



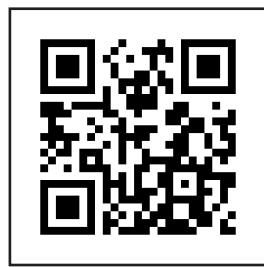
كنوز عمان

Treasures of Oman

Teacher's handbook

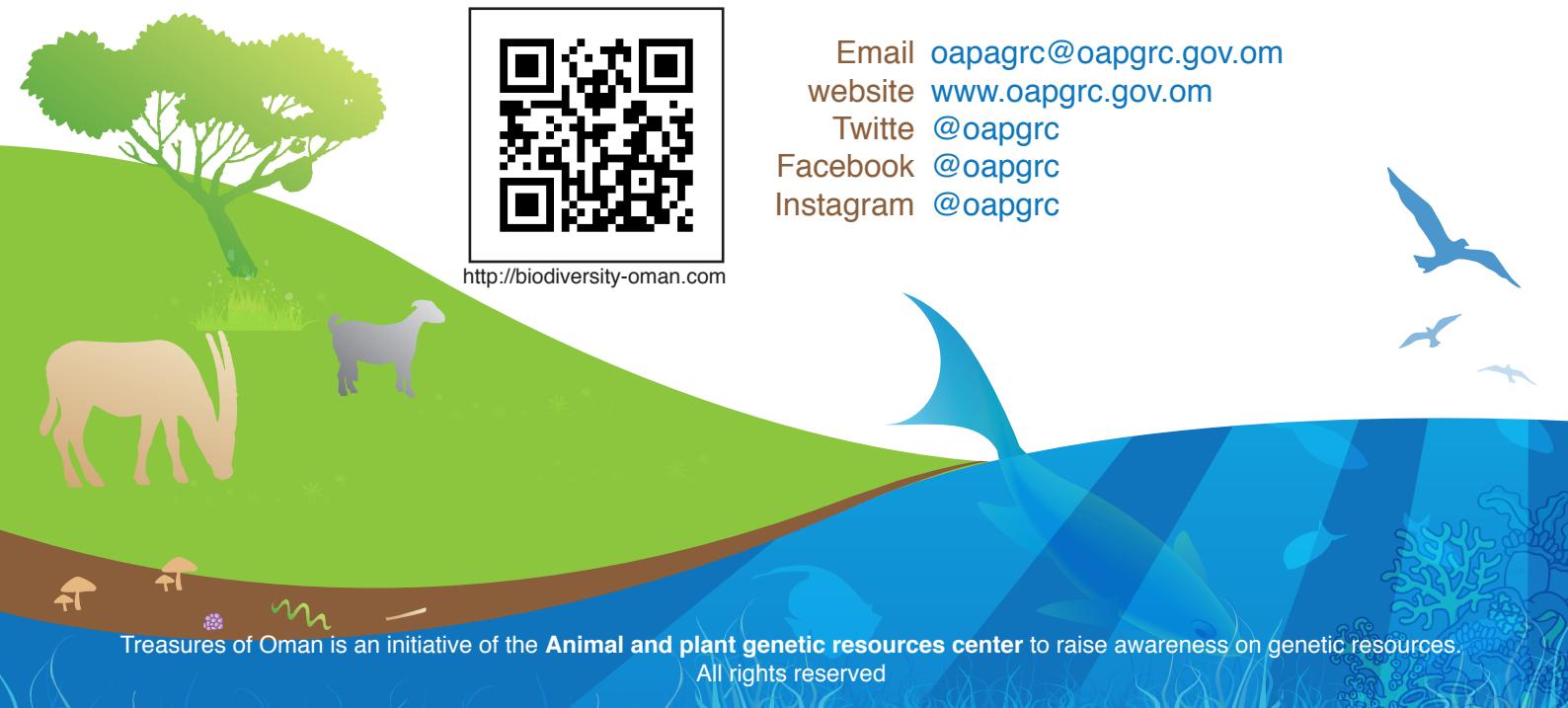
Genetic Resources of Oman

a Resource Document for the OAPGRC Roadshow 2015



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Introduction

There are millions of creatures living all around us. We use the word biodiversity to talk about this enormous variety of living things. Biodiversity includes all plants, animals, and microorganisms. It also represents the sum of all the genes of these organisms and the ecosystems (networks) they form. It is biodiversity that provides the raw materials and services essential for our life on this planet. Oman is blessed with unique biodiversity due to its diverse climatic conditions, size and geographic location.

Biodiversity

Biodiversity is the variety of all living things, including plants, animals, marine life, microorganisms and their interrelationships. It includes the genes they contain and the ecosystems they form.

Biological diversity [biodiversity] means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems. The International Convention on Biological Diversity (2003)

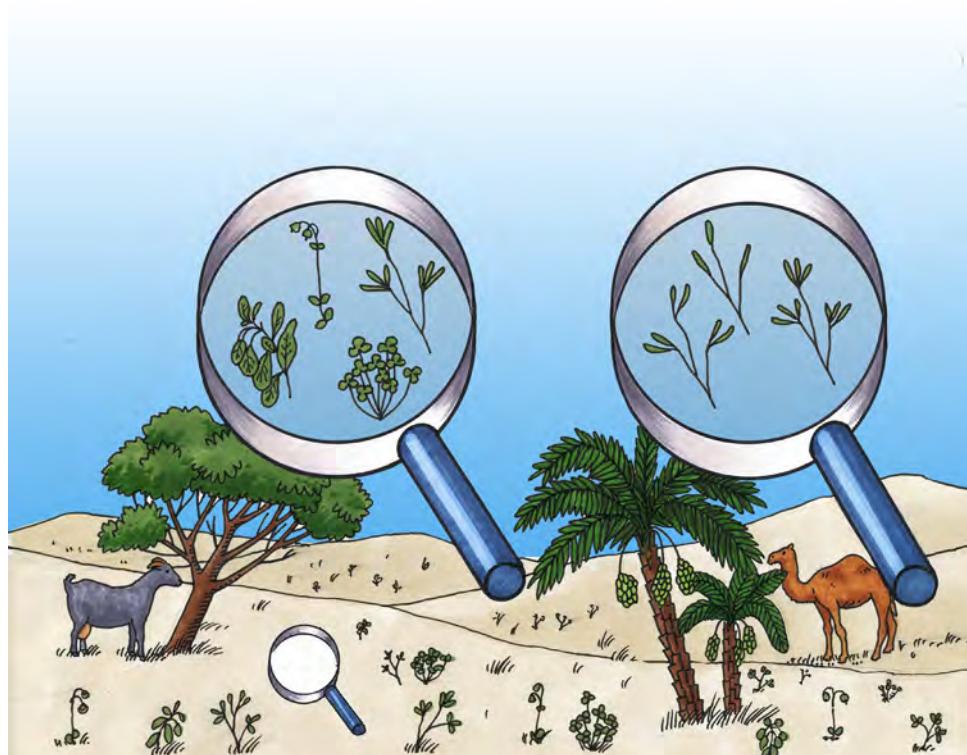
Much is known of Omani ecosystems and species diversity, with admittedly little being known of Oman's exact genetic wealth, even though it is predicted to have global significance given the conditions it has evolved under for millennia.

Genetic resources are defined as biological materials of actual or potential value containing functional units of heredity. Essentially they are the biological diversity at the genetic level that has, or may have, value.

The value of our biodiversity

- The hidden value of our biodiversity, to provide alternative solutions to basic human needs (food, health and energy), is not being explored yet.
- Diverse plant, animal and microbial genetic resources have medicinal properties and may provide solutions to current and future food, health and energy issues.
- Researchers are involved in discovering natural substances in plants, animals, marine life and microbes that can have a number of practical uses, such as medicine, food, fuel and cosmetics.
- There are chances for discovering cures along with innumerable compounds beneficial to human beings.
- It is the diversity of species that ensures the stability and resilience of ecosystems.
- The ability of organisms to adapt and respond to changing environmental conditions depends on the variations they possess.
- Therefore we need to protect the incredible genetic resources of our nation. Conserving biodiversity is beneficial to our life in many ways and improves the quality of the environment.

We need people to participate in this vital mission. It will help us to gather the past and present available resources in the regions, their problems and the current status. It will also help to collect and document traditional wisdom about the plants and animals of particular regions and the benefits derived from them.



How do we study such a huge number of organisms easily?

We do this by classifying them into specific groups on the basis of their similarities and differences. This is called Taxonomy.

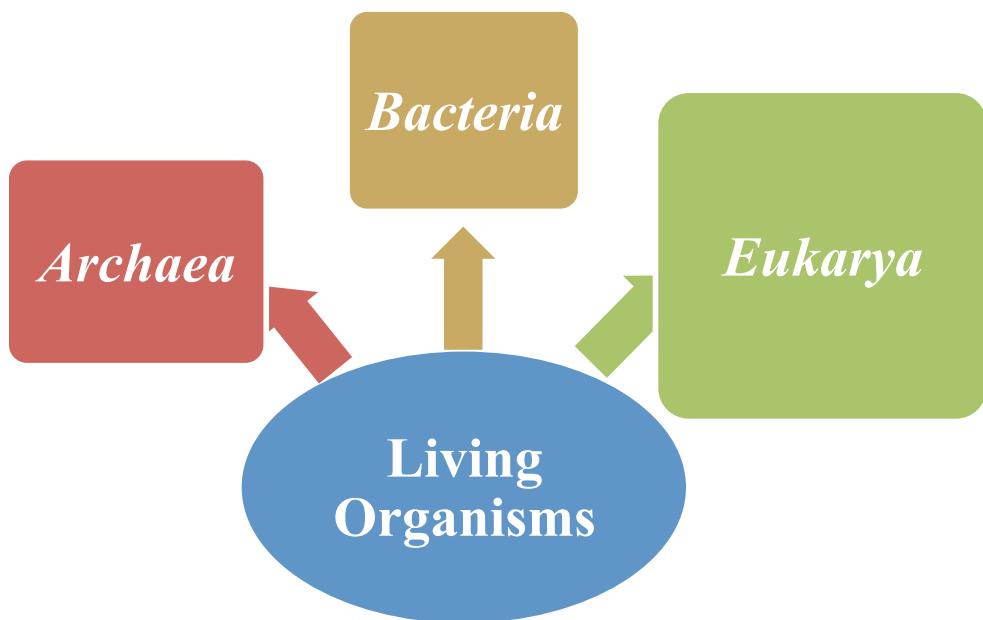
Taxonomy of Living Things

- Taxonomy is the science of identifying, naming and classifying living organisms.
- Scientists separated living organisms into specific groups based on the way they look and behave.
- For example, every warm-blooded animal that provides milk for their young belongs to the group called mammals and every creature that lays eggs and has feathers belongs to the group we call birds.
- Nowadays with the advancement of technology molecular and genetic information is used for classification.
- In biological classification living organisms are grouped into taxa (singular taxon) and are given a taxonomic rank.
- The taxonomic ranks in descending order are as follows.

Domain > Kingdoms > Phylum > Class > Order > Family > Genus > Species.

As per the latest system, living organisms are classified into three domains namely Archaea, Bacteria and Eukarya. Each domain is then divided into kingdoms.

