



Curriculum-based Outdoor Learning Programmes in Country Parks General Studies (P.4 – P.6)

Food Chains and Food Webs

Student Handbook

Name:	Class:	

Group:

Date:

The Balance of Nature is Made of a "Network"

Imagine that all living things (e.g. animals, plants, microorganisms) and nonliving things (e.g. air, water, sunlight, soil) on the earth are **dots** on a plane. The relationships between each dot (e.g. feeding is a relationship among organisms, breathing is a relationship between living things and non-living things) are connected by **lines**. The countless connections between dots then form a **network**.

Now put a sphere on the network. The network supports the sphere so that it hardly slips away, and this is just like maintaining a balance. This is the ecological balance maintained by the network consisting of living and non-living things.

Some of the line segments may break down slowly over time, but at the same time, new relationships among organisms and between organisms and the environment will also be formed; hence the network remains stable. However, what if the lines are broken due to human factors, and the fracture speed is faster than the speed of construction?



All About "Eating"

Why do we eat?

Have you ever thought about why human needs to eat every day? Mahatma Gandhi used to go on several hunger strikes (that is, stop eating, and a few would stop drinking at the same time), and one of the hunger strikes even lasted for 21 days long. Does it mean that eating is not necessary for humans?



In fact, we need to eat because we have to consume energy, which is used to support our daily activities, such as walking, running, breathing, and even sleeping, from food. When there is not enough energy in our bodies, our brains will signal our bodies' needs for food, which makes us feel hungry.

If the amount of food we eat is not enough to replenish the energy we use, we are prone to symptoms such as dizziness, fatigue, and lack of concentration. Moreover, if you have eating disorders, you may suffer from serious health problems, such as malnutrition and anorexia.



Quiz

In addition to humans, other animals also need to get energy by eating other living things. Can you name an example of herbivores and carnivores?

Example Lions eat zebras (carnivores)



Learn More About the Feeding Relationships Among Organisms

"Eat" and "eaten by"

Below are three organisms that can be found locally:



Try to find out the "who eats who" relationships among the above organisms.

_ eats butterfly larva, butterfly larva eats

Rewrite the above sentence using the passive voice.

_____ is eaten by butterfly larva, butterfly larva is eaten by ______.

Energy flow

During the process of food consumption, energy transfers from the "eaten by" side to the "eat" side (e.g. our digestive systems break down and absorb the nutrients from the food we eat; hence, energy transfers from the food to our bodies), and this is the process of energy flow. We use arrow (\rightarrow) to represent the direction of energy flow.

Now let's try to <u>circle the correct energy flow direction</u> for the feeding relationships between the following organisms:



Food chains

The feeding relationships among organisms do not just consist of two but multiple organisms. A food chain can show the sequence of organisms in a particular feeding relationship with the concept of energy flow. With reference to the example of the feeding relationship on P.3 and the concept of energy flow you just learnt, <u>circle the right direction of energy flow:</u>



Example of a food chain



Roles of different organisms in a food chain

Organisms play different roles, which are producers and consumers, in a food chain.

Producers

Have you noticed which organism in the food chain we just learnt does not eat other organisms? Most plants do not rely on eating other organisms for energy. Instead, they can make their own food by capturing light energy, and this process is called photosynthesis. Since plants can transfer the energy they capture from light to other animals when they are being eaten, they are also known as the producers in the food chains. Can you think of anything related to "light" in nature?



Green plants are the main producers in terrestrial ecosystems



Phytoplankton are the main producers in aquatic ecosystems (Credit: CSIRO)

Extended Learning

Gaseous cycles

Like animal respiration, plants also absorb and release gases during photosynthesis. This process helps the cycling of oxygen (O_2) and carbon dioxide (CO_2) in the atmosphere.



Roles of different organisms in a food chain (cont'd)

Consumers

Unlike producers, consumers acquire energy by feeding on other organisms, including plants and animals. Since no animal has been found to be able to produce food in its own body since birth, basically all animals are considered as consumers.

Now you have learnt what producers and consumers are. Going back to the food chain example on P.5, can you point out the role of each organism in the food chain? <u>Please draw lines to match the organisms with the roles.</u>



Extended Learning

Nutrient cycling

Have you wondered where the energy stored in the producers and consumers will go when they die? In addition to producers and consumers, some organisms also play the role of decomposers in the ecosystem. Decomposers can decompose biological waste (like feces) or corpses into fine nutrient particles. Roots of plants can absorb these nutrient particles, so that energy can circulate in the ecosystem. Although we generally do not mention decomposers in food chains, please do not forget they are also essential members of the ecosystem!



