



Why do some people have blue eyes while others have brown eyes? What makes some people red-heads and others brunettes? Are some people born great musicians, or do their talents simply develop with practice? We know that certain characteristics are passed on from one generation to another, but sometimes strange things seem to happen. You may know someone who is the “jock” of her family, while her brother can’t throw a ball straight no matter how hard he tries. For thousands of years, people have tried to explain how parents’ traits are passed on to their children. Why are some characteristics passed on and others are not? Does one parent have more influence than the other? Why are some traits more common than others? Are all characteristics passed on in the same way?

The passing on of traits from parents to their offspring is called heredity. The branch of science that deals with the study of heredity is called **genetics**.



Figure 1.36 There is a wide range of human skin colours.

Two Kinds of Inherited Variation

At the beginning of this unit you looked at variation within the students in your class in terms of characteristics like height and hand span. These are examples of **continuous variation**. Many human characteristics such as skin colour, height, and hair colour show this form of inheritance. There is a range of possibilities for each of these traits, like percentages given on a report card.



Figure 1.37 We may think of people as tall or short, but people can fall anywhere between these two extremes.

DidYouKnow?

How many people do you know who are left-handed? Do you think being left-handed is an inherited trait? Actually, no one knows for sure — not even scientists!

Other characteristics are examples of **discrete variation**. These characteristics have a limited number of possibilities. For example, the ability to curl your tongue is genetic. There are only two possibilities: you can do it or you cannot. The ABO blood group is another example of a discrete genetic characteristic. In this case there are four possibilities: blood group A, B, AB, or O. Sex (male or female) is another example of discrete variation. Discrete variation is like a report card that uses letter grades such as A, B, C, D, or F. Our knowledge of genetics is focussed on “discrete” characteristics because they are easier to understand and test.



Figure 1.38 Tongue rolling is a genetic trait.

Find Out **ACTIVITY**

Observing Human Characteristics

Every person is a collection of characteristics, or traits. Some traits occur in distinct forms. For example, your hairline can be either smooth or pointed. In this activity, you will observe some traits displayed by your fellow students.

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

1. Study the forms of each trait shown in the illustrations. Copy and complete a table such as the one below, using the total number of students in your class.

Characteristic	Middigital Hair		Tongue		Thumb		Earlobe		Hairline	
	Hair	No Hair	Can Roll	Cannot Roll	Bent Back	Straight	Attached	Detached	Smooth	Pointed
Student 1										

2. In your table, check off which of the two forms of each trait each class member displays. Plot your results on a bar graph.

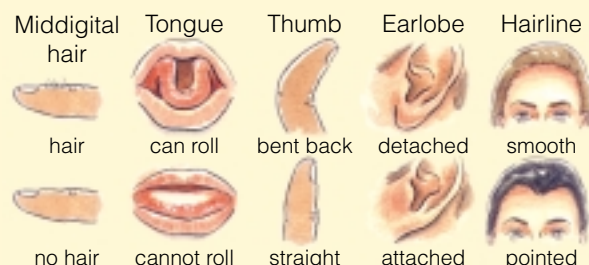
Skill

FOCUS

To review how to prepare a bar graph, turn to Skill Focus 10.

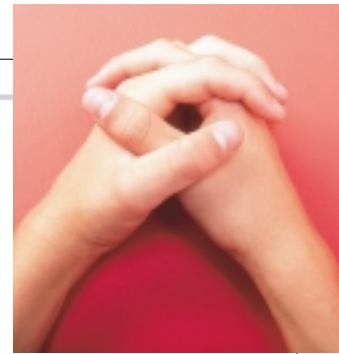
What Did You Find Out? ✨ **Analyzing and Interpreting**

1. Are some forms of a trait more common than others?
2. What can you conclude about the way traits vary among your class members? Why do you think some students show one form of a trait while others show a different form?
3. Do you think most traits are continuous or discrete?



Pause & Reflect

Bring your hands together and interlock your fingers. Which thumb is on top? Try bringing your hands together with the other thumb on top. For most people this is very uncomfortable. Believe it or not, the tendency to bring your hands together in a particular way is a genetic trait. Some people will put the left thumb on top while others will put the right thumb on top. Unlike most genetic traits that we know of, this one is not a structure that is inherited but a behaviour. If this simple behaviour is genetically controlled, what other behavioural traits are also controlled this way?

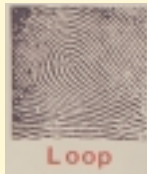


Dermal Ridge Counts

Did you know that fingerprint patterns are inherited? Yours will look something like one of the types shown here. Because fingerprints show continuous variation, your fingerprints may have any number of ridges. A dermal ridge count is simply a count of the ridges in your fingerprints.



Arch



Loop



Whorl

Materials

magnifying glass
inkpad with non-toxic ink
unlined paper
chalk

Procedure

- Performing and Recording
- Communication and Teamwork

1. Press your fingertips on the inkpad. Then press your fingertips onto the paper without smudging the prints. Press your fingertips onto the paper a second time if you used too much ink for the first set. Wash your hands when you are finished.
2. Use a magnifying glass to study your fingerprints. If possible, count the ridges for every fingerprint. For an arch fingerprint, record the number of ridges as zero. Record your totals in your notebook.
3. Add the numbers for all ten fingerprints. This will be your total dermal ridge count. Record this number on the chalkboard along with the other students' results.

