

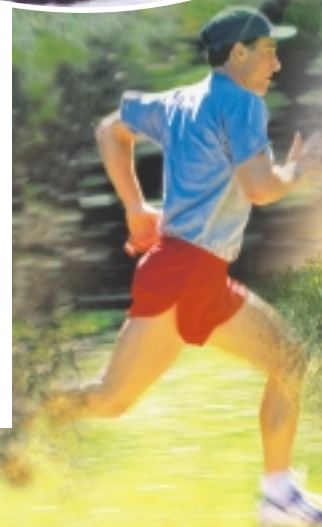
Biological Diversity

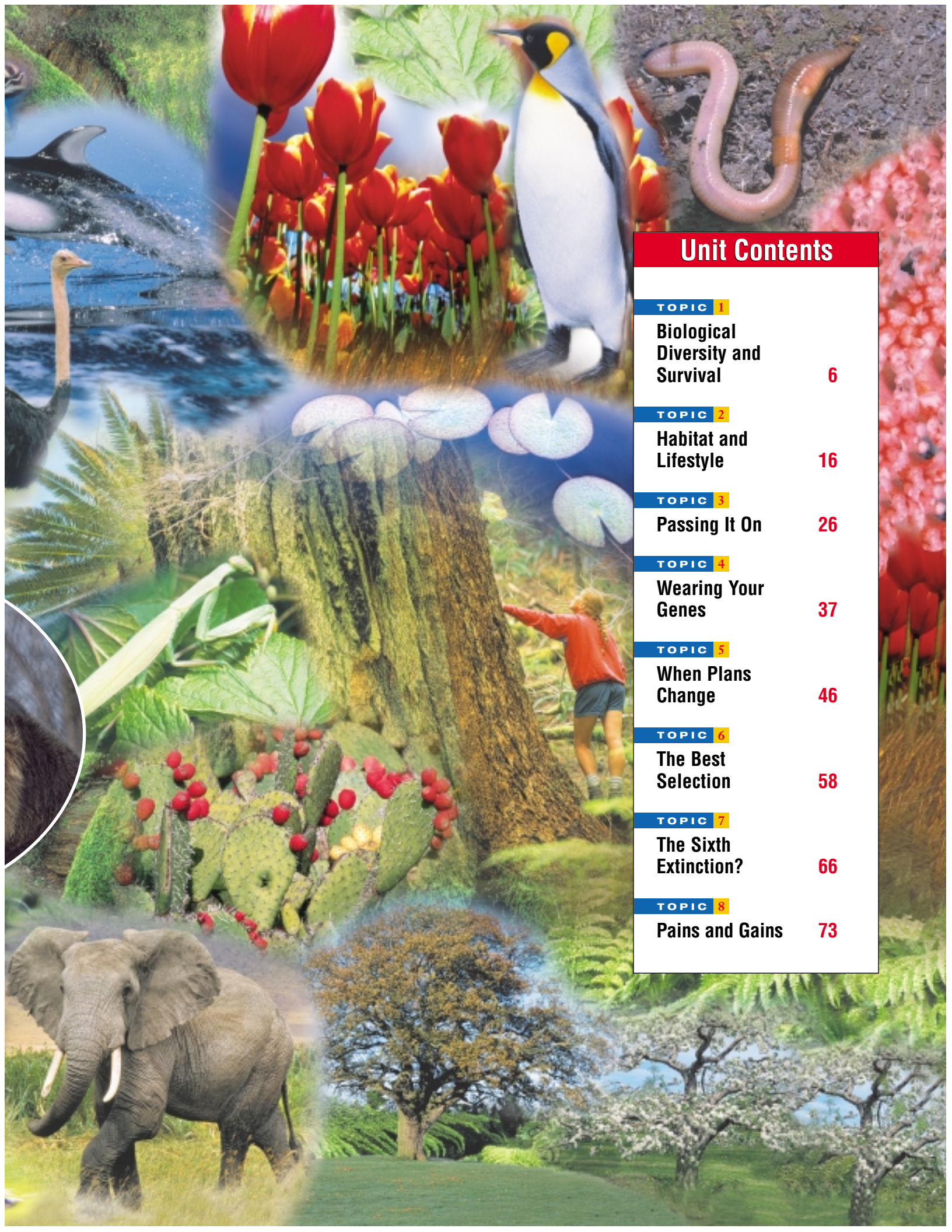
How would you feel if the grizzly bear pictured here were the last one left on Earth? Would it matter? Never before, since life appeared on this planet 3.5 billion years ago, have so many different species lived on the planet at the same time. From the simplest of cells to today's plants and animals, life has flourished and continues to express itself in amazing ways. E.O. Wilson, a famous U.S. biologist, has said that future generations may be able to forgive us for such disasters as using up Earth's stored energy supplies or destroying the economy. As terrible as these disasters would be, the environment could repair itself. Our one unforgivable act would be to contribute to the loss of Earth's biological diversity. This incredible variety of life that inhabits the world with us took millions of years to develop. Any losses could be permanent.