Microorganisms are the main decomposers in the natural environment



Apart from being decomposers in the soil, earthworms can also loosen the soil, which makes the nutrients in the soil more evenly distributed

Food Webs

There is more than one food chain in nature

You have just learnt a lot about food chains, but there is not only one food chain in nature. This is because each organism's feeding habit and territory are different, which makes the feeding relationships among organisms more complicated.

Based on the food chain on P.5, in addition to the bird, there is beetle that eats the butterfly larva, and the bird also eats the beetle. According to these feeding relationships, we can draw the following two food chains:

Food chain (1): Plant \rightarrow _____ \rightarrow Bird Food chain (2): _____ \rightarrow Butterfly larva \rightarrow _____ \rightarrow Bird



From food chains to a food web

We can determine the complex feeding relationship among organisms in an ecosystem from a food web. A food web is made up of multiple food chains. You can also imagine that the food web is a complex version of the food chain. Now please follow the teacher's instructions to merge the two food chains introduced on the previous page into a food web!



Inquiry Learning

Predict the population size of each organism in a food chain

You have already learnt a lot about food chains, including the concepts of energy flow and different roles of organisms in a food chain, and so on. Nonetheless, there is still a crucial concept related to food chains that needs to be addressed. This concept is the key to explain how food chains can maintain stability.

Have you ever thought about the population sizes of various organisms in the food chains? Do their sizes follow specific rules?



Understanding pyramid of numbers

The pyramid of numbers is a model used to show the population size of each organism in a food chain. The pyramid of numbers is composed of bars with different widths. The broader the bar, the greater the population size. Moreover, the base of the pyramid of numbers must be a producer.

The following model is an example of the pyramid of numbers. Discuss with your groupmates and <u>choose the most suitable organism from the options below</u> (Plant, Bird, Insect) to represent each food chain level, and then briefly explain the reasons for each choice.



Refresh Your Memory: Food Chains and Food Webs

1. Take a dish containing animal ingredients you just ate as an example to complete a food chain. (If you are a vegetarian, you can invite your classmates to provide you with a dish)

Example	
① Dish:	① Dish:
Beef and choy sum stir-fry	
② The animal I ate:	② The animal I ate:
Cows	
③ That animal feeds on: Grass	③ That animal feeds on:
 ④ Feeding relationships: Grass is eaten by cow, cow is eaten by human 	④ Feeding relationships:
⑤ The food chain: Grass → Cow → Human	⑤ The food chain:
⑥ The producer in the food chain: Grass	⑥ The producer in the food chain:
 The consumers in the food chain: Cow, human 	⑦ The consumers in the food chain:

Pre-trip lesson worksheet

2. This is a food web developed with Chinese banyan (榕樹) as the producer:



The above food web can be divided into 4 food chains. With reference to the food web, complete the following food chains:

- a. Chinese banyan \rightarrow _____ \rightarrow Owl
- b. Chinese banyan \rightarrow Eurasian tree sparrow \rightarrow _____
- c. Chinese banyan \rightarrow _____ \rightarrow Eurasian tree sparrow \rightarrow Owl
- d. Chinese banyan \rightarrow _____ \rightarrow _____ \rightarrow Eurasian tree sparrow \rightarrow _____

Challenging Question

2020 is the second warmest year on record in Hong Kong. The warm weather is very conducive to the growth and reproduction of the red banyan moth (朱紅毛 斑蛾) larvae (a kind of moth larva), causing serious damages to the Chinese banyan trees. Some people suggested that the natural enemies of moth larva can control the number of red banyan moth larvae. Based on the above food web, which animals would you recommend introducing to reduce the number of red banyan moth larva? Why?

Field Trip

Being a one-day ecological surveyor

You will work as an ecological surveyor in the Tai Po Kau Outdoor Study Centre (Study Centre) to assist in collecting habitat and wildlife data in the Study Centre. These data will be beneficial for us to understand the relationships among organisms and between organisms and the environment.

Besides, you also get another task to be done. Do you remember you made predictions on the population sizes of the plants, insects, and birds in the food chain in the previous lesson? During the field trip, please verify your predictions by carefully observing the numbers of different organisms in the natural environment!

Extended Knowledge

Tai Po Kau Nature Reserve

Tai Po Kau Nature Reserve is a special area located in Tai Po District, New Territories. Although this area is not part of a country park, it is also managed by the Agriculture, Fisheries and Conservation Department. This nature reserve is an ideal location for local nature lovers and ecologists to conduct ecological surveys and research because it has one of the most mature secondary forests in Hong Kong. In addition to a variety of native plants, the dense forest also attracts different kinds of animals, such as birds, mammals, amphibians, reptiles, and insects, to inhabit. Although the nature reserve is generally open to the public, the purpose of designating the nature reserve is to preserve flora and fauna of the area, so you must also take more care of the natural environment when you visit there.



