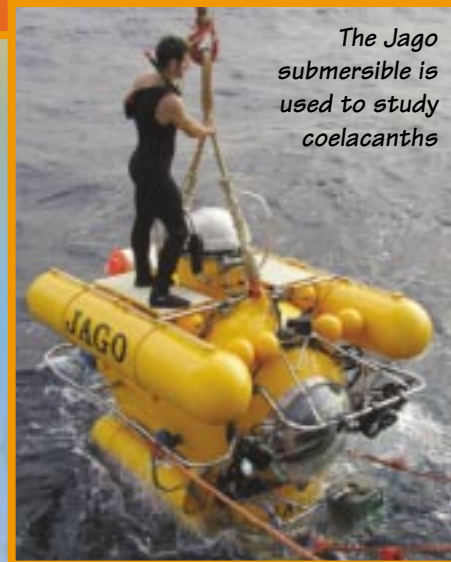
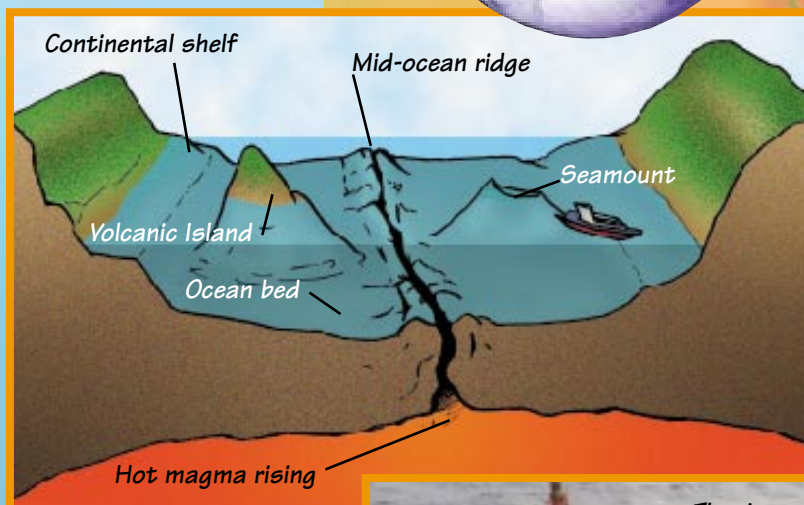
Until quite recently, we did not know much about the dark depths of the oceans. Now, with the help of small, manned underwater vehicles, and unmanned remote-operated vehicles, we can explore the world beneath their surface.

Explorers found that each ocean is shaped like a basin with a rim. The rim is called the continental shelf. Here the water is less than 200 metres deep. The real ocean bed lies 4 000 metres or more beneath the surface. This is a large, dark area that stretches for hundreds and sometimes thousands of kilometres. No sunlight reaches these dark depths. Here and there huge mountains rise up from the sea bed. They are called seamounts and are old volcanoes with their peaks far below the surface of the ocean.

Less than 50 years ago, scientists discovered the longest mountain range in the world. It stretches for some 65 000 kilometres through the middle of the world's oceans. The mountains are called mid-ocean ridges. Down the middle of these ridges run deep grooves, called rift valleys.

### Ocean currents

The waters nearer the poles are icy cold. They mix together with the warmer waters nearer the equator, moving around to create ocean currents. How does this happen? Warmer water from the oceans around the equator rises to the top, while colder water from the oceans around the poles sinks to the bottom. This cold water moves along the ocean bed towards the warm tropics, while the warm water from the tropics is pushed back to the poles at the surface. The water moves round and round. Ocean currents are therefore caused by the rising and sinking of warmer and colder water.



The Jago submersible is used to study coelacanths





## Let's see for ourselves how warm and cold water can cause ocean currents

### You will need:

- ◆ Pitcher or container
- ◆ Tap water
- ◆ Food dye (dark colour)
- ◆ Ice cube tray
- ◆ Clear glass baking dish

1. Mix the food dye into the water, pour the water into an ice cube tray and freeze it.
2. Fill the glass baking dish with warm tap water to represent the warm water near the equator.
3. Place one ice cube at each end of the baking dish, representing the cold water near the poles.

What do you think will happen as the ice cubes melt? See how the cold (coloured) water sinks and moves along the bottom of the baking dish toward the warmer water in the middle. The warmer water moves toward the ends of the baking dish; as the cold water begins to warm, it begins to rise. Can you explain how differences in water temperature in different parts of the "world ocean" cause ocean currents?



## Waves

Waves are made by the wind blowing across the surface of the ocean. The wind pushes the water upwards, making a wave crest. Gravity pulls it back down again, into a wave trough. See for yourself how waves are formed by blowing air through a straw across some water in a shallow pan.

Sometimes, in the top 500 metres of water, the wind drives rivers of moving water for thousands of kilometres. In the open ocean water moves in great circles that are called gyres. In the northern hemisphere, gyres circulate clockwise, while in the southern hemisphere they circulate anti-clockwise. These currents have a huge influence on the weather.

## Are our oceans healthy?

It is important to us that the oceans stay healthy, because:

- ◆ They drive our climate and weather;
- ◆ They provide a livelihood for many millions of people worldwide through fishing, the exploitation of energy and mineral resources, shipping and leisure activities;
- ◆ The oceans pose threats through floods, storms, sea level change and coastal erosion. More than half the world's population lives near the sea.

Oceans are used for waste disposal. Most waste eventually ends up in the oceans, with the result that marine pollution is a global problem – every part of every ocean is now affected. But the most critical threats are to shallow seas and shorelines near highly-populated areas.