Biologists estimate the number of different plants, animals, and micro-organisms at about 15 million, but the number could be as high as 100 million. However, many species are at risk and the rate of extinction is increasing. What has caused this rate to increase? What can science teach us about the causes of extinctions and the importance of biological diversity?

In this unit you will:

- Learn about the diversity of life on Earth.
- Discover how living things pass on their traits to future generations.
- Investigate the impacts of human activities on biological diversity, and understand issues and decisions associated with future activities.





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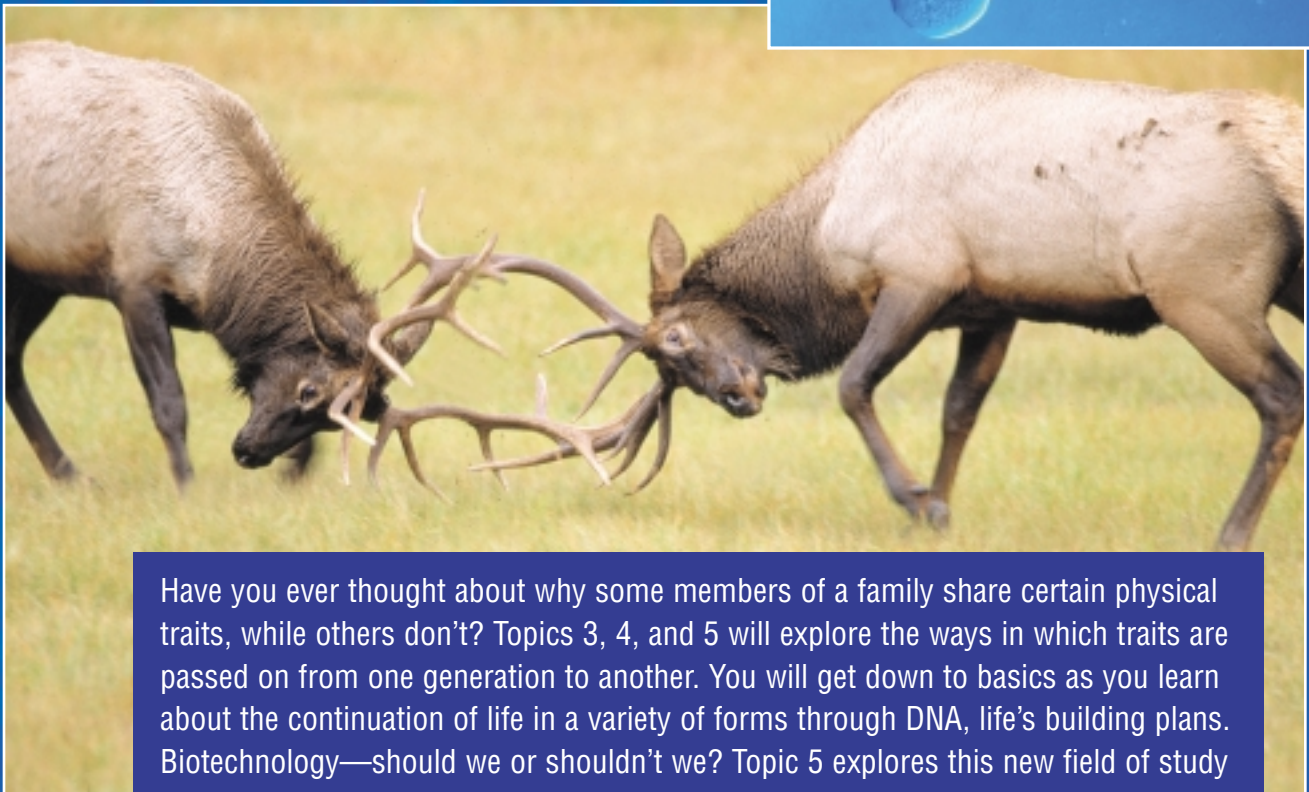
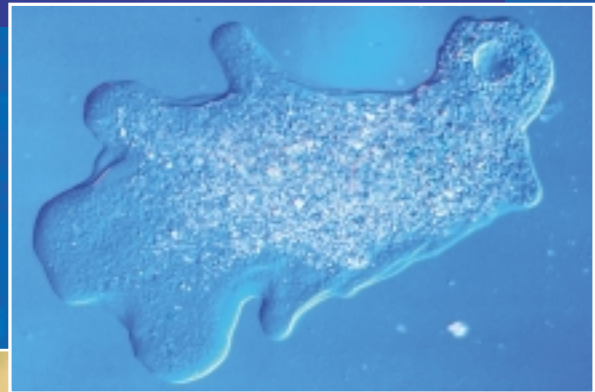
TOPIC 8