THREE DOMAINS OF LIVING ORGANISMS



Three Domain System of Classification

DOMAIN	KINGDOM	KEY CHARACTERISTICS	EXAMPLES
BACTERIA	EUBACTERIA	Unicellular Prokaryotic	N-Fixing Bacteria Blue-green Algae, Bacteria Spiral Bacteria Intracellular Parasites
ARCHAEA	ARCHAEBACTERIA	Extreme Environments Unicellular Prokaryotic	Thermophiles Methanogens Halophiles Microbes in Hot Springs
EUKARYA	PROTISTA	Mostly unicellular Eukaryotic Some colonial	Amoeba Paramecium Euglena Algae
	FUNGI	Mostly multicellular Eukaryotic Heterotrophic Sessile	Mushrooms, Molds & Mildews
	PLANTAE	Multicellular Eukaryotic Autotrophic Sessile Cell walls made of Cellulose	Moss Ferns Flowering Plants Bushes Trees
	ANIMALIA	Multicellular Eukaryotic Heterotrophic Motile Specialized sense organs	Insects Jellyfish Crabs Fish Birds Lions, Tigers, Bears

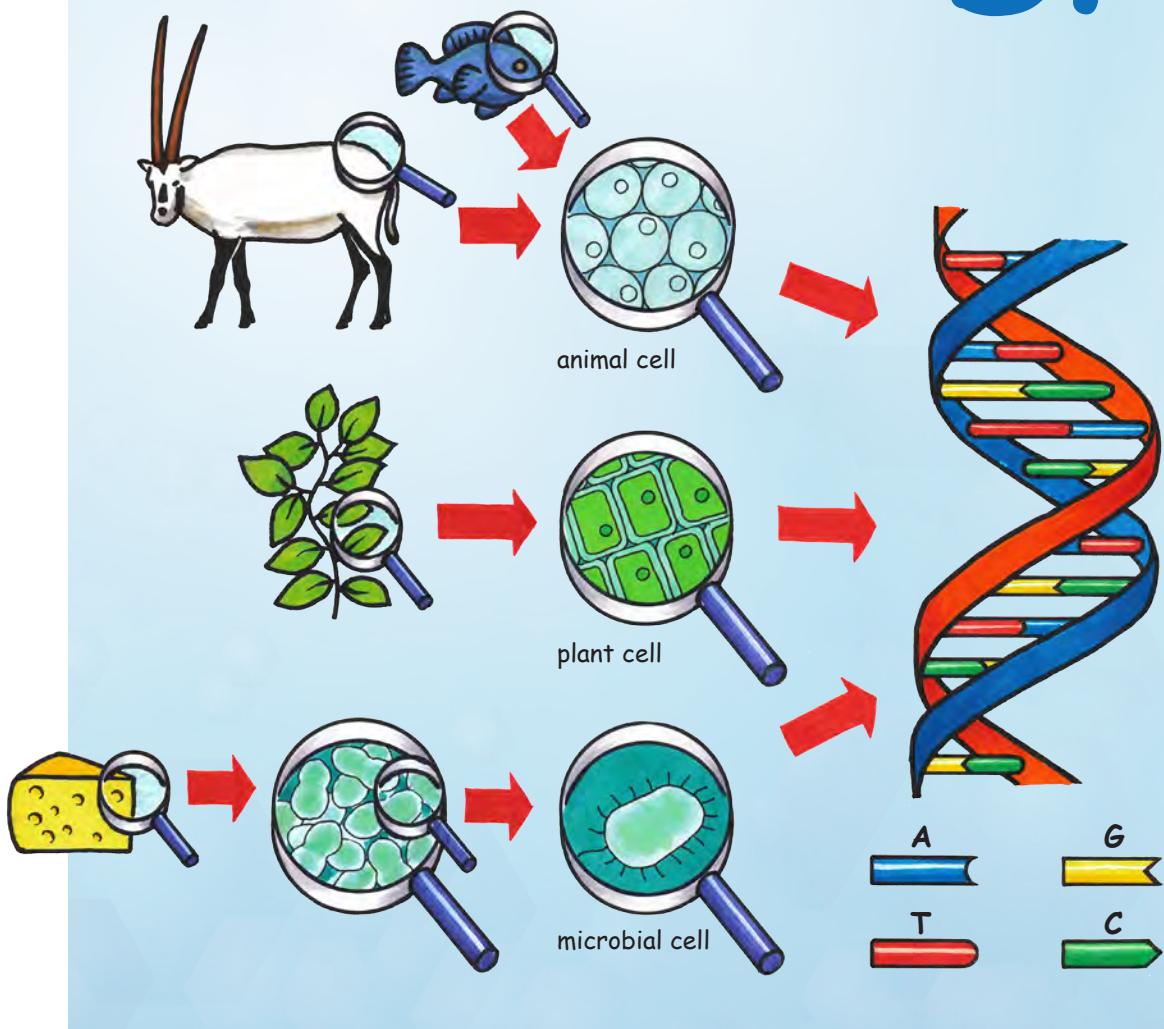
What do we mean by species?

Species is the basic unit of classification. It is a group of similar organisms which can reproduce among themselves (interbreed).

Why are organisms different from each other?

Organisms are different from one another because of the difference in their Deoxyribo Nucleic Acid (DNA).

DNA



DNA: The Hereditary Material

- All living organisms have one thing in common – DNA (well, apart from a few viruses).
- DNA is the blueprint for life.
- Scientists have discovered that DNA is what makes one organism different from another.
- DNA is the major component of chromosomes.
- Each strand of chromosome has DNA in it.
- DNA describes all the elements and characteristic features of living organisms.
- Each and every feature of an organism is controlled by a unit of DNA. Therefore DNA is called the hereditary/genetic material.
- The functional units or codes of DNA are called genes. The DNA in each chromosome has thousands of genes.

Do you know...

Each and every species has a specific number of chromosomes.

Humans have 46 chromosomes in our cells and are arranged into 23 pairs, of which 23 chromosomes come from the mother and 23 from the father. That's why we resemble our parents, we carry their genes.

Chromosome numbers of some organisms with their scientific names

Organism with scientific name	Chromosome Number
Cattle (<i>Bos taurus</i>)	60 (30 pairs)
Dog (<i>Canis familiaris</i>)	78 (39 pairs)
Horse (<i>Equus caballus</i>)	64 (32 pairs)
Goat (<i>Capra hircus</i>)	60 (30 pairs)
Cat (<i>Felis catus</i>)	38 (19 pairs)
Tomato (<i>Lycopersicum aestivum</i>)	24 (12 pairs)
Bread Wheat (<i>Triticum vulgare</i>)	42 (21 pairs)
Date palm (<i>Phoenix dactylifera</i>)	36 (18 pairs).

How do genes work?

- Each gene has a special job to do. That job is to give instructions for producing a specific protein.
- We have around 19,000 protein coding genes functioning in our cells.
- Genes, with the proteins they encode, control all life processes, including how the body responds to the environment.
- The complete set of genes of an organism is called its genome.
- Any change to the genome of an organism results in changes in the features of that living organism. For example, the roots of a plant might get longer or the colour of a bird might change.
- It is these changes in genes that result in different varieties of the same species of plants or animals.
- Sometimes these changes allow the organism to adapt to the particular place it lives.
- The place an organism lives in is called its **habitat**.

Adaptation

- Through time organisms have adapted new features to suit the place they live.
- The adjustment that an organism makes to live in its habitat is called adaptation.
- Sometimes you can find organisms that started the same but changed because of their adaptation to their particular habitat over long periods of time.
- For example, in the case goats, breeds from one location look different from those from another location due to adaptation to their specific environment.
- All these variations add to the gene pool of that particular species.
- Diversity within species is important for the survival of the species in changing environments.

Do you know...?

In Oman there are over 250 varieties of date palm. They yield fruit of different colors, sizes and shapes!!

Conservation of Genetic Resources

The conservation of genetic resources is essential to the sustainable development of our nation.

The role of OAPGRC is to conserve both species, and within species, diversity either in natural habitat (in-situ) or outside natural habitats in gene banks (ex-situ) for research and future use.

In-situ conservation:

- It is the conservation of species in their natural habitat.
- This includes in the wild, protected areas and natural parks.
- It is important to protect species in their natural habitat as it allows them to keep adapting to their changing environment.

Ex-situ conservation:

- It is the conservation of species outside their natural habitat either in gene banks as seeds, tissues and cells, or in field banks as whole organisms.

Gene Banks

- Gene banks are the biological banks (storehouses) for preserving the genetic materials of organisms.
- The genes of an organism are stored by freezing their tissues (seeds, leaf, sperm, eggs, hair cells, DNA etc.) at low temperatures.
- Samples from the organisms can also be frozen in liquid nitrogen (-196 ° C) and kept for years without any damage. This process is known as **cryopreservation**.

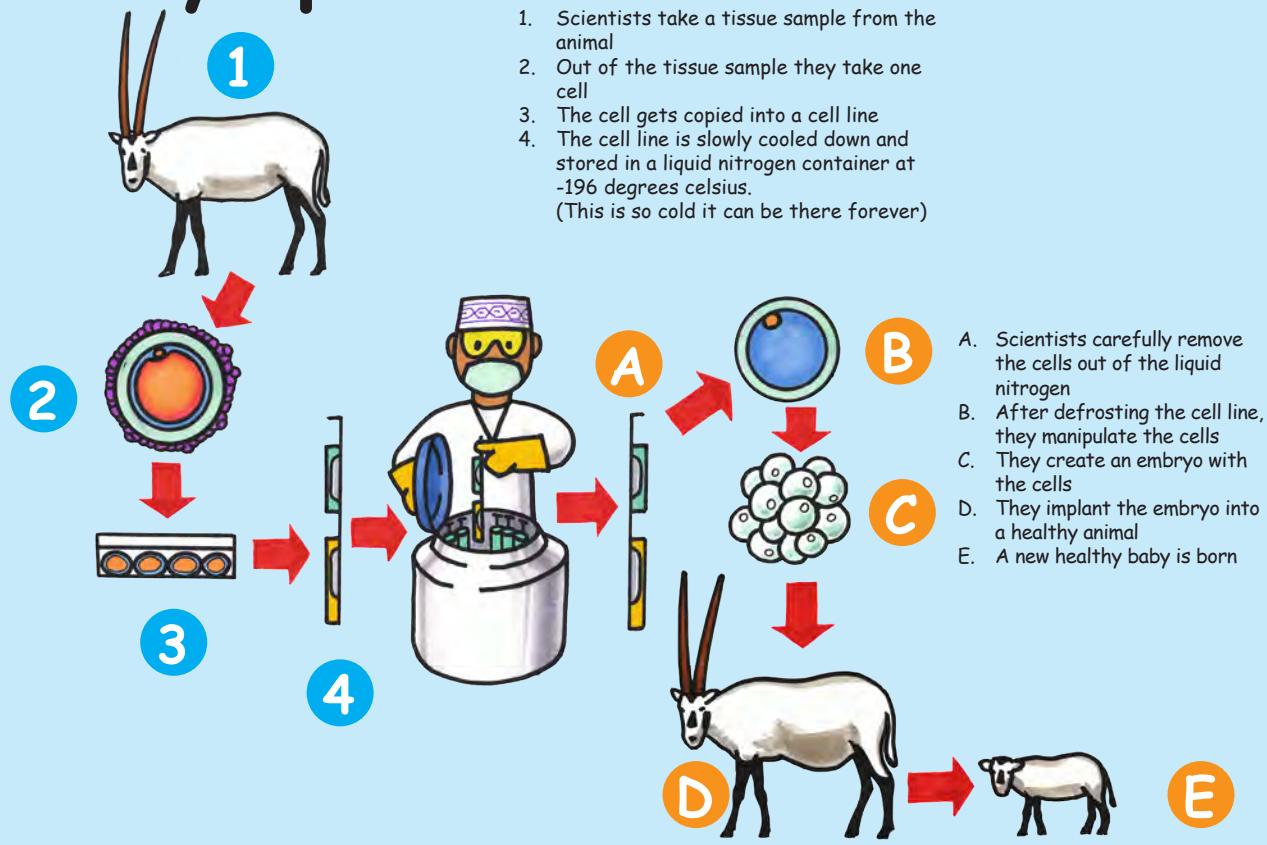
Do you know...

In Oman there are 18 protected areas and 4 protected Rangelands

(Source: Ministry of Environment and Climate Affairs & Ministry of Agriculture and Fisheries Wealth)

How scientists can help endangered animals?

cryo-preservation



What is Cryopreservation?

Cryopreservation is the use of very low temperatures to preserve living cells and tissues.

- This kind of storage gives virtually indefinite longevity to the cells and tissues.
- All specimens are stored in the vapor phase of liquid nitrogen for cryogenic preservation, at a constant temperature of -196°C.
- Cryo-storage facilities have the following features:
 - i.Built as a reinforced bunker to withstand the worst possible natural disasters
 - ii.Constantly monitored for security and temperature
 - iii.Equipped with a comprehensive emergency infrastructure.

What are the advantages of cryopreservation?

- It safeguards valuable genetic resources.
- It preserves their genetic integrity.
- It is a good alternative to keeping a breeding colony.
- It allows the usage of genes for generations to come and facilitate scientific breakthroughs.
- It means we can transport stock more easily – it is easier to transport a test tube than a whole animal!
- It helps stop diseases being spread since the whole animal is not transported.
- In case there is a disaster and a species becomes extinct, the cryo preserved stock can be used to build it up again.



Cryopreservation facilities: cryo-tanks

- Ex situ conservation of genetic materials from livestock and fish are preserved in the form of semen, oocytes, embryonic cells or somatic cells kept at freezing temperatures in cryobanks.
- Plant genes can be stored as seeds, tissue, or cells. When seeds of the plants are stored, it is called a seed bank. When tissues are stored on a special media it is called tissue culture. We can also have pollen banks that store pollen samples.
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-



A. Tissue culture



B.. Seed bank

Field Gene Banks

- In the case of plants which do not produce viable seeds or have seeds which are difficult to store in the seed banks, we use a field gene bank.
- It is a specifically allocated area where we grow the plants we want to preserve.

Did you know?

- a. The Oman Botanic Gardens conserves around 350 species of Omani plants.
- b. The Ministry of Agriculture and Fisheries Wealth support the maintenance of field gene banks for date palm, banana, sweetlime, papaya, custard apple, guava, pomegranate frankincense and coconut.
Field gene banks of 244 fodder plants and 103 medicinal plants are established at Rumais.

Source: Sultanate of Oman Country Status Report of Conservation and utilization of plant genetic resources, Dr. Ali H. Al Lawati, Second Regular Meeting of the Coordinating Board (CB) of NEAR EAST and North Africa Plant Genetic Resources (NENA-PGRN), September 2012

For example: Omani Frankincense

- Frankincense is an integral part of the Omani culture and heritage. The collection and trade of Frankincense has been the main source of income for many families in Dhofar for centuries.



