Interdependence

"Tuning in & Finding out"
Learners are introduced to the different interactions between living organisms.

Grading: Y Y Y
Time: ⌛
Place: Inside
Group size: Class divided into 3 groups

Activity Outcomes:

Learners are able to:

- understand the different kinds of symbiotic interactions between organisms and the importance of these interactions

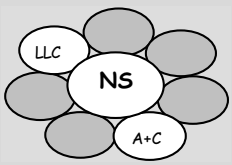
Assessment:

- Educator assessment of presentations and role-play (**see **Teaching Tip** on next page*)
- Evaluate each learner's completed questionnaire using a rubric

Skills:

- Research partnerships in nature
- Interpretation of findings
- Communication and presentation through role-play

Learning Area links



Odd couples – unusual plant and animal partnerships

Background

Sometimes two (or more) different organisms live together and form a kind of partnership. Such associations are called symbiotic relationships. The word **symbiosis** means, "living together". If only one of the species benefits, the partnership is called **commensalism**. If both organisms benefit, it is called **mutualism**. Symbiosis often exists between different plant species, **or** different animal species **or** between a plant and an animal. Symbiosis is only one of the many different ways in which living organisms relate to one another. Other feeding relationships are:

- **Parasitism** – in which one organism benefits to the detriment of the other
- **Predation** – where one organism (the predator) catches, kills and eats another organism (the prey) and
- **Competition** – when more than one organism needs and competes for the same resource from the environment

Living organisms cannot exist on their own but live interdependently (i.e. they depend on each other).

Activity Guidelines:

Needed: *One set of fact cards (see pp E10 - 18); Poster paper; Colour markers.*

As a class group:

- Find out what learners already know about symbiosis.
- Discuss the terminology which has reference to different interactions between living organisms.
- By using their ideas, write a definition for each term on the black board.

Assessment of Role Play during activity.

Here are some examples of assessment criteria that could be included in evaluating the learners' outcomes in this activity:

- Handling information, including collecting, organising and analysing material
- Strategies for building rational arguments
- Generating alternative approaches, problem solving strategies and solutions.
- Team participation in the role-playing process. The participation of individual members in the groups would be assessed; it is important to encourage the participation of each member in the group.
- Ability to generate warranted conclusions
- Ability to recognize and utilize useful information provided by other members of the group in the role-play
- Willingness to listen and understand the other members in role-play
- Group performance: For example, how effectively did each group function?

- Divide the class into three groups and ask each group to draw a FACT CARD from the collection of examples.
- Allow enough time for each group to study their FACT CARD in order to complete the following assignments: (write these assignments on the blackboard for learners to see)

✍ ***Assignments:***

- Work out a demonstration of the interaction of your examples through role play or dialogue. Try to involve the maximum number of learners from your group. Present this to the rest of the learners.
- Name and explain the kind of interaction on your fact card, to the class.
- Explain specific adaptations which play an important role in the interaction of your particular example.
- Create a colourful poster to illustrate the interaction between the organisms on your FACT CARD. (you could use the poster in your presentation)

✍ Repeat this procedure by having groups choose new FACT CARDS

✍ Once all groups have given their presentations, ask **each learner** to complete the questionnaire (see pp E19 - 20) and to hand it in.

Variations

Write a dialogue

Write a dialogue between two species which illustrates the relationship between them and how their lives are interconnected. Present to class. (You could use examples from the FACT CARDS)

Create a flower

Create a flower to suit a pollinator:

- Think of different parts of the flower: calyx, corolla, petals, stamens, anther, style, stigma.
- The pollinators could include birds, insects or any other organisms.
- Make drawings to explain your example.
- What is the difference between self-pollination and cross-pollination?
- Describe the ways in which insect-pollinated flowers attract pollinators.

Parasitism and Predation

Learners create their own "fact cards", but this time on parasitism and predatism. Present to the rest of the class.

STRANGE BUT TRUE

Man see, man do- but using monkey insect-repellent is a tough act to follow. Capuchin monkeys have perfected their own insect repellent – but it won't be on the shelves at your local chemist any time soon.

For one thing, the monkeys get it from the body of a freshly squashed 1- centimeter millipede. And the only human brave enough to try it so far – one of the team of Americans scientists who discovered it – collapsed in agony. Deep in the jungle, wedge-capped capuchin monkeys – the species which used to be trained to accompany organ grinders – can be found gathering in groups of up to 35 for mass rub-down sessions. The lotion they use comes from a freshly-squashed Orthoporus dosovittatus millipede. American researchers working at Venezuela's Fudno Pecuario Masaguaral jungle reserve studied capuchins rooting around in termite mounds or behind loose tree bark hoping to find a plump, 10 cm specimen. Apparently one is potent enough for the entire group.