## Threats to oceans

Some scientists think that climate change, perhaps helped on by human activities, will cause major changes in ocean currents. We cannot yet say what these changes or their implications will be. Some idea of the economic disruption which could be caused is shown by El Niño, a frequently occurring, natural phenomenon in which an ocean current suddenly switches off. In the 1997/98 event droughts, forest fires and air pollution were severe in some parts while floods and storms devastated other areas. Fisheries and agriculture were affected across the globe.

All over the world, the sea level is currently rising at 1- 2 centimetres every ten years as the oceans warm and expand. Scientists predict that this increase will double in the next century. It will have greater effects where land is naturally sinking, or where human activities have damaged coastal protection.

## Fisheries

Most of the world's sea fisheries are over-exploited. Excessive fishing effort leads to the collapse of stocks and affects the ecological balance for all marine organisms.

Certain fishing techniques such as bottom trawling and dredging damage the sea bed and coral reefs. Other methods such as gill-nets catch large numbers of non-target species including marine mammals, turtles and seabirds.

## The role of science

Oceanographic research has gathered a huge store of knowledge on the physics, chemistry and biology of the oceans since the 19th century. Current work is now combining separate pools of information to help us understand how the living and non-living elements of the marine environment interact and how the atmosphere interacts with the oceans.

*Oil spills from tankers cause acute pollution to coastal communities and chronic pollution to the marine environment generally.*

*(Photograph: Marine and Coastal Management, Department of Environmental Affairs and Tourism)*

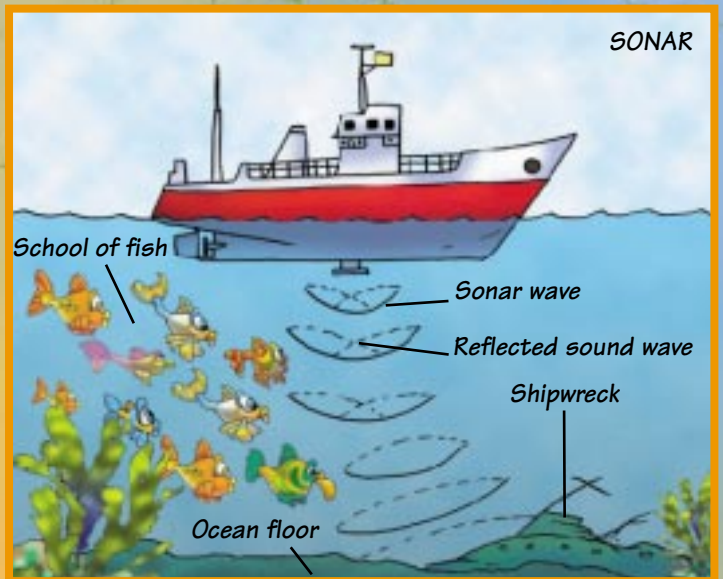




## Mapping the ocean floor

For many years scientists knew more about the surface of the Moon than about the ocean floor. In recent years, however, they have made much progress with mapping the ocean floor, using sonar detectors. Sonar stands for Sound Navigation And Ranging. Sonar detectors send out pulses of sound. When the pulses hit the ocean floor, they send back echoes. The pattern of the echoes gives a picture of what the ocean floor looks like, showing features like seamounts and trenches.

The time echoes take to return tells scientists how deep the ocean floor is. Sonar is also used to find shipwrecks and shoals of fish. Sonar was invented in 1915 by Professor Paul Langevin in France to detect icebergs following the sinking of the passenger ship the Titanic by an iceberg in 1912.



## Find out more on the Web:

Ocean Planet Smithsonian Exhibition:  
[http://seawifs.gsfc.nasa.gov/ocean\\_planet.html](http://seawifs.gsfc.nasa.gov/ocean_planet.html)  
Seaworld: [www.seaworld.org](http://www.seaworld.org)

NOAA Ocean Photo Collection:  
[www.photolib.noaa.gov](http://www.photolib.noaa.gov)  
Secrets of the Ocean Realm:  
[www.pbs.org/oceanrealm](http://www.pbs.org/oceanrealm)

## Discovering a "living fossil"

Coelacanths (pronounced sea-la-cants) are "living fossils" dating back millions of years to well before the time of the dinosaurs. Coelacanths, like dinosaurs, were known only from fossils cast in ancient stone. Scientists believed they had been extinct for over 70 million years. Then, astonishingly, fishermen found a strange, blue fish – a living coelacanth – in their nets near East London in 1938. This discovery shook the scientific world.

The coelacanth made the headlines again 14 years later, when one was caught in the Comoros and flown to South Africa for study by Professor JLB Smith. Thereafter, a number of these fish were caught in the Comoros, off Mozambique and Madagascar.

Three years ago, a group of divers amazed the world when they discovered coelacanths swimming in South Africa's Greater St Lucia Wetland Park at a depth of just over 100 metres. Nowhere else in the world are coelacanths in such shallow water and so accessible to research. As a result of this find, the South African government launched the Coelacanth Programme in 2002.

These unique prehistoric creatures provide scientists with an extraordinary window into the past, allowing us to look back in time. They also unlock the door to the future, opening opportunities to explore the deep reefs of the sea, and to research our marine resources.



This will allow people who depend upon the sea to have a better future.

The coelacanth allows young and old to participate in "living" history in an exciting chapter of southern African science. The Coelacanth Programme's research ship is often opened to learners and educators. There they can get information about careers associated with deep-sea exploration, from being a scientist, captain of a ship, or electronics technician to an engineer in charge of huge engines.

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