A. Omani frankincense conservation : *Boswellia sacra*

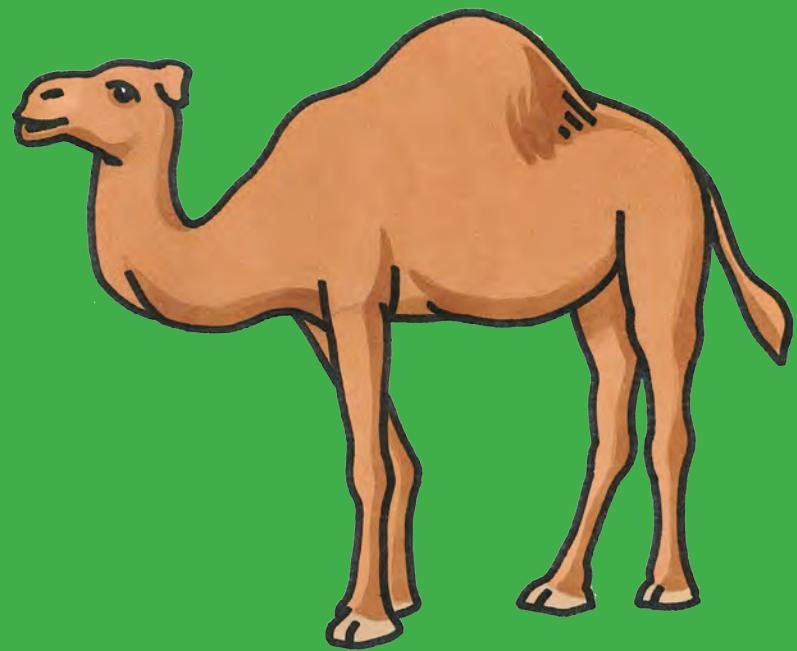
(Photo: JA)



B. OBG field plant conservation : *Limonium axillare* (Photo: JA)

Why do we need to store genes?

- If we store all the genes, we can help conserve animals, marine life, plants and microbes.
- The OAPGRCs role is to collect, document, conserve, characterize and use genetic resources for research and our benefit.



the animal world
extinction is forever

Oman's Animal Genetic Resources

Oman is blessed with over 99 species of terrestrial mammals, 546 species of birds, two species of amphibians and more than 75 species of reptiles, around 1000 species of fish, 56 species of echinoderms, 253 species of coral, 58 species of molluscs and 399 species of arthropods.
(Source: Checklist of Oman Biodiversity, DGNC-MECA, 2009).

Some uses of our animal genetic resources

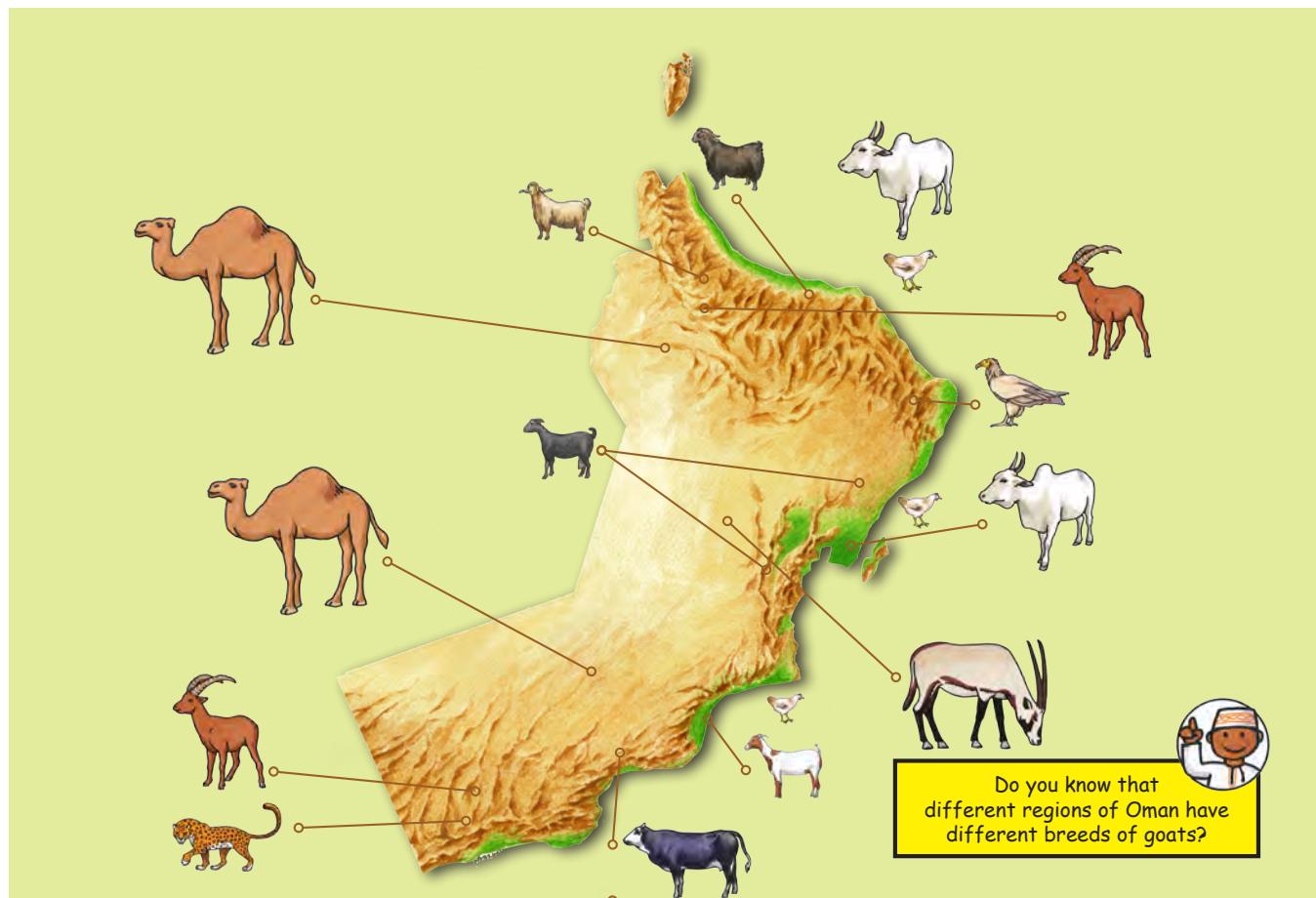
- Humans have been domesticating wild animals for thousands of years but very few of these animal genetic resources are now being used as livestock.
- The main types of animals that people in Oman farm and eat are cattle, sheep, goats, camels and poultry.
- The great majority of these are local but foreign breeds of dairy cattle and chicken are used in commercial farms.
- Meat and milk are the most important products from cattle, while meat is the most important product from sheep and goats.
- Poultry is used for its meat and eggs.
- Cattle, goat, sheep and poultry provide manures for our farms too.
- Animals play an important role in society. They are a source of energy, manures and income. Some animals are kept as pets.

Animal genetic resources face a lot of threats from environmental changes and human activities. Animals are important for our survival as we get food and materials. We need to protect them.

Did you know?

There are over 1,367,555 recognized species of animals in the world.

(Source: IUCN Red List version 2010.1: Table 1)



The Diversity of Domesticated Animals in Oman

Domesticated animals in Oman include: camels, goats, horses, sheep, cattle, donkeys and poultry. Camels, goat, horses and poultry are the most important livestock in Oman. Local breeds represent the great majority in these species. Foreign breeds are mainly used in dairy cattle and commercial chicken farms.

Omani Camels

- Camels are important to us because we use them for so many things.
- We eat the meat of young camels and melt fat from its hump to make butter.
- You can drink camel milk and make cheese from it.
- Camels also supply hair used for making high-grade fabrics and hides for leather.
- Dried camel droppings provide fuel.
- In the desert, camels are an important source of transportation, food, clothing and shelter.

Different types of Omani camels include

tAlrahila	camels that are good at carrying heavy loads
Alshahla	brown camels
Alhajeen	camels that are only used for riding
Alhayran	a newborn camel
Alkhalfa	these camels give a lot milk
Alsafra	camels with light wool

Camels have adapted to the different places they live by acquiring different features. For example, camels that live in mountainous areas have developed stronger limbs than camels that live in plains and deserts.

Omani goats

Goats are useful for lots of different things. They are an important provider of meat and milk.

- Batinah goats
- Dhofari goats
- Jabal Akhdar goats
- Sahrawi goat
- Jabali goat

Omani Horses

- Horses are part of Arabian culture.
- Arabia has a long tradition of breeding horses
- They have characteristics like patience and a very good memory.

Cattle breeds of Oman

North Oman breeds (Batinah /Sharqiyah)

- Brown to dark brown in colour
- Small in size with short horns
- Low milk yielding but disease tolerant

South Oman breeds (Dhofari)

- Mostly black in color
- Small to medium in size with short horns
- Low milk yielding but disease tolerant

Camel breeds

سلالات الإبل



Khiwara

الخوارة



Ramli

الرملي

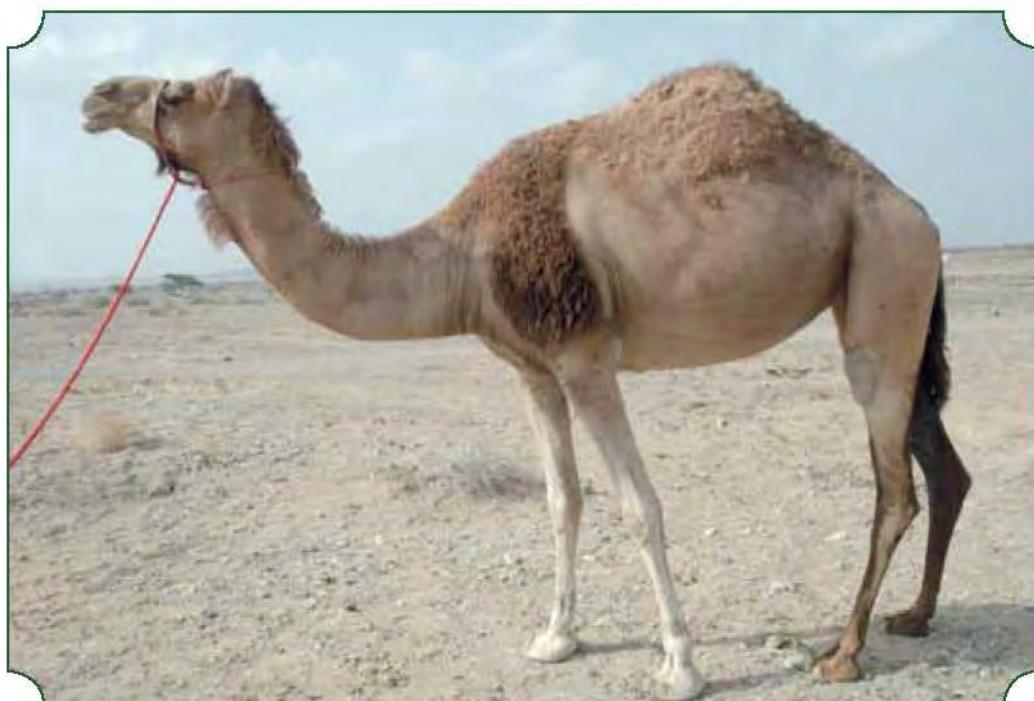
Camel breeds

سلالات الأبل



Samha

سمحة



Musiha

محبحة

Poultry breeds

سلالات الدواجن



Black Strain



سلالة الدجاج الأسود



White Strain



سلالة الدجاج الأبيض



Brown Strain



سلالة الدجاج البني

Images of Indigenous animal breeds

صور السلالات الحيوانية

Cow breeds

سلالات الأبقار



North of Oman (Male)

شمال السلطنة (ذكر)



South of Oman (Female)

جنوب السلطنة (أنثى)



Dhofari (Female)

ذفاري (أنثى)



Sahraoui (Female)

صحراوي (أنثى)