Impatient monkeys waiting for their comrades to pass the squashed millipede rubbed their bodies against a capuchin already dripping with the juice. The toxic liquid set the monkeys drooling, with glazed eyes, but didn't stop them smearing themselves with the liquids, especially if they were being menaced by mosquitoes. "You'll see one or more monkeys looking frenzied and agitated, their bodies contorted, as they're patting themselves all over," said Ximena Vlderrama, a graduate anthropology student from Columbia University. When Thomas Eisner of Cornell University tried the monkeys' technique himself, he fell to his knees in excruciating pain. The millipede juice is far more powerful than the strongest jungle strength repellent used by the army. For years, researchers have speculated that rainforest monkeys use plants as painkillers, antibiotics, or even hallucinogenics. Now there seems to be proof that monkeys make their own medicine.

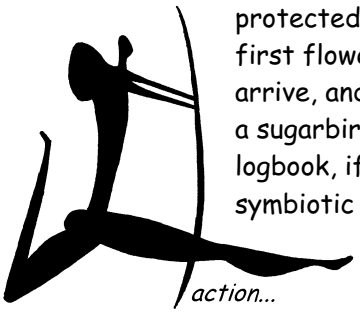
– *The Independent* -

A butterfly garden.

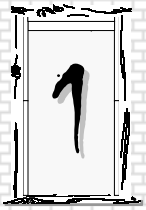
Create a garden at your school to attract birds and butterflies. Plant flowers such as proteas, ericas, cosmos, marigolds, salvia or any other that you will find attractive (if vandalism is a problem at your school, plant your garden in a protected area). In about 6 weeks (with the first flowers) the butterflies, swallowtail will arrive, and if you are lucky, you might also spot a sugarbird. Enter your observations in your logbook, if you have one, and explain briefly the symbiotic relationships between flowers and butterflies.

Organising your action plan

- **What** is to be done?
- **How** is it to be done?
- By **whom**?
- By **when**?



FACT CARD



THE WEB BELOW - ROOT PARTNERS

Walking through a forest is like paddling past a hippo in a pool; you may see the ears, but you are missing the biggest part of the picture. Trees may hide half their biomass (living tissue) in a vast underground tangle of roots, which are woven in an even bigger web made of fungus threads (some of which thrust fruiting bodies, such as mushrooms, to the surface). This "infection" of the roots is a classic example of **symbiosis**, or **mutualism** - a relationship where both organisms benefit. Trees can make new tissue from water, sunlight and air (especially carbon dioxide), but their roots cannot extract enough vital food elements such as nitrogen and phosphorous from the soil. Fungi can produce enzymes that free these elements, but they in turn, cannot draw carbon form the air. So the organisms collaborate, the fungus taking carbon compounds from the plant roots and pumping soil nutrients back into the roots in return.

A forest ecologist, Suzanne Simard, found that the fungus network must also connect different trees, even different species, in a vast network under the soil. In a series of experiments she showed the trees growing in the shade of others, and which therefore cannot produce carbon-containing compounds through photosynthesis at the same tempo as their sun-drenched neighbours, often receive their carbon from their neighbours through the network of fungal threads that connect the trees. She concluded that the fungus was "menacing" the trees, extracting carbon from the healthy ones and pumping it to shaded ones, regardless of species. In an experiment, she calculated that shaded trees often get up to 6 % of their carbon from neighbours through the fungal threads.

In plantations, many species of trees are often removed as "weeds", as foresters think that because they are usually faster growing, they are harmful to the preferred species. Simard's research shows that we need to think again. It may be possible that the "weeds", through their fungal partners, may be nurturing the chosen species by providing essential carbon compounds to them ….

FACT CARD

ANTS WELCOME AT CATERPILLAR PICNICS

Southern Africa is particularly rich in butterflies of the family Lycaenidae, known as the "blues" and "coppers". The caterpillar of the beautiful thysbe copper butterfly (Poecilmitis thysbe) has an intriguing relationship with cocktail ants (Genus crematogaster) without which it cannot survive at an early stage of its development. The caterpillars crawl down the food plant to live in shelters made by the ants. Most caterpillars avoid ants out of self-preservation. But these caterpillars strike a deal with their predators. In exchange for receiving nectar droplets, ants groom the caterpillars and fend off other predators. The caterpillar is a most welcome guest because a "honey gland" on its back secretes a sugary substance the ants find quite irresistible. The caterpillar stays in the ants' subterranean shelter during the day, coming out at night to feed. It also pupates in these shelters. In exchange for this protection, the ants are allowed to "milk" the caterpillar of its sugary secretion. Now researchers have shown that such symbiotic relationships also are one with a twist: Lycaenid Caterpillars, when threatened increase their production of nectar to entice the ants to stick around in a crisis. A team of biologists gently squeezed Lycaenid caterpillars with tweezers to mimic an ant attack. The caterpillars, surrounded by ants, oozed twice as much sugar as they normally do when being groomed. The ants, in turn, spent 30 % more time tending to these caterpillars than their peers grooming the unsqueezed caterpillars!