Preparation

Safety tips and precautions

Safety should always be the top priority no matter what outdoor activities you are conducting. Please read the following safety tips and precautions carefully, and keep in mind the principle of "safety first" during the field trip.

- 1. Follow the instructions of the teachers. Running, yelling and leaving without permission are not allowed
- 2. Wear appropriate clothing, such as light-coloured longsleeved clothing and sneakers
- 3. Avoid stepping on steep slopes or slippery rocks
- 4. Cherish the natural environment and take your litter home
- 5. Stay calm during an emergency and ask the teachers for help

Materials and tools

Check if you have all the materials and tools needed for the survey, and then practice the use of the tools. <u>Please circle the items below</u> after receiving the related materials and tools.

• Magnifier	• Binocular	•	Stationeries
Species Identi	fication Guide	• Pho	to taking devices

Field Trip Activity (1): Habitat Exploration

A. Walk around in the Study Centre

The first step in a field trip is to be familiar with the environment of the site. Now please follow your teachers to walk around the Study Centre. If you found the below habitats in the Study Centre, <u>please fill in " \checkmark " in the blank near the</u> <u>habitat you found.</u>

Pictures of Reference	 ✓

B. Observing habitats

Observe carefully the survey area assigned to you or of your own choice, and answer the following questions:

1. Which of the following natural resources/environments can be found in your survey area? Please circle the appropriate answers. (you can choose more than one answer)



2. Continue with the above question, and based on the environment of your survey area, what kinds of animals do you think you can find? Please circle the appropriate answers, and then match the animals with the related natural resources/environments by using (a) – (f) (e.g. if you think soil is related to insects, then you need to fill in the blank under "insects" with (e) which represents soil). (you can choose more than one answer)

(you can refer to the Species Identification Guide)

Birds	Insects	Amphibians
Reptiles	Fish	Mammals

Field Trip Activity (2): Revision: What process is used by plants to **Recording Wildlife**



A. Find out the plants and recognise the producers

Producers are the foundations that support the entire food web. Depending on the types of producers, the consumers we find may be different (e.g. it is easier to find butterflies near flowering plants and birds in forests composed of tall trees). Please search for 3 producers in your survey area and record their information in the table below.

Plant name (skip this column if you can't identify the species)	Type A: Terrestrial woody plants B: Terrestrial herbs C: Aquatic plants D: Others	Draw the plants or paste photos of the plants
1		
2		
3		

B. Find out the animals/consumers

(you can refer to the Species Identification Guide if necessary)

Animals are usually consumers. Herbivores and carnivores feed on plants and animals to maintain their lives, while omnivores consume a variety of food at the same time. <u>Please search for animals in the survey area and record their numbers.</u>

Tips

You can choose one of the following methods to record the animals depending on your ability of identifying species:

Method 1: Identify each species		Method 2: Identify the type of animals		
	Species	Quantity	Species	Quantity
1	Red-base Jezebel	1	1 Butterfly (1)	1
2	Red Helen	1	2 Butterfly (2)	1

Insects (e.g. butterflies, dragonflies, beetles, bees, ants)				
Species	Quantity	Species	Quantity	
1		6		
2		7		
3		8		
4		9		
5		10		

Birds			
Species	Quantity	Species	Quantity
1		6	
2		7	
3		8	
4		9	
5		10	

Mammals				
Species	Quantity	Species	Quantity	
1		6		
2		7		
3		8		
4		9		
5		10		

Reptiles and amphibians

Species	Quantity	Species	Quantity
1		6	
2		7	
3		8	
4		9	
5		10	

Fish

Species	Quantity	Species	Quantity
1		6	
2		7	
3		8	
4		9	
5		10	

Data Analysis

A. Constructing food chains

1) Discuss with your groupmates the data obtained from the field trip, and then answer the following questions:

1	During the field trip, what producers did you observe?				
	Producer 1:	Producer 2:	Producer 3:		
2.1	Based on your observa you observed during th	tions or the Species Identific ne field trip feed on Produce	cation Guide, which of the animals er 1?		
2.2	Continue with the above question, which of the animals you observed during the field trip feed on the animals listed in question 2.1 ?				
2.3	Continue with the abo in question 2.2	ve question, which of the a	nimals feed on the animals listed		
3.1	Based on your observations or the Species Identification Guide, which of the animals you observed during the field trip feed on Producer 2 ?				
3.2	Continue with the abo field trip feed on the a	ove question, which of the nimals listed in question 3.1	animals you observed during the 1?		
3.3	Continue with the abo in question 3.2	ve question, which of the a	nimals feed on the animals listed		