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**Focussing
Questions**

- What does biological diversity look like?
- How do organisms pass on their traits?
- How can we prevent the loss of biological diversity on Earth?

What could a single-celled amoeba and a towering Douglas fir tree possibly have in common? You'll find some answers to this question in Topic 1 as you explore life's diversity. You will see what makes life forms similar and what makes them different. You will also investigate the special features that allow some organisms to succeed and survive, while others do not. What role do organisms play in their habitats? What are their relationships with other organisms? Read Topic 2 to find out.



Have you ever thought about why some members of a family share certain physical traits, while others don't? Topics 3, 4, and 5 will explore the ways in which traits are passed on from one generation to another. You will get down to basics as you learn about the continuation of life in a variety of forms through DNA, life's building plans. Biotechnology—should we or shouldn't we? Topic 5 explores this new field of study and its implications.



How does your lifestyle affect biological diversity? Topics 6, 7, and 8 provide an opportunity to examine changes in organisms and our influences on these changes. What do we need to know about other organisms in order to make decisions that will positively affect them?



Read pages 82–83. “An Issue to Analyze: To Burn or Not to Burn?” As a class, you will be assigned to investigate whether to use controlled fires in protected areas. You can begin by collecting information about controlled fires, forest fires, and protected natural spaces.

- Check newspapers for related articles.
- Look for information on this topic on the Internet.
- Speak with natural resources managers and scientists.
- Keep a file of the pros and cons, and decide what scientific background you need in order to make an effective decision.



Biological Diversity and Survival



Figure 1.1 People, like all other life forms, display a wide variety of similarities and differences. What is it that makes us the same? What is it that makes us different?

No two people are alike. Look around your classroom. You recognize your friends because they have distinctive characteristics or features that make them different from everyone else. These differences or **variations** are a normal part of our lives. Variations are found not only in humans, but in all populations or groups of similar living things. The number and variety of organisms is called **biological diversity**. Why, and in what ways, might biological diversity be important?

Word **CONNECT**

You will often see the words “biological diversity” shortened to “biodiversity.” This word is known as a portmanteau word, which means it is formed by merging the meaning of two different words. Where did the term “portmanteau word” come from? Look up “portmanteau” in the dictionary and write an explanation in your notebook. Write down two other examples of portmanteau words that you know.



Figure 1.2 Can you see the variation among the individuals in the photograph above?