FACT CARD 3

TERMITES AND THEIR PROTOZOA

Termites: Getting by with a little help from their friends

Termites belong to the Isoptera, a more primitive group of insects which has strong links with the cockroaches. They are best known for their wood-eating habits, which result in enormous damage to buildings and to living trees as the insects chew their way through the timber. Cellulose, the complex sugar that is the main constituent of wood and woody tissues, is the most abundant storehouse of food on earth. Yet only a few animals can digest cellulose. Termites are not among them. They can eat wood and grass but they cannot digest it, unless they have in their bodies other organisms that can!

The large, slow-moving micro-organisms (Protozoa) found in the intestinal tract of termites are symbiotic organisms that digest the cellulose consumed by the termites. These organisms produce a cellulose-splitting enzyme lacking in termites and are able to convert cellulose into sugar to feed both themselves and their termite hosts. The conspiracy between termites and these cellulose-digesting micro-organisms is what seems to have made the insects social. Termites do not hatch with the micro-organisms already in their intestinal tracts; they are inoculated only when other termites feed them with regurgitated digestive juice, which contains the micro-organisms.

From the outset then, termites are forced to interact socially – or loose access to the abundant and nutritious stores of food in cellulose. Termites benefit from being able to digest cellulose and the micro-organisms gain by having organisms with legs and nervous systems searching for and gathering food for them. Together, they prosper but separately they would not be able to survive.

FACT CARD 4

SYMBIOTIC CLEANERS

1. Cattle egrets and other birds spend their lives eating ticks and parasitic insects from the backs of cattle, antelopes and rhinoceroses.

2. If you visit the Kruger National Park or one of the other game parks in South Africa, you will probably see small groups of red-billed ox-peckers clambering around the bigger game mammals, from impalas and the larger antelopes to white rhinoceroses, giraffes and zebras. The ox-peckers get their diet of ticks and horseflies from the mammals, as well as nesting material in the form of hair. In return, the mammals benefit in two ways: The ox-pecker rids them of the parasites and acts like a portable alarm system, their hissing calls warning the approaching danger.

3. There is an Egyptian plover which walks boldly into the open mouth of a crocodile to peck leeches from between its teeth.

4. Shrimps of several families in the Atlantic and Pacific oceans have developed a very special symbiotic relationship with fishes. An individual shrimp occupies a "cleaning station" to which fish come to have parasites removed. Some fish, ordinarily predatory on crustaceans, will allow the shrimps to enter their mouths and gill chambers to search for food.

5. A small, blind goby fish found along the California coast lives together with a kind of shrimp in the shrimp's cave-like tubular dwelling. The shrimp carries food to the goby while the goby keeps the shrimp's burrow clean.

FACT CARD 5

WHEN THE GOING GETS TOUGH, THE TOUGH COOPERATE!

A biologist, Mark Bertness, studied the interaction between various species that inhabit the New England salt marshes. In benign conditions, the organisms compete, but under stressful conditions, he has found, they behave in mutually beneficial ways. To wrest a toehold from the sea, for example, large numbers of ribbed mussels settle in among the small, marsh grasses growing on exposed coastal mud flats. The mussels use threads to attach to the marsh grasses, which in turn help anchor the soil and other less hardy grasses. In addition they nourish the plants by defecating right above their root systems.

The mud flats are also home to legions of fiddler crabs. Like thousands of John Deer tractors, the crabs plow through the soil, aerating it and making it easier for grass roots to establish themselves. If they are taken away, grass production drops by about 50 percent in one growing season. Although these findings about mussels, crabs and marsh plants are not applicable to other ecological regions, such as forest or grasslands, these kinds of interactions will be found in those areas too- it all depends on the physical regime ….." benign or harsh"

FACT CARD

WATER BUDDIES

Sharks and their companions

Sharks often have sucker fish (Remora) attached to them and pilotfish swimming nearby. The suckerfish hitches a free ride and shares the shark's discarded food with the pilot fish. The shark does not benefit from this relationship. Both the smaller fish benefit from the fact that their large companion scares away, or eats animals which would otherwise attack them. Another striking example of symbiosis from the ocean is a small tropical fish that lives in the respiratory tree of a particular species of sea cucumber. The fish emerges to feed at night and then returns to its curious abode by first poking its host's rectal opening with his snout and then quickly turning so that it is drawn tail first through the rectal chamber into the respiratory tree where it is well-sheltered. Apparently it does no harm to its host. (Biological Science – Keeton)

FACT CARD 7

POLLINATION PALS

One of the best illustrations of plant and animal partnerships is pollination. The majority of plants depend on animals for pollination. Insects and birds are the most common pollinators and appear to be specifically designed for the job.