Find Out ACTIVITY



4. Group the data into categories: everyone's total dermal ridge count should fall into one of the groups. Count the number of students in each group. For example, you may note that there are five students with total dermal ridge counts between 140–159, and three students with counts between 160–179. Draw a histogram showing the range of dermal ridge counts in your class.

What Did You Find Out? Analyzing and Interpreting

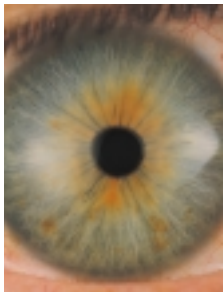
1. Which one of the three kinds of fingerprints do you have?
2. What is your dermal ridge count? How does it compare with the counts of other students?
3. Why do you think there are so many different dermal ridge counts? (Hint: Fingerprint patterns are inherited from both parents.)
4. Is there a difference between the total dermal ridge counts of the girls versus the boys in your class? What is the difference between the highest and lowest dermal ridge counts for the boys? The girls?
5. Where in your histogram do most counts fall? How many people have counts at either end of the graph?

Computer CONNECT

Use a spreadsheet application to sort the raw data. Group the data into categories. Then use the spreadsheet to generate a computer graph.

Pause & Reflect

In general, brown eyes are dominant to blue eyes. However, eyes come in many shades of blue, brown, and even green. The person in this picture has hazel eyes, which are a mixture of green and brown. How can you explain the variety in human eye colour? In your Science Log, make a note of this and other questions that come up as you read through Unit 1.



Math CONNECT

Asparagus has a curious effect on people: after eating asparagus, people excrete bad-smelling compounds in their urine. However, not everyone is able to smell these compounds. Scientists believe that the ability to smell these compounds is a dominant trait. In a study conducted at a university, 18 out of 81 students could smell the bad-smelling compounds in urine. What was the frequency of “smellers” in the university class? What was the frequency of “non-smellers” in the class?

Dominant or Recessive?

Children inherit their genes from both parents. However, children do not always show their parents’ traits. During sexual reproduction, traits like tongue rolling are passed from parents to offspring. If one parent gives the characteristic for tongue rolling and the other parent gives the “non-roller” characteristic, the child will be able to roll his or her tongue. Tongue rolling is an example of a **dominant** characteristic. Non-rolling is a recessive characteristic. A dominant characteristic shows up when mixed with a **recessive** characteristic.

Many people connect the frequency of a characteristic with whether it is dominant or recessive. People often assume that if a trait is widespread in a population (has a high frequency), then it must be dominant. However, dominance and frequency are not the same. The frequency of a trait can vary from population to population. In some populations almost everyone has the recessive traits of blue eyes and blond hair. Other populations are made up entirely of people with brown eyes and black hair. Having six fingers is a dominant trait, but it is relatively rare in human populations.



Figure 1.39 Polydactyly (having six fingers) is a dominant trait.

Word CONNECT

Break the word “polydactyly” into two parts. “Poly” means “many” and “dactyl” refers to fingers. Thus, “polydactyly” really means “many fingers.” Write down some other words that begin with “poly.” Look up more words in the dictionary to add to your list.

off the Wall

Have you ever heard of a white black bear? People are not the only organisms to show dominant and recessive traits. The Kermode bear of British Columbia is a rare type of black bear (*Ursus americanus*). This bear has white fur, which is a recessive trait.



Inheritance of Human Characteristics

Think About It

There is no single rule that explains how human characteristics are passed on from parents to their children. Some inherited characteristics seem to be “stronger” or dominant and more likely to show up than others. In this investigation you will look at different traits of one child and his or her parents. Your teacher will supply you with images of the family members.



What to Do

- 1 Earlier you observed various human traits among students in your class. Choose four human characteristics (or more) and create a chart, such as the one shown here. Intermediate characteristics are ones that are in between the traits of both parents.
- 2 Compare the characteristics of the child with those of the parents. Record the data on your chart.

Characteristic of child	Same as both parents	Same as one parent	Intermediate characteristic	Different from both parents
dimples				
medium height				
attached earlobes				
pointed hairline				
left thumb on top of clasped fingers				
no middigital hair				
brown hair				

Analyze

1. Which characteristics do you think are discrete and which ones are continuous?
2. Compare your results with other students. Did other students get the same results as you did? Give examples.
3. Did other students get different results from yours? Give examples.
4. What conclusions can you draw from these results?
5. Which of the characteristics that you have studied do you think are dominant and which ones are recessive?
6. **Apply** How could you find out if a characteristic was dominant or recessive?