Goat breeds

سلالات الماعز



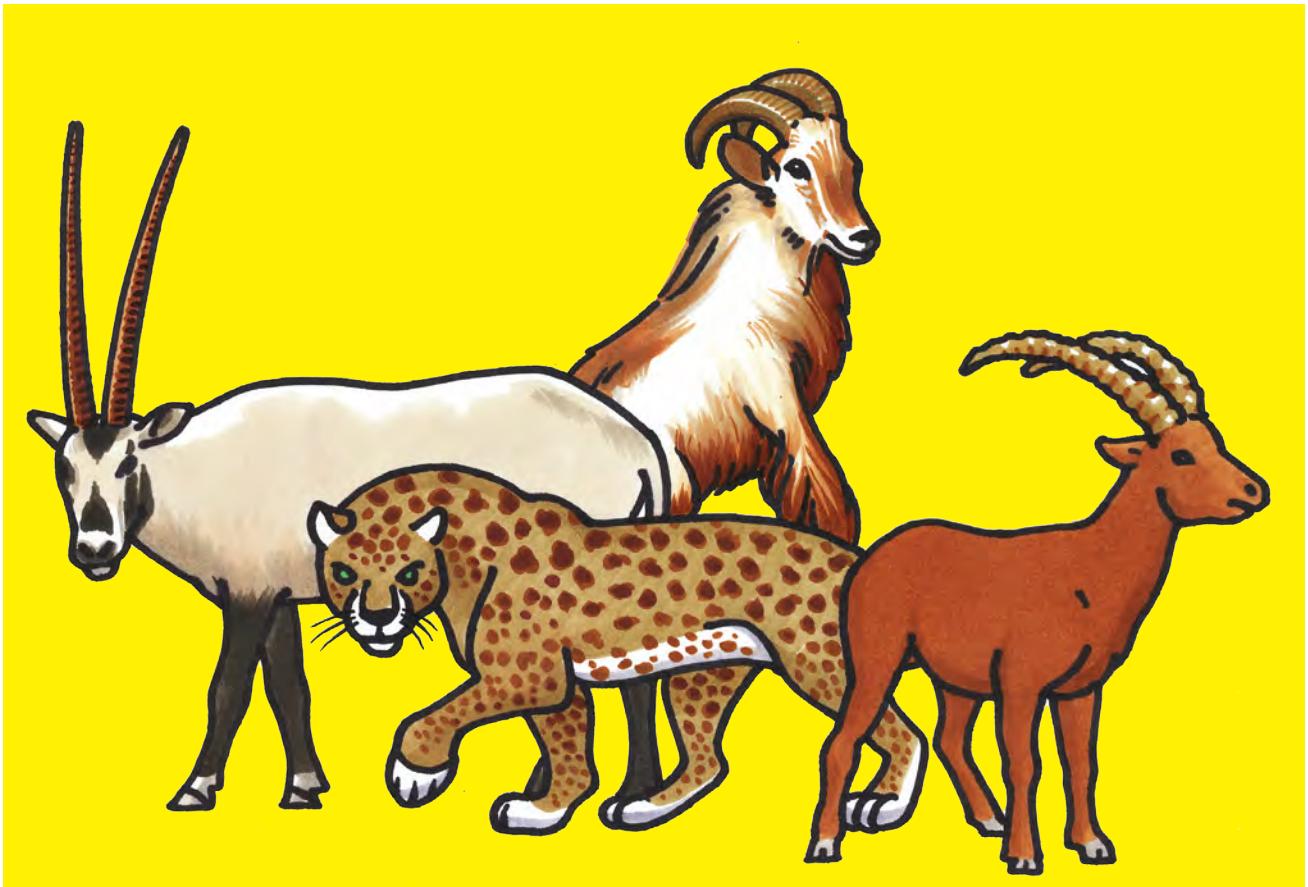
Al-Jabal Al-Akhdar (Male)

الجبل الأخضر (ذكر)



Al-Batinah (Female)

الباطنة (أنثى)



The diversity of wild animal species of Oman

Wild animals are non-domesticated animals living in their natural habitats.

Oman has a unique wealth of wildlife. This is one of the main attractions of the country.

Nubian Ibex

- In Oman, the ibex lives in Wadi A'sireen

The houbara bird

- The houbara bird is a resident breeder in Oman

The Arabian Tahr

- The Arabian Tahr lives on the steep rocky slopes of the Hajar Mountains.

Blanford Fox

- The Blanford fox lives in northern parts of Oman

Amphibians

- Arabian Toad (*Bufo arabicus*) and the Dhofar Toad (*Bufo dhufarensis*) are the two toad species that exist in Oman.

Reptiles

- More than 75 species of reptiles are found in the country.
- The Yellow-spotted Agama (*Trapelus flavimaculatus*) and the Arabian Spiny tailed lizard (*Uromastyx aegyptius*) are two endangered species.
- The six endemic species of lizards in Oman include four geckos and two lacertids.





Did you know that turtles always come back to the same place they were born to lay their eggs?

turtles in Oman



Olive Ridley



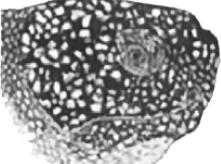
Hawks bill



Loggerhead



Green Turtle



Leather back



The Olive Ridley is a small turtle that weighs about 40kg and feeds on seaweed and sea grasses and can lay about 100 eggs at a time.



The Hawksbill weighs about 70 kg and feeds on soft coral, sea grasses and seaweed. They lay about 100 to 160 eggs at a time.



Loggerheads weigh about 150 kg. They have powerful jaws which allow them to feed on hard shelled jellyfish. They lay about a 100 eggs at a time.



Green Turtles can weigh about 200 kg and feed on seaweed and other green plants. Green Turtles lay about 110 eggs at a time.



The Leatherback Turtle is a giant turtle reaching between 400 to 900 kg! It feeds on jellyfish. They lay about 80 eggs at a time.

Turtles of Oman

Five out of the seven recognized species of marine turtle in the world, occur in the waters of Oman.

They include four nesting turtles: the endangered Green Turtle (Sul Hafah Al Khuthera), Loggerheads (Rimani) and Olive Ridley (Al- Sherfaf) and the critically endangered Hawksbill(Al Zaytooni) and one visiting turtle, the Leatherback(Al-Niml). They are endangered species (IUCN).

The Green Turtle has a nesting population of more than 13,000 with the largest concentration in Ras al Hadd area. The largest nesting population of the Loggerheads in the world is found in Masirah Island. (MRMEWR, 2001).

- Turtles are cold-blooded reptiles. They are one of Oman's oldest marine species
- The Damaniyat Islands are where Hawksbill Turtles nest.
- The five species of turtles have distinct differences in their size, color, shape and mouth parts.
- Each species has mouth parts that are specifically suited to feed on different types of food.
- Green Turtles can weigh about 200 kg and feed on seaweed and other green plants. They lay about 110 eggs in a clutch.
- The Hawksbills are much smaller and weigh about 70 kg. They feed on soft coral, sea grass and seaweed. They lay about 100 to 160 eggs in a clutch.
- The Loggerheads weigh about 150 kg. They have powerful jaws which allow them to feed on hard shelled jellyfish. They lay about 100 eggs in a clutch.
- The Olive Ridley is a small turtle that weighs about 40 kg and feeds on seaweed and sea grasses. It can lay about 100 eggs per clutch.
- The Leatherback Turtle is a giant turtle reaching between 400 to 900 kg and feeds on jellyfish. They lay about 80 eggs per clutch.
- Apart from being threatened by natural predators, the survival of the turtle species is greatly affected by human activities such as disturbance by campers, off-road driving, coastal developments and pollution.
- Greater awareness needs to be raised to ensure the protection of these valuable species.

Benefits of our animals

- Being the consumers of certain species or becoming the food for some other species
- animals play an important role in maintaining the balance of nature.
- They preserve the vitality and health of our environment.

Threats to our animals

- Poaching for live trading outside the country
- Introduction of exotic animals
- Competition between wild and domestic animals especially during drought
- Loss of habitat due to developmental activities Eg: Prosopis juliflora (Alghaf Albahri), a plant species is introduced as a fodder crop.
- Spread of invasive, alien species

(Reference: Fourth national report to the convention on biological diversity

Produced by the Directorate-General of Nature Conservation, 2010)

Endangered Omani Animal

Endangered species are those at risk of extinction as defined by IUCN Threatened species are those which are vulnerable and may become endangered in the near future.

How many Omani animals are endangered?

- Eight species of birds
- Four species of reptiles
- Four species of fishes
- Nine species of mammals
- The Dhofar white-toothed shrew is critically endangered

INSECTS OF OMAN

Diversity

There are 221 species of insects reported in Oman.

Benefits of insects:

- Insects are pollinators of most plants.
- Honeybees give us honey and other products like beeswax and pollen.
- Some of them eat the pests which damage our crops. This method of pest control is called biological control.
- They help in maintaining the balance of nature.

Honey bees of Oman

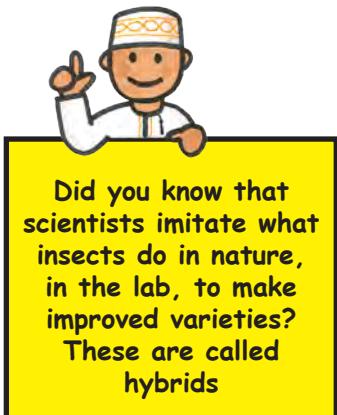
- Honey bees provide not only honey, and byproducts from honey but also services like pollination.
- Honey is the complex substance made by the honey bee when the nectar and sweet deposits from plants and trees are gathered, modified, and stored.
- It is stored in the honeycomb by honey bees as a food source for the colony.
- (Reference: Fourth national report to the convention on biological diversity
- Produced by the Directorate-General of Nature Conservation, 2010)

Pollination - a vital ecosystem service given by insects

- Flowers produce seeds after pollination and fertilization.
- Pollination is the transferring of pollen from the anther to the stigma of a flower.
- Sometimes plants can do it by themselves (self-pollination) but most flowers are pollinated with the help of agents (pollinators), like insects or wind.
- These agents carry pollen from another plant. (cross-pollination)
- Cross pollination results in different varieties of flowers and plants.

Threats to our insects

- Habitat loss
- Invasive alien organisms
- Environmental contamination
- Intensive use of pesticides.



How can we preserve the genetic diversity of these threatened species?

In situ conservation

The conservation of endangered plants and animals in their natural habitat is called in-situ conservation.

Examples: protected areas (**Dimaniyat Islands**), natural parks (**Al Saleel National Park**), sanctuaries (**Arabian Oryx sanctuary**) and wildlife reserves (**Ras al Hadd Turtle Reserve**)

Ex-situ conservation

The conservation of endangered plants and animals outside their natural habitats in artificial conditions.

Example: botanical gardens, zoological parks, cryopreservation centers.

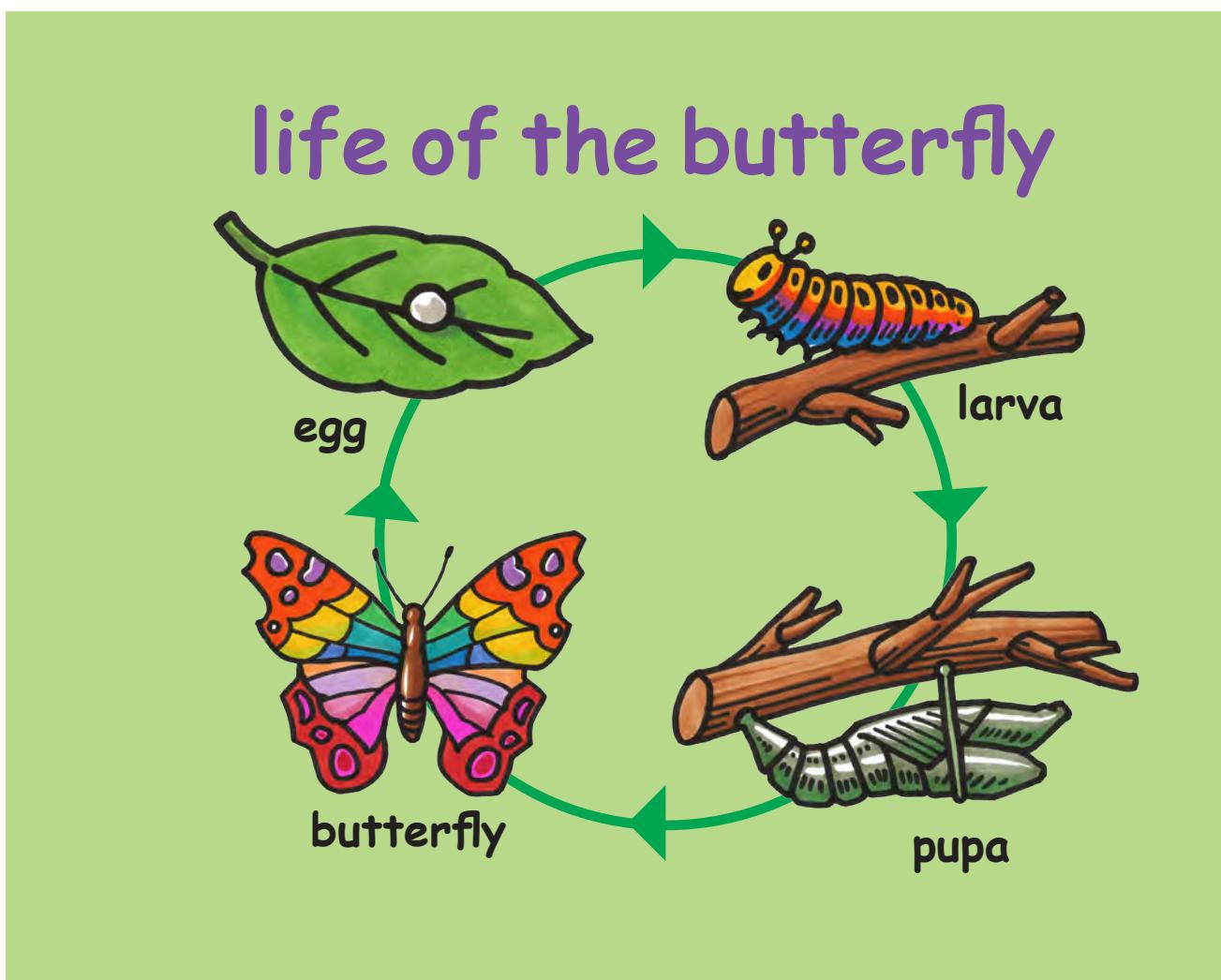
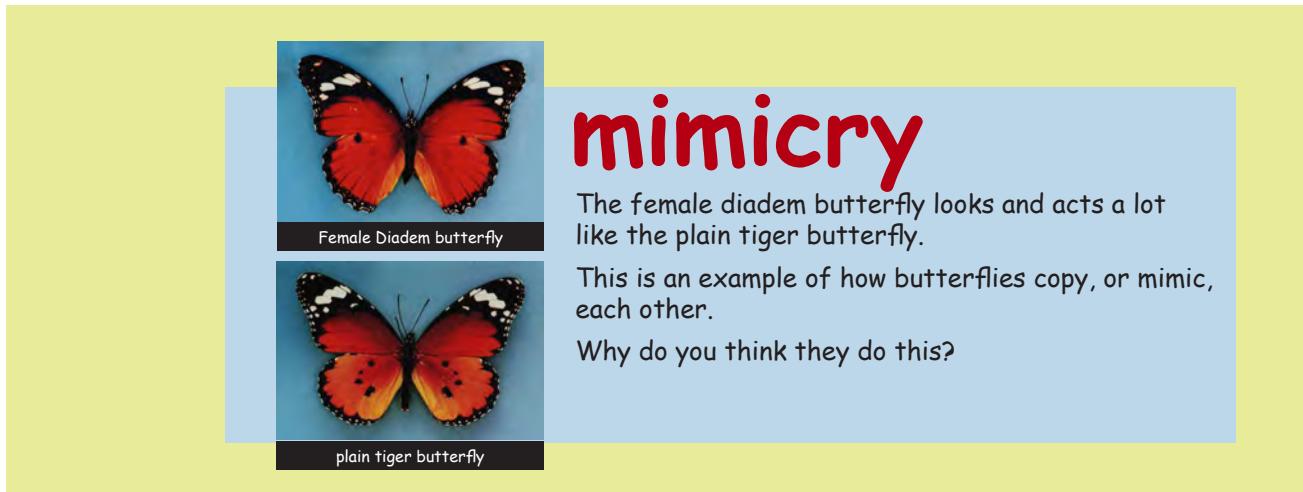
Butterflies in Oman