Based on your observations or the Species Identification Guide, which of the animals you observed during the field trip feed on Producer 3 ?
Continue with the above question, which of the animals you observed during the field trip feed on the animals listed in question 4.1 ?
Continue with the above question, which of the animals feed on the animals listed in question 4.2

 Refer to the answers on the previous page, <u>write at least one food chain</u> (each food chain must contain at least two organisms):

1			
2			
3			
4			
5			

B. Draw a food web

Summarising the results of the survey and the knowledge you learned in the class before the survey, and then draw a food web based on the food chains you wrote on the previous page (if you find that your data is insufficient to draw a food web, you can combine your results with other groups' results).

(Hint: you can refer to the food web example from **question 2 on P.13**)

Response to the Inquiry Question

Do you still remember that you made predictions on the numbers of producers and consumers in the food chain in the previous class? Do your observations during the field trip match with your predictions? Now please choose the most suitable organism from the following options to represent each food chain level again **based on your observations during the field trip**.

(Hint: if you forget what the pyramid of numbers is, you can refer to the example on **P.11**)



Study the process of energy transfer in the food chains again

Do you still remember the concept of "energy flow"? In fact, most energy is lost through different forms in the transfer process, so not 100% of energy can be transferred from one organism (or light) to another. This process is like transporting water in a bucket with a hole from one location to another. Very little water can eventually be transported to the destination:



On the contrary, if there is much more water at the beginning (e.g. there are five buckets of water), even if part of the water will be lost during transportation, enough water (maybe equivalent to a bucket of water) can still be transported to the destination:



Likewise, if there are more organisms in the first level of a food chain, the organisms in the third level of the same food chain will have a greater chance of getting enough energy!



Summary

In the natural environment, the <u>more/less</u> producers (such as plants) in food chains, the <u>more/less</u> consumers (at the top of the food chain).

The numbers of different organisms in the food chain that I observed during the field trip **match/do not match** my predictions.

The Animal We Ate to the Endangerment



Read the following two excerpts from newspapers published in 1946 and 2017, respectively, about yellow-breasted bunting and answer the questions.

(禾花雀)

Article 1

Let's Welcome the Yellow-Breasted Bunting to Hong Kong and Pig Out

..... The yellow-breasted bunting is a migrating bird that belongs to the bunting family and is usually found in the mountain area of northern Guangdong. It migrates to the south every autumn and early winter and feeds on the paddy about to be harvested. The farmers in Shanshui can predict the arrival of such birds by reading the wind direction. They trap the birds at night in the paddy field, and the birds will be drowned immediately and transported to the markets for sale.

Source: translated from The Kung Sheung Daily News (25th Oct, 1946)

Article 2

Green Groups Ringed the Yellow-Breasted Bunting with Coded Rings to Track the Migratory Route for Analysing the Cause of Death

..... The Harvest Festival of this year takes the yellow-breasted bunting as the theme to educate the public on the importance of conserving wetlands and the yellow-breasted bunting. Mr. Lam Chiu Ying, former director of the Hong Kong Observatory and a bird watching lover, also attended the event. He stated that although he rarely saw the yellow-breasted bunting 20 years ago, he was still shocked to know that recently the yellow-breasted bunting has been considered as a "critically endangered" species. He pointed out that humans have eaten many species into extinction, and he hoped that the public would stop eating the yellow-breasted bunting.

Source: translated from HK01 (30th Dec, 2017)

Post-trip lesson pre-lesson worksheet

- 1. According to Article 1, what does yellow-breasted bunting feed on?
- 2. Since 2017, the yellow-breasted bunting has been considered "critically endangered" by The International Union for Conservation of Nature (IUCN) Red List of Threatened Species, which means the risk of extinction of the yellow-breasted bunting is very high. Combining the contents of the two articles, what may be the possible reason that pushes the yellow-breasted bunting towards extinction?
 - A. Being overhunted by humans as food
 - B. Encountering natural disasters during migrations
 - C. People cause nuisance during bird watching
 - D. Being overhunted by humans as pets
- 3. Although eating yellow-breasted bunting is prohibited in mainland China now, the problem of yellow-breasted bunting poaching is still very serious since people believe that it promotes good health. Please invite a family member to share his/her views on the behaviour of eating yellow-breasted bunting.