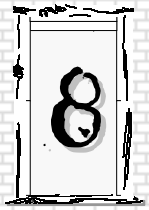
Sugarbirds are a family of birds unique to Southern Africa. There are only two species in the family, and the Cape sugarbird of the Western and Southern Cape is more spectacular because of its longer tail. Sugarbirds have long curved bills for probing deep into tubular flowers for nectar. You will see them perched on indigenous proteas, red-hot pokers, watsonias and heaths. Then, when the birds move off to feed on other neighbouring flowers of the same species, it carries the pollen with it, thus assisting in the fertilization of these flowers.

Unwittingly, the striped mouse also acts as an amazing match-maker for certain species of protea in the South Western Cape's floral kingdom: as it feeds on the succulent bracts and styles on the low-level blooms of some proteas, pollen clings to its head and is carried to other proteas, resulting in cross-pollination.

Buttercups, peas, dandelions and daisies are examples of the enormous number of flowering plants which make use of an extremely efficient pollen delivery service: insects. Insects do not carry pollen from flower to flower free of charge. They are rewarded for their service in two ways. First, they can eat some of the pollen themselves and second, many flowers produce nectar. Bees and butterflies find this sweet liquid so attractive that they spend almost all their lives in search for it.

Plants advertise their pollen and nectar with brightly coloured flowers and scents which insects find attractive. Often the brightest colours mark a path through the flower to where nectar is produced, but as it follows this path, the insect is either showered with pollen, or brushed by stigmas which pick up the pollen deposit on its body by another flower.

FACT CARD



SEED DISPERSAL

Plants and animals have formed seed sowing partnerships. Although some plants produce small seeds that are dispersed by wind, most plants rely on animals to disperse their seeds. These seeds are often encased in fruits that attract a specific kind of animal. Birds are usually attracted to brightly-coloured fruits, while bats and some other animals are drawn to fruits with strong odours. The fleshy, outer fruit is digested and the seed is regurgitated or later passes unharmed through the animal's digestive system.

Some plants, such as Proteas and Restios, produce large seeds with a protein rich cap -called an eliasome – at the base. Ants carry the seeds underground in order to eat the eliasome. The seed itself is left unharmed underground. The seeds have thus been dispersed effectively and, are protected from fire and rodents. Heat and smoke from veldfires will stimulate these seeds to germinate after the first winter rains.

FACT CARD 9

TREES AND EPIPHYTES: SITTING PRETTY

A special kind of relationship in which one organism benefits and the other is unaffected, exists between trees and plants called epiphytes. Many ferns, mosses, orchids, bromelias and even small trees are epiphytes. Because of the lush vegetation, the forest floor (especially in rain forests) is too dark for most plants. By growing high on the branches of trees, the epiphytes can obtain enough sunlight to carry out photosynthesis. Because epiphytes are not rooted in the ground and cannot soak up soil moisture and nutrients, they have developed several features that help them get the water and nutrients they need to survive. Some are able to store water inside their stems and others have aerial roots that absorb moisture right from the air. Some epiphytes grow in basketlike shapes that trap falling bits of vegetation, insects and other litter. These plants then absorb nutrients from the litter they collect. The epiphytes take nothing form their host trees. Yet they depend on the tree to obtain light. The host tree is neither harmed nor helped by the epiphyte.

- Questionnaire -

- Give learners time to complete the following questions individually.
- Provide an answer-sheet and let learners mark their own questionnaire.
- Afterwards, discuss their answers in class.

Questions:

1. Describe the difference between mutualism and commensalism

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2. What do we call the relationship between fungi and plantroots - why?

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3. Why should we think again before removing so-called "weeds" in plantations?

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4. Rabbits, sheep, cattle and other herbivores eat grass but cannot digest it by themselves. What does this job for them? What do these organisms gain in turn?

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5. Describe two ways in which small fish attached to sharks benefit from living with their larger fish partners. Why is this type of relationship called commensalism?

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6. How do termites and protozoa benefit from their partnership?

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7. How does a flowering plant benefit from attracting bees? Name the relationships between these two kinds of organisms.

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8. Name the type of relationship that exists between epiphytes and trees. Give a reason for your answer.

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9. Describe what the word myrrmecochery means.

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