There are about 70 species of butterflies in Oman though there are more than 15,000 species in the world. Only the toughest ones can survive in our hot and dry climate!

To breed successfully in Oman, a butterfly must be able to find the correct plant food for its caterpillars, some of which can only survive on a single type of plant.

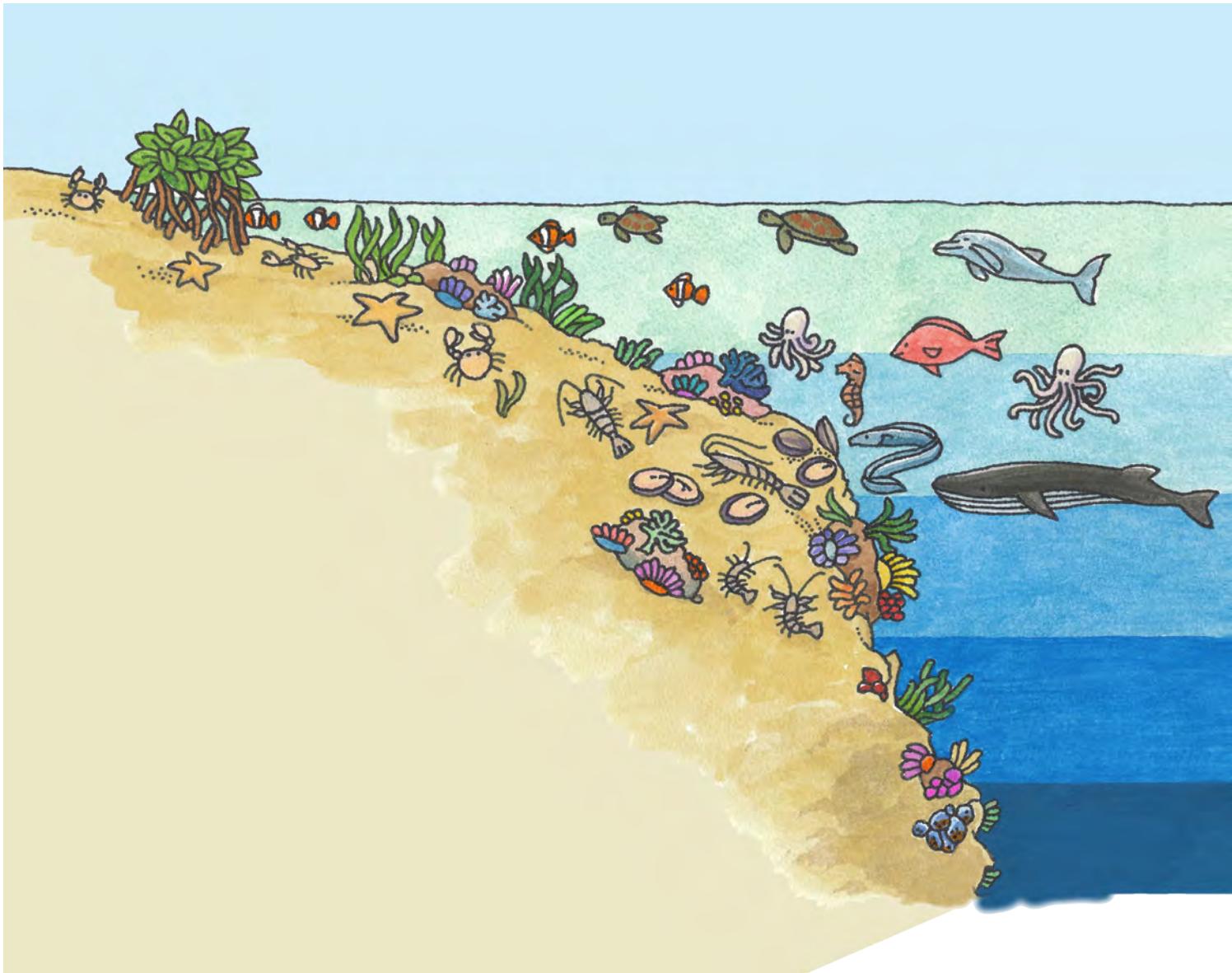
Mimicry

- It is a survival strategy of certain plants and animals. By displaying a superficial similarity in the appearance, behavior, scent, sound or location to another organism.
- For example: The female diadem butterfly looks and acts a lot like the plain tiger butterfly.





the marine world
into the blue!



THE MARINE WORLD

Oman, with its long coastline, is famous for having plenty of marine life. There are over 20 marine mammals, more than 1,000 types of fish, over 180 types of coral and five turtle species.

- The types of fish in Oman include: dolphins and whales; leopard, reef and whale sharks; a variety of moray eels; porcupine, lion and scorpion fish; and regular reef schooling fish such as batfish, parrot fish, angel fish, trevally, snapper and barracuda. Can you think of any others?
- As well as colourful varieties of fish, there are lots crustaceans, marine algae (seaweeds) and microorganisms that live in the seas of Oman.
- Oman's marine life has great potential to provide us with many useful products, and our scientist are working very hard to study it.
- The marine world is not only important as a source of food, but also can also supply us with things like medicine, make-up and raw materials for industry.
- Therefore it is very important that we know about our marine world and protect and utilize it responsibly and sustainably.

Answer: Kingfish, yellow-fin tuna, lobster, abalone, shrimp, crabs, grouper, emperor, seabream, seacockle, etc

Seaweed of Oman

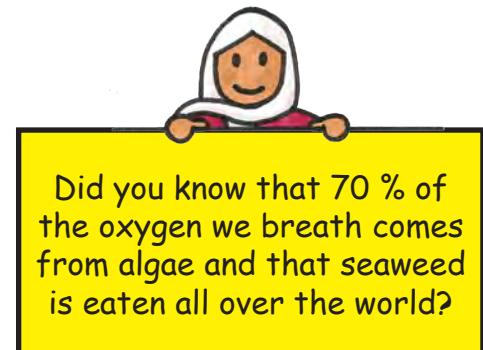
Seaweeds are macroscopic, multicellular algae that live in the sea or attached to the rocks along coastal areas.

- Oman has around 323 types of seaweed.
- People in Far Eastern countries, like Japan, eat seaweed!
- We can get agar (a starch like powder made from red seaweed). It is used in sweets and desserts!
- It's food for all kinds of sea creatures too
- Farmers can use it as fertilizers.
- Materials from seaweed are used in make-up and medicine.
- It helps the sea get oxygen.
- Seaweed farming is a potential industry in Oman.

But seaweed is under threat!

Threats to seaweeds include:

- Pollution
- Acidification of oceans
- Rising sea temperature due to global warming



[Picture]

Ulva fasciata green seaweed along the Salalah coast Photo by Jackson A.

[Picture]

Abundance of green, brown and red seaweed along the Salalah coast Photo by Jackson A.

[Picture]

Colpomenia sinuosa collected from the Darsait Coast of Oman

Seaweed Collected and photographed by Jackson Achankunju, ASU

Why do we need to conserve seaweed?

- It is important to conserve stocks of seaweed (algal beds) to use as feed for animals.
- Keeping seaweed helps us maintain the balance in our marine ecosystems.
- It oxygenates the sea.

Fish wealth of Oman

- Fisheries resources provide direct economic benefits.
- The fisheries sector accounts for 0.5% of GDP and is our leading non-oil export.
- Several species of cartilaginous fishes are protected in Oman with Narrow Sawfish and Olive Sawfish listed as critically endangered in the IUCN Red List.
- Small pupfish, milkfish, mullet, glassfish, gobies, grunts, and tiger perch are found in mangroves.



Omani Clown fish



Reef fish Scarus

Omani coral reef

- Coral reefs are the “rainforest of the sea” and the most species rich and productive marine ecosystems.
- There are over 180 species of corals in the seas of Oman.
- Our coral reefs are threatened by large scale, irreversible damage such as bleaching.



Dendronephthya –soft corals of Oman trc



Coral crab

Threats to corals

- Getting broken from tangled nets and anchors
- Coastal destruction
- Rubbish thrown in the sea
- Leisure activities, for example, speedboats
- Oil pollution
- Acidification of oceans.
- Discharge from desalination plant
- Water discharge from sea farms
- Overfishing and destructive fishing in coastal development.

Benefits of our coral reefs.

They are valuable to fisheries, tourism and recreation

We need them for conserving marine biodiversity, coastal protection and scientific studies.

They maintain the balance of our marine ecosystem.



the plant world
planting for tomorrow

The Plant World

- There are around 300,000 recognized species of plants in the world.
- Plants are the lungs of the Earth” as they take in carbon dioxide and give out fresh Oxygen by the process called photosynthesis.
- They are also the source of food, clothes, shelter and medicine.
- The Diversity of Plants in Oman
- Plant genetic resources are important to Oman, whether they are for agriculture or for things like medicine or industrial uses.
- Oman is blessed with a great many species of plants – more than 1,200!
- This plant diversity in Oman is because of its location between the regions of Asia and Africa.
- The plants in the north of Oman are more like those of Asia and those in the south are more like those you can find in Africa.
- We have some plants that are special to just Oman! These are the endemic species.
- Oman has a big diversity of plant genetic resources. That's why we have so many different kinds of fruits – from dates, mangoes and citrus fruit to bananas and pomegranates. There are many nutrient rich forage plants like Samur (*Acacia tortilis*) and Ghaf (*Prosopis cineraria*) that animals feed on.
- The Oman Animal and plant Genetic Resources Center is now collecting information about the plants of Oman and storing it in a database so that researchers can use the information.
- Like all our other genetic resources, our plants are under threat from our activities and changes to the environment. We cannot let it happen. We have to protect and preserve our plant wealth!

Omani Crops

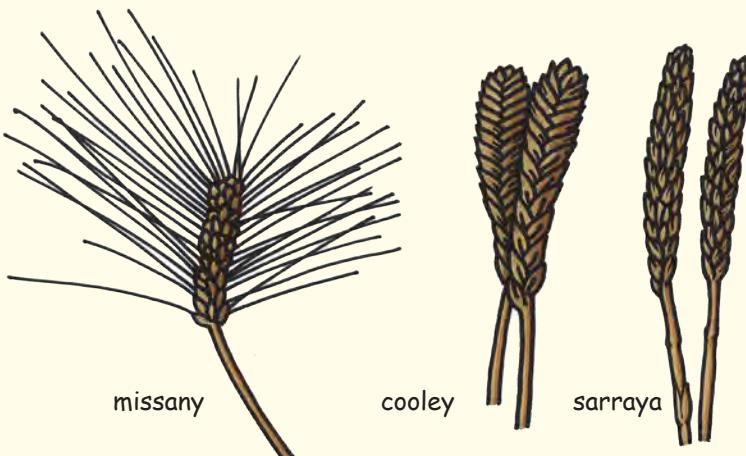
- Different types of crops are grown in various parts of Oman.
- The major crops grown in Oman include dates, limes, coconuts, pomegranates, wheat, barley, alfalfa , onion, garlic, tomatoes, eggplant, dates, bananas, limes and carrots.
- They grow well in our dry climate.
- We use irrigation systems like falajs, to help grow plantation crops like: figs, guava, jujube, papaya, lemon, mango, dates.
- A lot of the food we eat comes from locally grown crops. We also import many crops to meet demand.
- Native Omani plants are also used in handicrafts, medicine and household items.