A Wealth of Diversity

Imagine a world without mosquitoes. That would be a good thing, wouldn't it – or would it? Besides the advantage of never suffering from another itchy mosquito bite, what other effects might there be? What would you need to know about mosquitoes in order to decide whether or not to try to eliminate them? How does the decision to eliminate one type of organism affect us and other species in both positive and negative ways? While people benefit from a wealth of biological diversity, so do entire ecosystems. What would happen to the food web if there were no more mosquitoes? Is there any way to predict the outcome?

As well, a great deal of our medicines come from biological sources. The Pacific yew tree, for example, is the source of a cancer-fighting chemical called Taxol. Before the discovery of Taxol, many people considered the Pacific yew a useless "trash" tree. Each time Earth loses a plant or animal species, are we also losing an important medicine?



Figure 1.3 The Pacific yew tree was once burned as trash. Now, the tree is highly valued for its life-giving properties. Should we burn trees that cannot be used for building materials or other products? What would be the overall result of this action?

Scientists still have a lot to learn about how the different members in natural communities affect one another. Some studies suggest that when several different types of plants grow in an area, the interactions among them promote their growth. This research supports the belief of many scientists that biological diversity is important for the health and survival of natural communities.

Skill

FOCUS

For tips on societal decision making turn to Skill Focus 8.

Pause & Reflect

Make a note in your Science Log describing what might happen if a mosquito-eating bird were introduced to Alberta from another part of the world.

Did You Know?

Conserving venomous animals may be good for our health! How? Venoms are complex mixtures of compounds, with various effects. For instance, some snake venoms and secretions from frogs have antibacterial action. Such venoms could be the source of new antibiotics.

Pause & Reflect

In the 1700s Swedish biologist Carolus Linnaeus developed the system of naming species that we use today. His published lists of all species known to science included the names of over 4000 plants and 7000 animals. Since that time his list has expanded to include the names of over 1.75 million species. This listing is still incomplete! Some scientists believe we may have identified only 1–2% of the total number of species alive today. How will we maintain this diversity of life without even knowing some species exist? Write your thoughts in your Science Log. To review classification systems, turn to Appendix A.

Did You Know?

Organisms are often grouped together as a species if:

1. They interbreed in nature.
2. Their offspring are able to breed.

Tigers and lions are separate species. They are not known to breed together in the wild. Tigers and lions have been bred together in zoos, but their offspring are infertile.

Word CONNECT

The word “flora” refers to all of the plant life in a region. What do you think “fauna” means? Check the dictionary to see if you are correct.

Variation Within Species

Take a look at the photographs on the first page of this unit. Each organism is an example of a different **species**, or one type of plant or animal. In general, organisms of the same species are similar in appearance. However, there is always variation within a species.

To many of us all dandelions look the same. If you were to take a closer look, you would see differences between individual dandelion plants. In some cases biologists can have difficulty deciding if two similar groups of organisms belong to the same species. On the other hand, there can sometimes be a great deal of variation within a species.



Figure 1.4 How many different species of dandelion are in this field?

Exploring Variation

All domestic cats belong to one species, *Felis catus*. However, these cats show many variations.

Materials

photographs of farm, house, or stray cats

Procedure

1. Along with your classmates, find a photograph of a domestic cat. You can look in magazines or newspapers, or you can use a photograph of your own pet.
2. Post the photographs (or photocopies) on a bulletin board in your class. Group the photographs of similar looking cats together.



Find Out ACTIVITY

What Did You Find Out? Analyzing and Interpreting

1. What are the major characteristics for each group of cats in the photographs?
2. How do purebreds differ from other domestic cats?
3. **Thinking Critically** Explain how the different types of cats might be suited to different environments.
4. **Thinking Critically** Which cats are most likely to be rat-hunters? Which cats are most likely to hunt mice?

A Classroom of Differences

Your school provides an excellent place to investigate variations or differences within a group of similar living things. In this case, the population consists of the students in your class and the variations are physical characteristics that you can easily measure.