I interviewed my ______, he/she agreed/disagreed the behaviour of eating yellow-breasted bunting, because ______

Think Over

- How have people's views towards the behaviour of eating yellow-breasted bunting changed from 1946 to 2017?
- Continue with the above question, what do you think are the reasons for those changes?
- Apart from the yellow-breasted bunting, do you know any other endangered species that can be found in Hong Kong?

Reflect on the Relationship Between Human and Nature

Ecological disasters caused by "eating"

After a series of lessons and the field trip, you should have a deeper understanding of food chains, food webs, and other related concepts. Now let's learn from the case of yellow-breasted bunting to see how human disrupts the food webs in nature, thereby threatening the living spaces of different species.

The following organisms were mentioned in the articles of the post-trip lesson pre-lesson worksheet (P.27):



Please try to figure out the feeding relationship among these three organisms by referring to the articles and write down the relevant food chain:



Supply and demand in food chains

According to the articles, people in the last century hunted the yellow-breasted bunting for food because they regarded it as a delicacy. If people overhunt the yellow-breasted bunting, the number of yellow-breasted bunting will **increase/decrease**.

When the number of yellow-breasted bunting decrease, the chance of the paddy being eaten by the yellow-breasted bunting will **increase/decrease**, so the number of paddy will **increase/decrease**.

Quiz

To conserve the yellow-breasted bunting, some people suggest planting more rice. This is because when the number of rice (paddy) increases, the opportunities for the yellow-breasted bunting to eat will **increase/decrease**, thereby **increasing/reducing** the number of the yellow-breasted bunting.

Summary

The numbers of different organisms in the food chains are adjusted according to the needs or numbers of other organisms.



Yellow-breasted bunting – critically endangered

The International Union for Conservation of Nature has raised the conservation status of the yellow-breasted bunting from "vulnerable" to "endangered", and then from "endangered" to "critically endangered" in the last couple of years. Even though eating yellow-breasted bunting is now prohibited in China, the black market (i.e. illegal buying and selling, eating) is still rampant. The living space of the yellow-breasted bunting is still in jeopardy.

It has been pointed out that the yellow-breasted bunting help eat the pests that feed on the rice. When the yellow-breasted bunting is over-hunted, the number of pests will increase, affecting the yield of crops and ultimately harming both human and nature.

In addition to the yellow-breasted bunting, do you know other examples of organisms being over-hunted and eaten by humans?



Reflection

As part of the earth's existence, human beings also belong to the natural ecosystem.

Each organism has its unique position in the ecosystem. Just like the food web we have learnt, organisms are connected to form a network, and any individual affected will impact the whole system. When the number of yellow-breasted bunting is abnormal, it is not only the yellow-breasted bunting themselves that are affected, but also the organisms that feed on the yellow-breasted bunting, the organisms that the yellow-breasted bunting eat, and the organisms that feed on the same plants as the yellow-breasted bunting, and so on.

I hope you all realise that human beings have close relationships with other organisms and the environment as a member of nature. While we are benefiting from natural resources, we should also cherish these resources.

To save the resources, in what way are you willing to practice green living? After discussing with your teachers and classmates, <u>please draw your thoughts</u> in the space below.



Impacts of Invasive Species on Food Webs

Read the following information and answer the questions.

Information 1

The red-eared slider, native to North America, was introduced to Hong Kong as a pet turtle because it is highly adaptable to new environments. However, many people abandon them because of their increased size and food intake, and some even purchase large numbers and release them into the wild for religious purposes. Due to their high adaptability and reproductive capacity, some of those released turtles can survive in the wild in the absence of natural predators. The redeared slider is omnivorous and eats aquatic plants, insects, fish, and frogs, thus competing with the native Reeves' turtle and posing a serious threat to local species.



Information 2

The figure below shows a food web that is found nearby a freshwater ecosystem.



1. Based on **Information 1**, add the red-eared slider to the food web shown in **Information 2** and draw a new food web.

2. If someone releases many red-eared sliders near the freshwater ecosystem mentioned in **Information 2**, what short-term impact will it have on the number of organisms in the food web of **Information 2**?

a. The number of red-eared slider	increase/decrease
b. The number of frog	increase/decrease
c. The number of fish	increase/decrease
d. The number of insect	increase/decrease
e. The number of aquatic plant	increase/decrease
f. The number of Reeves's turtle	increase/decrease

3. A friend of yours wants to release his red-eared slider into the wild. Based on the above information, explain to him how releasing red-eared sliders may harm the natural ecosystem.