Did you know?

Oman is famous for its very high quality agricultural products, for example limes and dates

Source: <http://www.nationsencyclopedia.com/economies/Asia-and-the-Pacific/Oman-AGRICULTURE.html>

Bread Wheat



Wheat is a staple food in Oman and is a major crop in traditional farming systems. It is a winter crop. The local cultivars include Sarrya, Missani, Cooley, Hamira, Greda and Walidi. The most popular among them is Cooley. It occupies about 80% of the area under cultivation of local wheat varieties.



Wheat cultivars grown in Oman

- Wheat is a staple food in Oman and it has been a major crop in traditional farming systems.
- It is a winter crop.
- The local cultivars include Sarrya, Missani, Cooley, Hamira, Greda and Walidi. The most popular among them is Cooley. It occupies about 80% of the area under cultivation of local wheat varieties. The area under cultivation for bread wheat is about 450 ha. with total production of 1,421 tons.

Alfalfa (*Medicago sativa L.*)

- It is the most important forage crop plant in Oman. It occupies an area of 5536.55ha.of arable land producing about 235055 tons

Barley

- Barley is the second cereal crop in Oman. It occupies an area of 1234 ha. producing about 3000 tons. It is used for both livestock and human consumption.
- Bathini and Duraqi are two omani cultivars of Barley.
- It is grown not only for grain but also for fodder.
- It is also used as a component of poultry feed
-

Omani Date Palms

- The date palm (*Phoenix dactylifera L.*) is considered the most important crop in Oman.
- Dates are high-energy food for people and livestock.
- Dates are consumed in the form of pre-matured (Rutab) and matured (Tamar).
- We grow and look after date palms is the same as our ancestors did.
- Across the sultanate, date plantations are well developed.
- Date palm trees occupy 25000 ha. About 82% of the total fruit area with an annual production about 3096.86 tons.
- There are more than 250 cultivated varieties of date palms in Oman.
- Thirty out of them produce high quality dates that are consumed fresh or processed.
- The main date palm gene bank is in Wadi Quriyat.

Other Uses of Date palms

- Palm leaves are commonly used in handicrafts. The midribs from the fronds make good building materials.
- Like all other genetic resources, date palms are under threat from the environment and humans.
- We need to protect them so we are collecting and conserving these genetic resources.
-



Omani Lime

- Omani lime is one of the main citrus crops grown in Oman.
- It is popular throughout Arabia because of its high acid content and particular flavor.
- The area under cultivation is about 1208 hectares with an annual production of 625 tons.

Omani Banana

- Banana is the second most important fruit crop cultivated in Oman.
- The Malindi, Fard, Barshi and Naggal are some of the local cultivars cultivated in Oman.
- The area under cultivation is 1,421.85 ha. and the total production is 19,968 tons per year.

Pomegranate

- It is one of the oldest known fruits.
- It is cultivated in the northern mountainous region of Oman with traditional farming methods. It has antioxidant and health benefits



Omani Lemon



omani Banana



Pomegranate

WILD PLANTS OF OMAN

Oman is blessed with lots of unique and beautiful plants. In addition to providing food and oxygen, some are the source of medicine. Many plants are distributed across Oman and grow without human intervention. They are wild plants. You can see these plants in the mountains, wadis, oases, coastlines, deserts and on either side of roads.

Some of these plants are native (endemic) to Oman.

Almost all of these plants are useful to us in a variety of ways.

They give us fresh air, food, shelter and medicine and of course they are beautiful.

They are essential to maintain the balance of nature. Therefore, we cannot afford to lose any of them!

Medicinal Plants – another precious genetic resource of Oman

- Oman is home to over 250 medicinal plants and out of them 93 species are endemic and 37 species are threatened. Source: OAPGRC, 2014, unpublished information
- Conservation of such plants is needed.
- Medicinal plants have the potential to generate sustainable economic and health benefits.



Tetraena simplex Syn: Zygophyllum simplex

Common names: Qarmal (Kharmeel) Thareeb, Abu rukaiba

- Extract of leaves used to cure eye infections.
- The seeds are anthelmintic and also used as food by nomads in the deserts.
- It is eaten by camels.

Aloe vera

Aloe vera has been used in cosmetics, as a cooling eye ointment and as a medicine for many diseases. Oman has many other species of Aloe too. They are *Aloe dhufarensis* and *Aloe praetermissa* and are endemic to Dhofar.



Aloe praetermissa, endemic to Arabia, seen in Dhofar JA



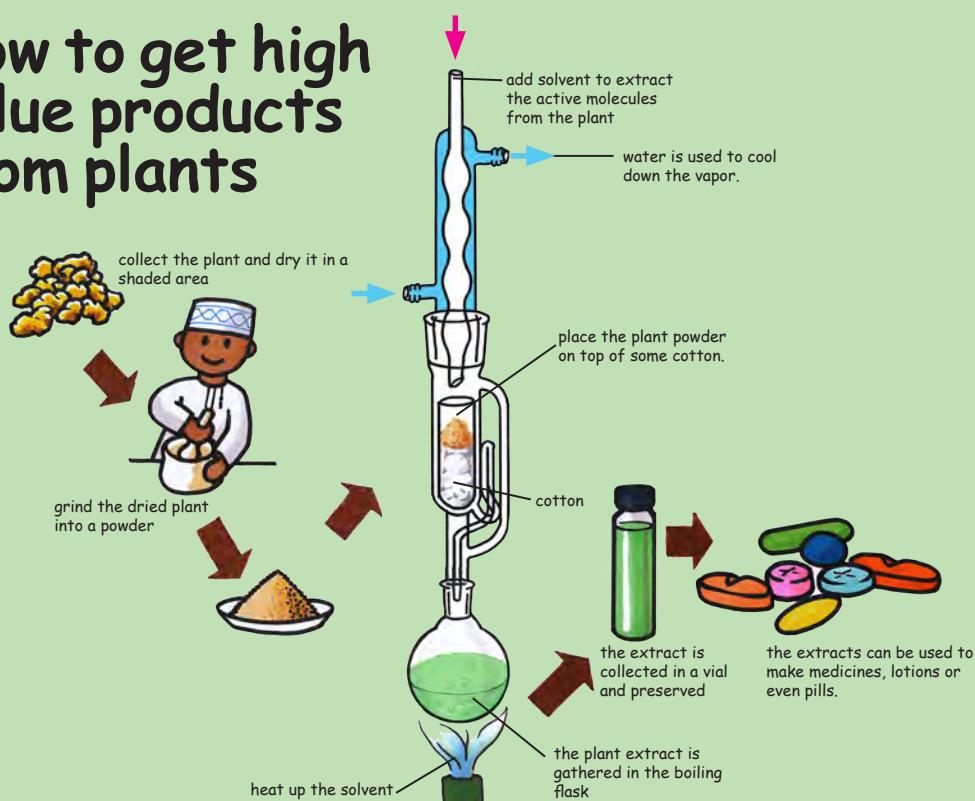
Aloe dhufarensis photo: JA

Aloe dhufarensis

Aloe dhufarensis endemic to Oman, growing on dry north facing slopes of Dhofar.

Juice from the leaves has been used to cure a range of ailments including headaches, aching limbs, diabetes, and constipation.

How to get high value products from plants



1. Collection and cleaning of the medicinal plant



2. Drying and powdering of the specific plant parts



3. Extraction of biochemicals



4. Fractionation and purification of the active compound

Do you know?

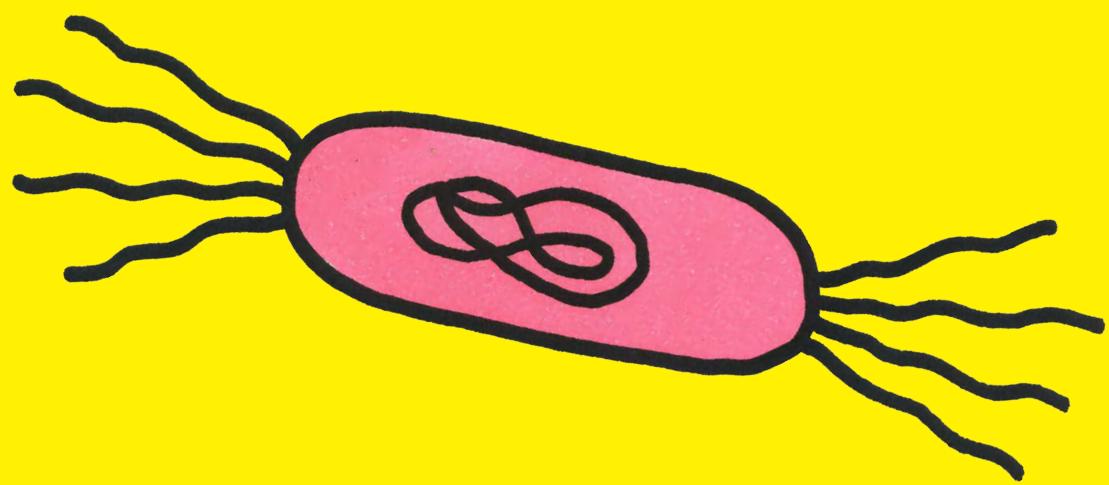
- Most medicines we use come from plants!
- People have used these plants for curing sicknesses for many years.
- Some medicinal plants, and their uses, are even mentioned in the Holy Quran.
- Our scientists are working to develop medicines for diseases like cancer from the extract of Omani Frankincense trees.

Why should we conserve our plants?

Some of the plants we find here are not found anywhere else in the world.

Why are we losing plant diversity?

- Habitats loss – natural habitats are being altered to suit human needs.
- Pollution
- Biological invasions (other species coming into Oman and taking over)
- Almost all the spring-stream systems in the country have been harnessed into the falaj networks.
- Traditional retention dams to harness surface run-off are also common in mountain villages.
- Developmental like the construction of recharge dams and roads have severe impacts on habitats.
- Mining, oil production and agriculture also impact on habitats.
- The alteration of wadi courses and changes in the drainage characteristics of catchments impact on both aquatic and land biodiversity.
- Over-use of water for agriculture has resulted in salt water intrusion. This causes salinization of groundwater. This is yet another cause of biodiversity loss.

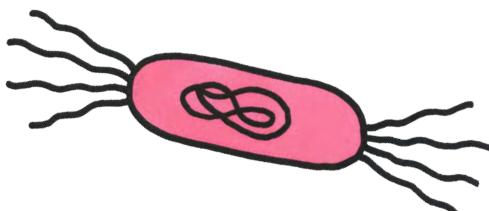


the microbial world
look into my world

The Microbial World

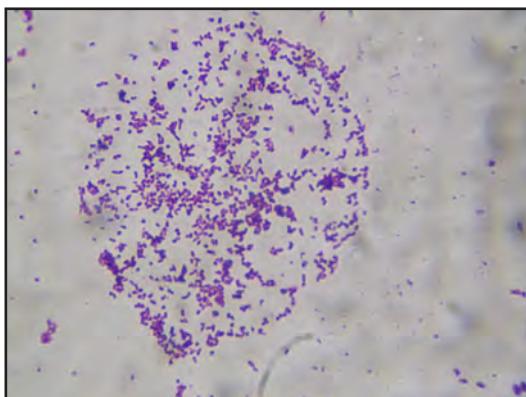
Microorganisms, or microbes, are tiny creatures that usually can only be seen with the help of a microscope. They are mostly just a single cell or made up of a cluster of cells.

- There are lots of different types of microbes. They include virus, microalgae, fungi protozoans and bacteria.
- You can find microbes in every place that has some moisture such as soil, the atmosphere, and the ocean floor... even on your hand!
- Microbes play an important role in maintaining our environment and some are useful in our daily lives. They help us make our food, grow our plants and give us medicine. Scientists are even finding ways to use them in industry.
- But some microbes are harmful! They can cause diseases to humans and other organisms. Lucky good microbes give us medicine!
- Microbial genetic resources are becoming more and more important because of all the help they can give us.
- Therefore we need to identify them and protect them... just like all our other genetic resources. This is one of the roles of the Oman Animal and Plant Genetic Resources Center along with other related organizations and researchers.