Materials

tape measure
chalkboard

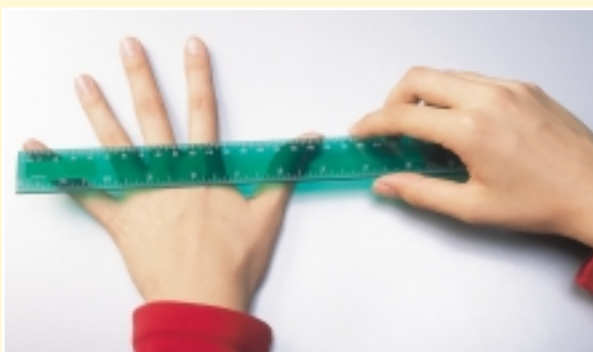
chalk and pencils
flipchart paper

Procedure ✨ **Performing and Recording**
✨ **Communication and Teamwork**

1. Working in pairs, measure each student's height to the nearest centimetre and record each measurement on the chalkboard.



2. Stretch out your hand. Measure the distance (to the nearest millimetre) from the tip of the thumb to the tip of the little finger of your outstretched hand. Again record all results on the chalkboard.



Skill FOCUS

For tips on how to prepare graphs, turn to Skill Focus 10.

Find Out **ACTIVITY**



3. Measure, or have your partner measure, the distance around your left wrist to the nearest millimetre at the point where the wrist bone sticks up. Record your results on the chalkboard.



4. Write all of the class results in your notebook and record the class results for each set of measurements on the chalkboard or separate pieces of flipchart paper. Show each measurement and the number of students that share it. Put the measurements into groups. For example, put the number of students that have heights between 176–180 cm into one group.
5. Prepare a histogram for each of your three measurements. You may use a computer to record and sort the data and draw the graphs.

What Did You Find Out? ✨ **Analyzing and Interpreting**

1. Are there any similarities between the graphs?
2. Can you explain the shapes of the graphs?
3. Is there any reason why a graph for right wrist measurements might be different from left wrist measurements?
4. What are some of the factors that might cause variations between you and your classmates?

DidYouKnow?

Taxonomists classify things, such as living organisms. Sometimes taxonomists have lengthy discussions about whether or not two organisms belong to the same species. For example, Bullock's and Baltimore orioles were once considered separate species. Later, the birds were re-classified as a single species, the northern oriole. Recently, scientists split the grouping once again.

Why might it be important to know whether or not two types of organisms belonged to the same species?



Variation Among Species

Many organisms show similar characteristics: insects have six legs, birds have feathers, and mammals nurse their young. Even so, there are many species of each of these creatures. How did so much variety come about? To answer this question scientists have looked to areas of the world that are rich in various species of plants and animals. Great biological diversity often occurs on islands, or other places where animals and plants have been isolated for a long time.

Many studies on similar species, such as wild cats like the lynx, bobcat, and cougar, indicate that all came from a common ancestor. Over time, one type of cat evolved into a variety of similar yet separate species. This process is called **speciation**. Much of Earth's biological diversity is due to speciation.

Figure 1.5 The cougar (A), lynx (B), and bobcat (C) are classified in the same family of animals. However, each cat is a different species.