Bacteria

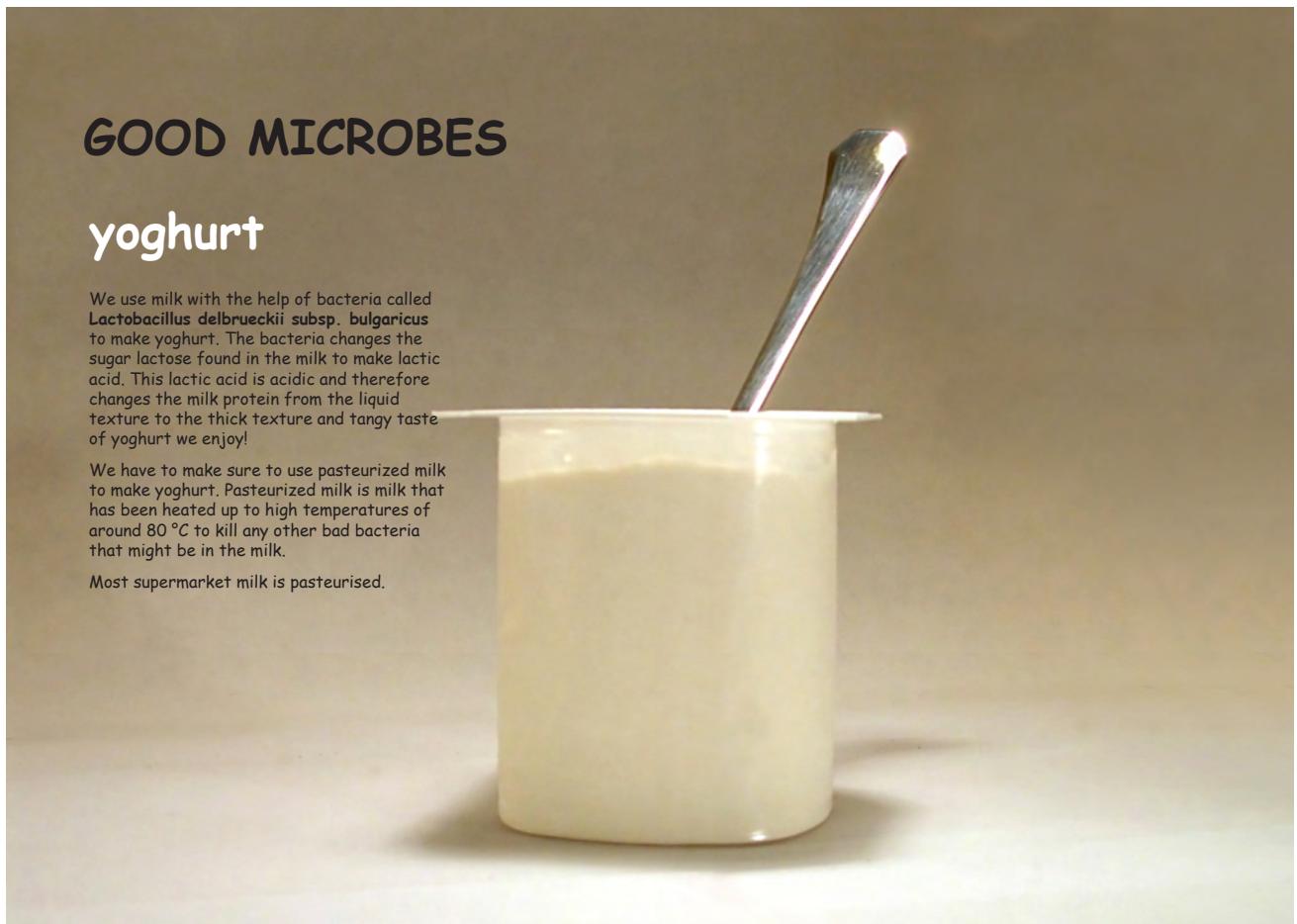
- Bacteria are single-celled microorganisms that come in lots of different Shapes - rods, spirals, commas and spheres.
- Shape is the basis for the primary classification of bacteria.
- Their cell structure is unique because they don't have a true nucleus. Such cells are called Prokaryotic.
- Bacteria are all over our bodies, they are inside our bodies and they are on everything from door knobs to tables and chairs!
- There are lots of different types of bacteria.
- Some kinds of bacteria are bad and they can make us sick when they are inside us. But most bacteria are actually good.
- They help us by doing jobs that are really important and difficult for us, for example, they eat up rotting rubbish! As they eat it up it turns into nutrients for the soil.
- We can see bacteria with a microscope. They can grow up to 5 micrometers in size.



Escherichia coli

Diversity of Bacteria

- There are millions of bacterial species, of which around 9,000 species are known.
- Scientists classify bacteria into three most common shapes, sphere (Coccus), spiral (Spirillum), or rod (Bacillus). The bacteria in comma shape are called Vibrio.
- Each bacterium (singular of bacteria) is a pretty tiny creature. If you look at it under a microscope.
- You can see them on a culture plate as colonies without a microscope – but that's when billions of them are grouped together!



GOOD MICROBES

yoghurt

We use milk with the help of bacteria called *Lactobacillus delbrueckii subsp. bulgaricus* to make yoghurt. The bacteria changes the sugar lactose found in the milk to make lactic acid. This lactic acid is acidic and therefore changes the milk protein from the liquid texture to the thick texture and tangy taste of yoghurt we enjoy!

We have to make sure to use pasteurized milk to make yoghurt. Pasteurized milk is milk that has been heated up to high temperatures of around 80 °C to kill any other bad bacteria that might be in the milk.

Most supermarket milk is pasteurised.

Good Bacteria

Bacteria are used in the preparation of lots of different foods, for example, cheese, butter, yoghurt, pickles, soy sauce and vinegar.

They are also used for manufacturing beauty care products like perfumes and lotions and chemicals like acetone (used in nail polish remover) and ethanol (used in various medical products and also as biofuel).

Bacteria that grow on our skin can help protect our body from disease causing germs.

Some bacteria that live in the gut of cattle, horses and other herbivores secrete cellulase, an enzyme that helps in the digestion of the plants they eat.

Some bacteria are used as probiotics (microbes like bacteria and yeast that are good for our health) in foods. We also use bacteria to produce vaccines and antibiotics.

BAD MICROBES



bread mold

- Molds are fungi that are present in our homes.
- Some molds are dangerous to human and can cause diseases, they can form in breads or fruits after 3 or 4 days.
- When you see bread like this, please do not eat it!
- Always protect your bread and fruits from going off.

How to protect your food from mold?

- Keep your food in a clean area.
- Do not mix food left-over with other untouched food.
- Do not store food in wet containers and do not wrap food while it is still hot.

Bad Bacteria

Some bacteria are harmful and can cause diseases in plants and animals.

The bacteria that cause diseases are known as pathogenic bacteria.

Bacteria can spoil your food.

FIGHT GERMS BY WASHING YOUR HANDS



1. Palm to palm



2. Backs of hands



3. Interdigital spaces



4. Fingertips



5. Thumbs and wrists



6. Nails

Algae are classified primarily on the basis of their colour and size

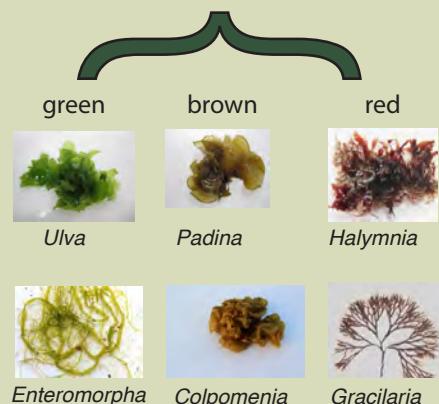
microalgae

too tiny to see (phytoplankton)



macroalgae

big algae like seaweed



Algae

- Algae (singular: alga) are a very diverse group of chlorophyll containing organisms living in fresh and marine waters.
- They can be found in wadis and falajs, and the ocean.
- They were the first oxygen producers to appear in the living world and the primary producers of food.
- They are major contributors to global biodiversity with millions of species.
- They vary in size from single celled microalgae to 60 meters long macroalgae, like giant seaweed.
- Many algae are used in farming, food and dairy products.
- All algae contain chlorophyll, a green pigment, but that's not the only pigment they have so they can come in all kinds of colours.
- Algae produce 70 to 80% of oxygen in the atmosphere.
- Algae living in the cells of corals are called zooxanthellae.

Diversity of Algae

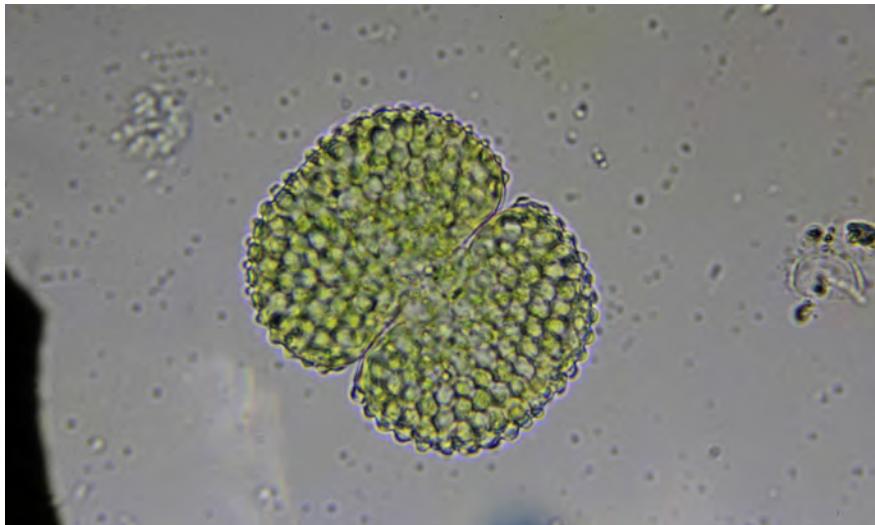
There are over 72,500 species of algae.

There are around 180 species of phytoplanktons (microalgae) in Oman.

Algae are classified primarily on the basis of their colour.

The major divisions of algae are:

- CHLOROPHYTA (Green algae)
- CYANOPHYTA (Blue-green algae)
- PHAEOPHYTA (Brown algae)
- CHRYSOPHYTA (Golden brown algae)
- XANTHOPHYTA (Yellow- green algae)
- RHODOPHYTA (Red algae)
- BACILLARIOPHYTA (Diatoms)



Cosmarium Ornatumi- a green alga (desmid)



Synedra ulna – a diatom.



Assemblage of diatoms (Synedra) - on a cyanobacterial filament

Collection, Identification and photomicrography by Jackson Achankunju



Chroococcusturgidus – a Cyanobacterium with a diatom and Euglena



Arthrospira platensis (Spirulina-the super food)

Collection, Identification and photomicrography by Jackson Achankunju



What makes *Spirulina* – the blue-green alga the super food for future ?

FIBERS

help detoxification
The fibers in *Spirulina* also aids in slimming by creating feeling of satiety.

PROTEINS

are essential for cells, hormones, antibodies, enzymes synthesis. Around 65% of *Spirulina* cell is plant proteins that are rich in the essential amino acids

CARBOHYDRATES

are an the main source of energy for the body. *Spirulina* contains 15% Polysccharides including glycogen. They also help in stimulating the immune system

OTHER NUTRIENTS

Natural pigments like Phycocyanin, Chlorophyll, Xanthophyll, Beta carotene present in *Spirulina* help building Blood cells and immunity.

Minerals like Ca, Fe, Mg help in the functions and effects of other nutrients

VITAMINS

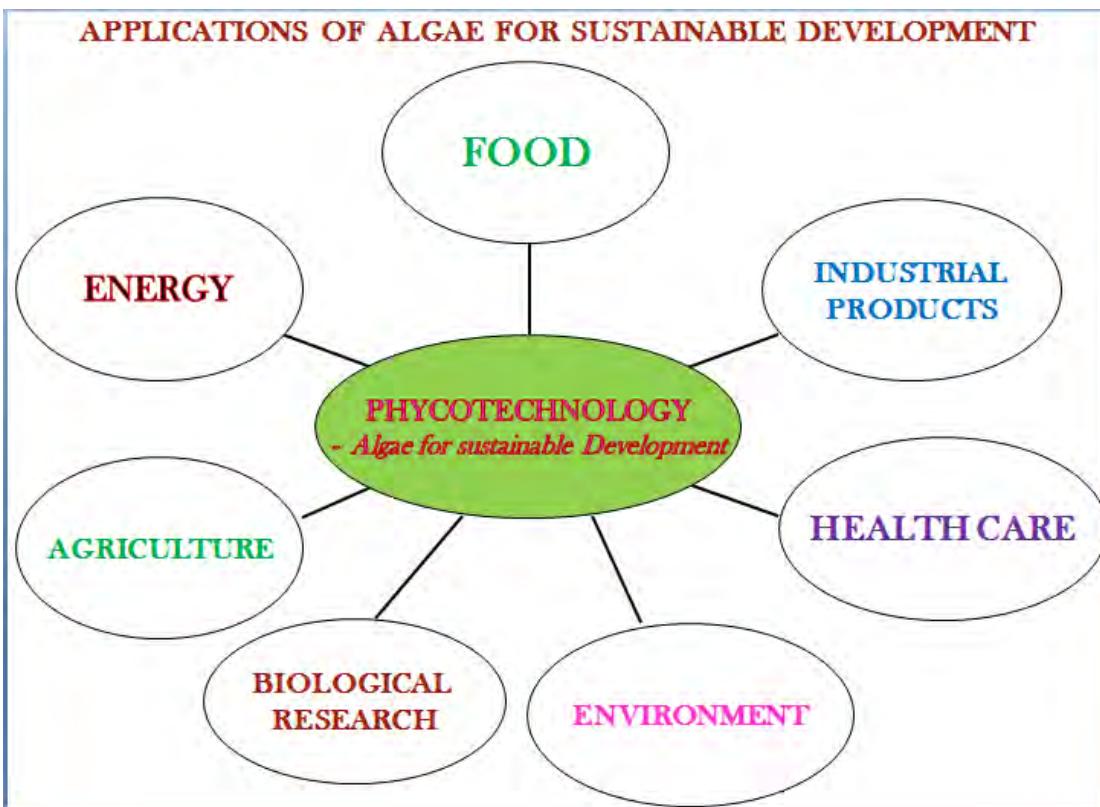
are essential for maintaining good health. *Spirulina* contains vitamins like B1, B2, B3, B5, B6, B12, E, K, A&D and folic acid..etc...

LIPIDS(FATS)

provide energy, aids in vitamins translation, monounsaturated fatty acids in *Spirulina* helps in development and maintenance of brain cells



Courtesy: jacksonachankunju@asu.edu.om



Benefits of Algae

- Algae are used in agriculture, the food industry, medicine, biofuels etc.
- We get antibiotics from some algae.
- Agar and Carrageenan extracted from red algae are used in desserts, ice cream, cream and milkshakes.
- Alginates are extracted from brown algae and used in medicine, cosmetics and in soups and jellies.

Disadvantages of Algae

- They can cause water pollution.
- Algal blooms (Eutrophication) can badly affect aquatic ecosystems.
- Some of them can cause green tides and red tides in the sea.
- A couple of them (Cephleuros) can cause diseases on some plants.

We do need to conserve the genetic diversity of algae!

One way of doing this is to preserve our fresh water falajs and wadis

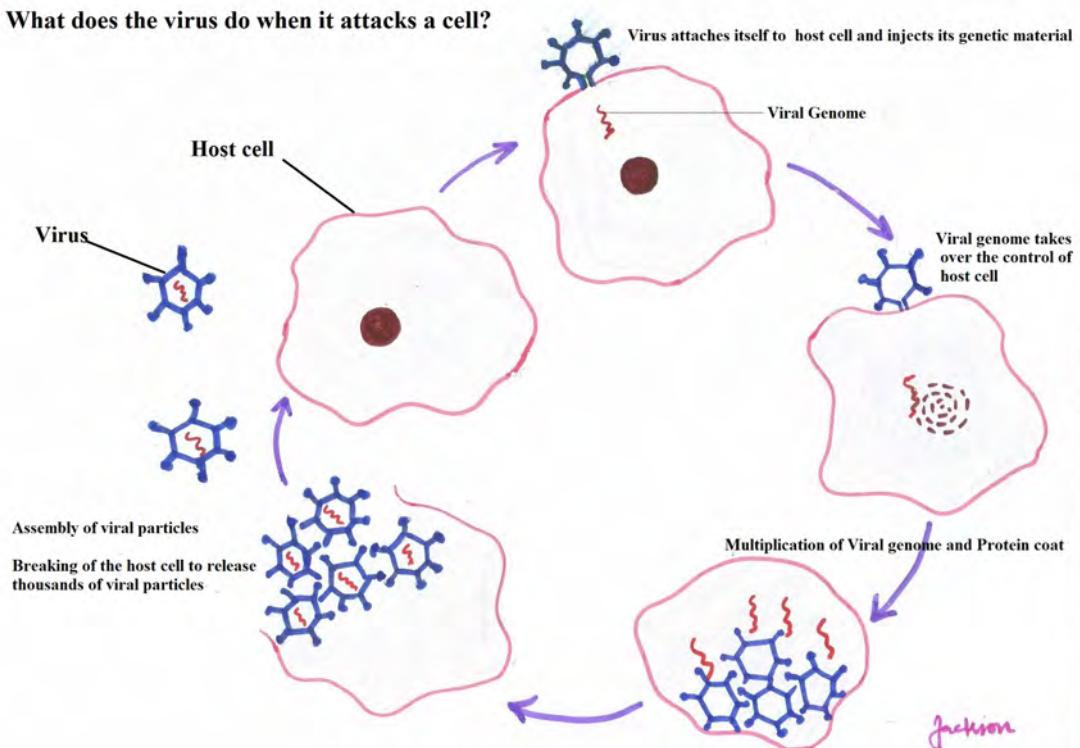


Viruses

- The name comes from the Latin word virus which means poison or slimy liquid.
- Viruses are 20 to 250 nanometers in size and they cannot be seen with a regular microscope!
- We consider viruses as non-living because they can't live independently.
- They live and breed inside the cells of other organisms.
- They don't have cellular organization but are composed of DNA/RNA and proteins.
- Viruses can cause flu and the common cold.
- Did you know?
- Viruses can float through the air
- They can survive in water and on the surface of your skin.
- They can be passed from one person to the other by shaking hands, touching food, or when people cough and sneeze.
- Some viral infections (like that of chickenpox), give you immunity against that particular virus.
- The viruses which infect plants are harmless to animals.
- Most viruses that infect animals are harmless to humans.

Life cycle of a Virus

What does the virus do when it attacks a cell?

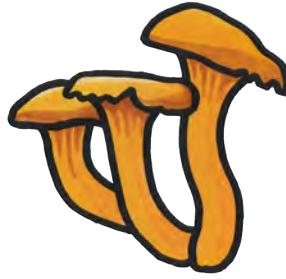


Benefits of Viruses

- Viruses can be modified to carry the required materials for the treatment of a disease. They can then carry them to the target cells.
- They are used a lot in molecular biology studies because they are simple systems.
- Vaccines against polio, measles, chicken pox etc. are made from specific viruses.
- Viruses can also be used as biological agents to control pests.

Dangers of Viruses

- Most viral infections eventually result in the death of the host cell.
- Viruses can survive for a long time on any surfaces such as stainless steel, plastics, fabrics, tissues.
- They cause diseases to plants, animals and microbes.

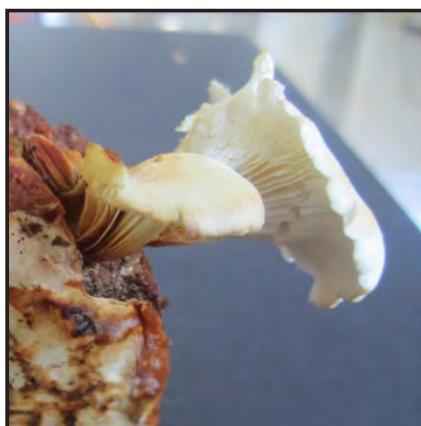


Fungi

- Fungi are non-green plant like organisms that grow as fine threads on spoiled food and other organic matter.
- Fungi include yeasts, molds and mushrooms.
- They can't make their food by themselves.
- You probably use fungal products every day without being aware of it.
- Yeast is used in making lots of things – from bread to perfume!
- Mushrooms appear in all shapes, sizes and colors and some of them are edible!
- Fungi are used to make flavoring for cooking, vitamins and enzymes for removing stains.
- Drugs made from fungi cure diseases and stop the rejection of transplanted hearts and other organs.



White button mushrooms



Oyster Mushroom

Diversity of Fungi

- There are around 1.5 million species of fungi in the world
- Around 100,000 species of fungi have been formally described by taxonomists.
- Oman has more than 100 different species of fungi belonging to 44 different types.

Did you know?

Mycology is the branch of biology that deals with the systematic study of fungi.

Classification of Fungi

The various groups of fungi include:

PHYCOMYCETES	(Algal fungi)
ZYGOMYCETES	(Conjugation fungi)
DEUTEROMYCETES	(Imperfect fungi)
ASCOMYCETES	(Sac fungi)
BASIDIOMYCOTAES	(Club fungi)

- Mushrooms are the fleshy, spore-bearing fruiting body of fungi, typically produced above ground on soil or on its food source.
- We can eat some mushrooms.
- They provide important nutrients, including minerals (selenium, potassium) and vitamins (riboflavin, niacin, vitamin D, etc)



Ganoderma applanatum on Prosopsis cineraria collected from Sharqiyah region of Oman by Jackson Achankunju, Asharqiyah University, Ibra

Benefits of Fungi

- We can eat some mushrooms.
- Mushroom farming is big business in many countries.
- Mushrooms are grown to produce an enormous range of natural products.
- Many species are used, or are being developed, in the production of antibiotics, vitamins, and anti-cancer and cholesterol drugs.
- Fungi eat waste and dead bodies!
- Certain fungi can break down herbicides, insecticides, coal tars, and heavy fuels and turn them into carbon dioxide.
- Some species of fungi like Trichoderma which grows on tree bark are the source of industrial enzymes.
- Some of these are used in the food industry and some are used to make biological detergents.

Disadvantages of Fungi

Fungi cause diseases in plants and animals.

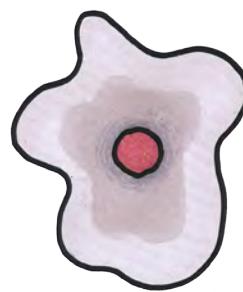
They grow in food and make it go off.

Beware! Some mushrooms can be deadly!

Conservation of fungi

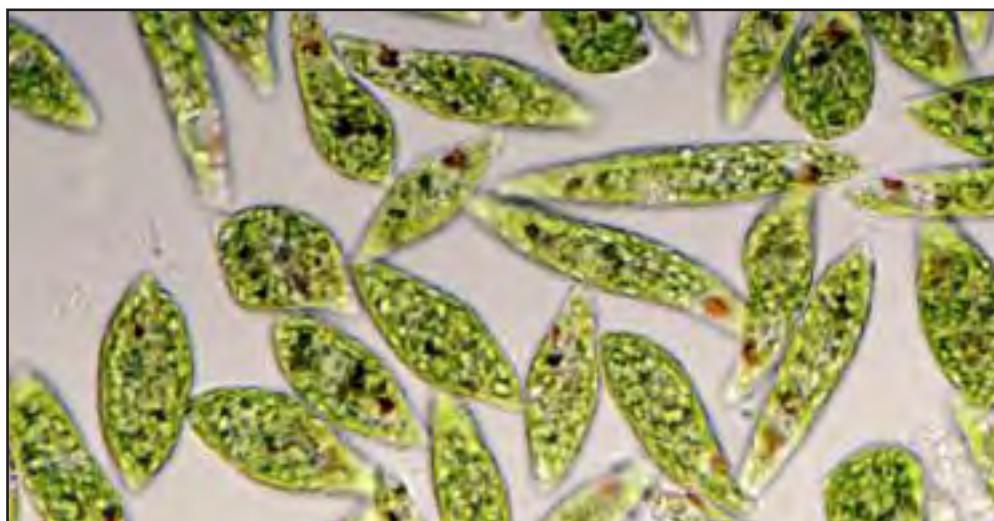
At the moment, threats to fungi include:

- destruction of their habitats
- changes in land use
- pollution
- climate change
- over-exploitation of species that can be used in business.



Protozoa

- Protozoa are a very varied group of single-celled organisms.
- They are considered to be the primitive relatives of animals.
- Protozoa are single-celled animals, too small to see with the naked eye.
- Most of them live as predators or parasites or they live on, and feed off, dead things (Saprotrophs)!
- Most of them measure less than 1/200 mm.
- They may live in the sea, in rivers, lakes, stagnant freshwater, soil, and in some decaying matter.
- Some species are even parasites on plants and animals (including humans).
- There are over 65,000 known species of protozoa.



Lepocinclis texta-a Euglenophyte

Benefits of Protozoa

- Protozoa can be good for the soil.
- In water, they are an important food supply for other creatures.
- Certain species can be used as food supplement.

Disadvantages of Protozoa

- Many are parasites (they live and feed on other animals and humans.)
- They cause disease, including: malaria, sleeping sickness, amoebiasis, giardiasis and dysentery.



Conclusion

Oman is blessed with a unique biodiversity consisting of all the microbes, plants, marine life, animals and their ecological constituents. This genetic diversity is the biological capital of our nation.

Development, which has taken place over the years, has resulted in the degradation of the habitats for some of the organisms leading to genetic erosion of species diversity. As a result, some Omani species are threatened or endangered and we may lose their genetic diversity if we do not take care. Some of the species are unique and are found only in specific areas of Oman. Therefore conserving natural habitats along with their biological diversity has become a matter of high priority.

Our scientists and researchers, at various organizations, are working against time to identify the genetic diversity of microbes, plants, marine life and animals. Exploration, surveying, identification, database development and DNA barcoding, micropropagation and cryopreservation are all parts of this great mission of conservation. Genetic resources are the main components of our natural capital.

Oman Animal and Plant Genetic Resource Center is committed to make this genetic conservation a reality and contribute to the global conservation efforts.

This road show comes as yet another initiative of OAPRGC to raise awareness on genetic diversity and its conservation among the younger generation of Oman. The children of today are the future citizens and are the greatest resource of Oman. Conserving the biodiversity is vital to the preservation of our heritage and natural capital of our nation.

Together we can conserve better!!

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