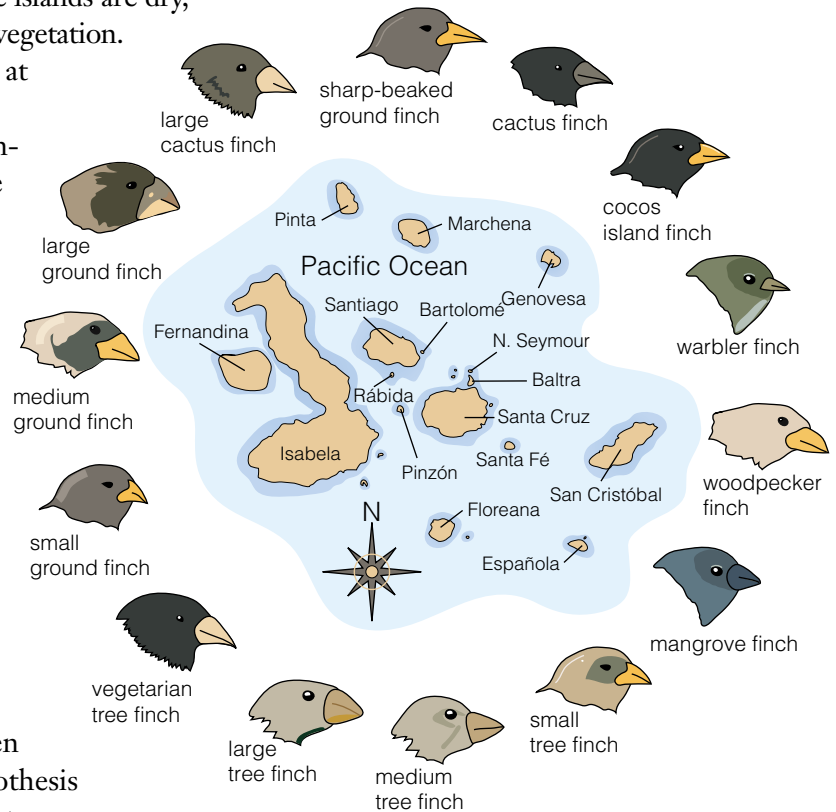


The Galápagos Finches

Think About It

The Galápagos Islands are located on the Equator in the Pacific Ocean about 1000 km from the coast of Ecuador, South America. The 13 main islands and several smaller islands are volcanic in origin and contain a number of ecosystems. At lower elevations the islands are dry, and bushes, trees, and cacti make up the vegetation.

Humid forests grow on the larger islands at higher elevations. On his stop at the Galápagos, biologist Charles Darwin gathered specimens of birds from some of the islands. He noticed that there were a large number of closely related finches, each of which was a distinctive species. Darwin counted 13 species of finch from the Galápagos, and one from Cocos Island, located 830 km north of the Galápagos. In this investigation you will examine Darwin's finches and how the islands gave rise to the variety of different species.



What To Do

- 1 Study the diagram of the different finches. What is the major anatomical difference between the species illustrated? Form a hypothesis that might explain the difference between, for example, the woodpecker finch and the cactus finch.
- 2 Ground finches that depend primarily on seeds as a source of food live primarily on solidified lava beds. What kinds of habitats might be suitable for some other species of finches? If information is available, match these habitats to particular islands.
- 3 Research the different areas on the Galápagos Islands. What are the conditions like in each of these places?

Analyze

1. Did your research findings support your hypothesis?
2. What problems might you encounter when developing a hypothesis from an artist's drawing of an organism?

Off the Wall

Geckos are small lizards with some strange habits! They can walk upside down across the bottom of a leaf without falling off. As they walk, their feet uncurl, flattening tiny projections called setae. Intermolecular forces of attraction bond the setae to the leaf's surface.



INTERNET CONNECT

www.mcgrawhill.ca/links/sciencefocus9

Madagascar is an island that lies off the coast of Africa. The unique species on Madagascar attract biologists from around the world. Unfortunately, many of these species are endangered. Choose one species from Madagascar and find out what makes it one of a kind. What effect would the loss of this species have on other species in Madagascar? Create a poster by hand or on a computer that shows this plant or animal's special features. To begin your research, go to the web site above, and click on **Web Links** to find out where to go next.

Variations for Survival

As you may remember, every organism has adaptations that enable it to survive in its environment. There are many ways to solve a problem, such as obtaining food. As a result, a great variety of adaptations can be seen in living things. Examine the photographs shown below. Most plants obtain nutrients through their roots. The pitcher plant has an unusual way of obtaining the nutrient nitrogen. This plant obtains nitrogen from insects that it traps in its pitcher shaped leaf. This physical feature is a **structural adaptation**. **Behavioural adaptations** include the owl hunting at night and the migration of birds from the tropics to their nesting sites in the Far North. Variation in animal behaviours is not only interesting, but as you will learn in Topic 2, different behavioural adaptations allow each species to have its own place in an ecosystem.

Math CONNECT

The rufous hummingbird migrates farther than any bird its size. Each year rufous hummingbirds migrate from Mexico or the southern United States to summer homes in the northwestern states and western Canada, including southwestern Alberta. If a rufous hummingbird travels 1800 km, it will travel a distance 2×10^7 times the length of its body. How big is the rufous hummingbird? Give your answer in centimetres.



Figure 1.6 The pitcher plant may be found in boggy areas of northeastern Alberta and near Edson, typically in nitrogen-poor soils. Insects that are attracted to the plant slip down the smooth lip of the leaf into a liquid at the base. There they drown and are digested by the plant.



Figure 1.7 Most owls are nocturnal. This behavioural adaptation goes along with certain structural adaptations. What might some of these structural adaptations be? How do nocturnal owls differ from birds such as magpies that feed during the day?

The Value of Variation

Western forests are under attack. The mountain pine beetle is a pest of the lodgepole pine, a very common tree in the Rocky Mountains. A mountain pine beetle infestation can destroy a forest that is made up mainly of lodgepole pine. In contrast, areas with greater biological diversity are often more able to tolerate changes in the environment. A forest with many tree species has a good chance of staying healthy in spite of disease. If a disease destroys only one species of tree, the other trees will remain unharmed.

The lodgepole pine is an important source of timber in Canada. Finding a lasting solution to the mountain pine beetle problem could have economic benefits. Mature lodgepole pine are less resistant to infection, so one solution is to burn areas with older trees. What information would help you decide if burning these trees would be the best action to take?



Figure 1.8 This forest has been hit by a mountain pine beetle infestation. The beetle bores into the bark, carrying the spores of the bluestain fungus with it. Fungal infection and damage caused by the beetles eventually kill the trees.



Measuring Biological Diversity

To determine the biological diversity of an area, biologists use a measurement called the **diversity index**. This measurement compares the diversity of species in an area with the total number of organisms in the same area. It is normal for some places to have a higher diversity index than others.

The diversity index can be used to check the health of an ecosystem. For example, a river with many different kinds of organisms living in it would have a high diversity index. The river would also likely be healthier than a river that supports only a few types of organisms. Why would this be true? In fact, the large number of different species in a healthy river prevents the population of any one type of organism from becoming too great. A polluted river may have large numbers of the same organism. However, this river would support only the few species that are able to live in polluted conditions. You may remember that when rivers become polluted with sewage, algae can grow out of control, killing off other species. Such a river would have a low diversity index.

INTERNET CONNECT

www.mcgrawhill.ca/links/sciencefocus9

Why is there a new flu virus every year? It turns out that the flu virus is a master at variation! To learn more about the flu virus, visit the above web site. Go to the web site above, and click on **Web Links** to find out where to go next. Write a paragraph that explains why the human body has trouble recognizing the flu virus.

Build a model of the flu virus using modelling clay or create a computer model using modelling software to help illustrate your answer.


DidYouKnow?

The influenza outbreak of 1918–1919 killed 50 000 people in Canada alone. In just one year, the pandemic (a global outbreak) killed 25 million people worldwide. Yet 18 months after the disease was reported, it disappeared. It now seems that the virus ran out of susceptible people. Whether or not someone is likely to catch a disease can depend on the person's age, genetics, or general health. The fact that some people get diseases and others do not is another example of variation. Even today, scientists are only beginning to understand why some people get sick and others do not.



Remember to keep planning for your Unit 1 Issue Analysis. Think about the forum as you work through each Topic in this unit.

 Initiating and Planning

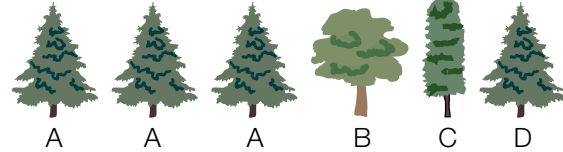
 Performing and Recording

 Analyzing and Interpreting

 Communication and Teamwork


Using the Diversity Index

In this investigation you will begin to explore the biodiversity of an area by focussing on one small piece of it. You will focus in even further by studying tree diversity only and developing a tree diversity index.



Question

How can the diversity index be used to measure diversity in different areas?

Hypothesis

State a hypothesis about the diversity of trees in natural areas compared to areas of human activity. Predict which of the areas in your study will have a higher tree diversity index.

Apparatus

notebook pen
ball of string metre sticks

Procedure

- Working in a group, **decide** upon two different study areas. One should be an area of human activity (such as a school yard or street) and the other a natural area (such as a community park).
- Using a string line 25 m in length, measure a path in the area you have chosen to study. Imagine a carpet that extends out one metre on either side of your string line. Beginning at one end of the string line, start to count all of the trees with a trunk that is inside or at least touches your two metre-wide carpet. (You might want to use your metre stick to measure in a case where you're unsure whether a tree is inside or outside the area.)
- Record** the first tree in the area as "A." If the next tree is the same as the first, **record** it as another "A." If the second tree is different from the first, **record** it as "B." Every time you come across a tree that is different from the last one, **record** a new letter (C, D, etc.). It is the change from one kind of tree to another that indicates diversity. Each change starts a new "run" of data. (See the example above.)
- Determine** the number of runs in your trial by counting how many different letters you have recorded. There were four runs in total in the example provided (AAABCD).

- Count** the total number of specimens (trees) in your trial. In the example trial there were six specimens.
- Copy the data table below in your notebook. Complete the table.

Data Table	
Number of Runs =	
Number of Specimens =	
Diversity Index =	$\frac{\text{Number of Runs}}{\text{Number of Specimens}} =$

- Repeat steps 2–5 for the second study area.

Analyze

- Which area has a higher tree diversity index?
- How did your results compare with those of other groups in the class?

Conclude and Apply

- The closer the diversity index is to one, the more diversity there is within an ecosystem. The smaller the diversity index, the less diversity there is in an area. Which of your two sites had more tree diversity?
- Did your observations support your hypothesis? How could you design an investigation to test for variables that might affect tree diversity in different areas?

Career **CONNECT**

The Nature of the Job

Imagine spending your working day walking along quiet woodland trails. Interpretive naturalists do just this! They lead nature walks and explain the natural environment to others, from young children to adults. Most naturalists work at conservation areas, wildlife reserves, government parks, or for conservation groups. Through nature walks, they help visitors experience nature first-hand. Naturalists also give talks, prepare displays, and sometimes write informational leaflets. They may even take care of animals or help maintain the habitats of local wildlife.

In this job, a love of both the outdoors and working with people is essential. Most interpretive naturalists are good communicators and have a post-secondary science degree. This may be either a Bachelor of Science degree from a university, or a college degree in outdoor education, wildlife studies, ecology, wildlife biology, or a related subject.

Can you picture yourself as an interpretive naturalist? Make two lists: one listing the parts of this job that appeal to you, and the other listing the parts that do not. Then complete the statement below using as many points as possible that apply to you. Your points can be as simple as “will not have to wear business clothes” or “can travel.” Choose five points that you feel will be the most important to you when choosing a career.

I am interested in a career in which I . . .



TOPIC 1 **Review**

1. Write your own definition for biological diversity.
2. Think about a time you have seen a flock of Canada geese (*Branta canadensis*) flying overhead. If you could examine the geese closely, would they look identical? Explain your answer.
3. **Apply** Name a situation in which it would be useful to determine the diversity index of an area.
4. **Thinking Critically** Invent an animal that is perfectly adapted for living inside the school gym.
5. One variation seen in birds is the placement of the eyes. Shown here is the American woodcock, which feeds on worms in the ground. Its eyes are located virtually on the top of the head. Explain how this variation may be a useful adaptation.
6. The bubonic plague, or Black Death, kills people every year. However, it was devastating when it swept through Europe in the sixth, fourteenth, and seventeenth centuries. It killed 90% of the people exposed to the germ and resulted in the deaths of approximately 137 million people. Why was everyone not killed by the Black Death?

Pause & Reflect

Biologists can use diversity indexes to monitor the health of Alberta ecosystems. What types of human activities could lower the diversity index of grasslands? How would you decide if these activities should be continued? Write your ideas in your Science Log