Nature Versus Nurture

Not all characteristics are inherited. Some characteristics depend entirely on the environment. For example, scars and injuries are not caused by genetics. In addition, clothing, hairstyle, makeup, and even cosmetic surgery can alter a person's characteristics. However, a person's weight is due to a combination of factors such as genetics, diet, and activity level. The interactions between a person's genetics (nature) and the environment (nurture) are complex and not well understood. The balance between the two is continually being debated. Some believe that "all people are created equal." They argue that a person's characteristics are due to his or her opportunities and choices. Others believe that heredity is responsible for all of someone's traits, including a person's likes and dislikes. The debate on the roles of heredity and the environment in determining human characteristics continues today.

Modern science has tried to separate traits that are inherited from those that are influenced by the environment. One way that has been used is to study the similarities and differences between identical twins who have been separated at birth and raised in different environments. Since identical twins have the same genetic information, they share many inherited traits. Some of the results of these studies are highly controversial and hard to explain. In one example, a pair of identical male twins were separated when

they were five days old. When they were reunited, many years later, it turned out that they were both volunteer firefighters, had the same type of moustache, and wore the same style of sunglasses. Some people argue that examples such as this show that many complex behaviours are inherited.

We now know the environment and our genetics interact to produce many of our characteristics. At this stage, however, we still have a lot to learn.



DidYouKnow?

Why is it that some people cringe when they hear a wrong note, while others don't even notice? Studies show that identical twins tend to have the same ability to recognize mistakes in tunes. This means that, to some extent, the ability to recognize wrong notes is inherited. Studies also show that musical experience plays a role in this ability.



DidYouKnow?

Body size is not always a matter of genetics. Women who smoke while pregnant tend to have smaller babies than women who do not smoke during pregnancy. Smaller babies may have more health problems.

Changing Our Genetic Information

Our genetic information itself can be changed by factors in the environment and by random errors. These changes to DNA, the genetic material, are called **mutations**. Mutations can cause changes in the structure of organisms, including people. X rays, ultraviolet rays, cosmic rays, and some chemicals are called **mutagens** because they cause mutations. Sometimes mutations have little or no effect on an organism, but often they can disrupt the complex interactions of chemicals and cells that are necessary for life.

In some cases, mutations in individual cells cause cancer. Cancerous cells go through rapid cell divisions and do not develop in the same way that healthy cells develop. The cancerous cells can interfere with nearby cells and prevent the body from performing normally.

If mutations occur in the DNA of reproductive cells (sperm or eggs), the changes may be passed on from parent to child. These changes in the genetic material increase the variation within a species. Usually the mutations result in variations that are unfavourable. Occasionally, however, the new variations are harmless or even beneficial.

Figure 1.40 The dark spot shown in this photograph is skin cancer. About 20 000 Canadians develop skin cancer every year, and 500 to 600 die from it. Which environmental factor contributes to the development of skin cancer?



DidYouKnow?

In 1986 a nuclear reactor exploded in Chernobyl, Ukraine. Some of the people exposed to the highest levels of radiation in this disaster were the clean-up crew. Later, some of the clean-up crew had children. It is now known that these children have high rates of mutations in their genetic material. These mutations were inherited from their parents.

DidYouKnow?

Sickled, or deformed, red blood cells are caused by a mutation. Sickle cells are a recessive trait, and people with this trait are very ill. However, when the sickle-cell trait is mixed with the dominant normal-cell trait, the mutation is beneficial. In this case, people with the mutation are less likely to catch the disease malaria.

Reducing Cancer Risks

Our risk of getting some cancers, such as melanoma, or skin cancer, can be greatly reduced by staying out of the Sun during peak periods of ultraviolet radiation. Making other simple lifestyle choices, such as not smoking, can also greatly reduce our risk of developing lung or throat cancer.

Procedure

- ✦ Initiating and Planning
- ✦ Analyzing and Interpreting
- ✦ Communication and Teamwork

1. In your group, brainstorm a list of questions related to cancer and lifestyle. For example: What chemicals are thought to cause cancer? What are the most common types of cancer in Canada? What are the rates of these cancers in women and men? How

Find Out **ACTIVITY**

do these compare with cancer rates in your community? What lifestyle changes could you make to reduce your risk of getting these cancers?

2. Next, brainstorm a list of possible resources and institutions in your community where you could get information about cancer. Make a list of web sites and collect pamphlets, if they are available.
3. Use your information to design a web site or create a poster by hand or on a computer. Present your findings to the class. You may electronically send your poster to other schools for display.

Causes of Human Variation

Think About It

You have learned that some human characteristics are inherited and others develop as a result of environmental factors. How do genetics and the environment combine to increase human variation?

What to Do

Make a chart listing at least 10 of the human characteristics that have been mentioned in this Topic. Like the sample chart shown on the right, your chart should include columns for Nature (genetics), Nurture (environment), Both, and Unknown. Use the information in this Topic and other sources to decide if the characteristic is controlled by genetics, the environment, by a combination of both, or if this information is not known.



Human Characteristics	Nature	Nurture	Both	Unknown
left handedness				✓
skin colour			✓	

Analyze

1. According to your data, what is the most important factor that determines human characteristics? Explain.
2. Make a bar graph to illustrate your data.

Conclude and Apply

1. Do you think all types of human characteristics are represented on your chart? Explain.
2. Why are some characteristics difficult or impossible to put into categories?

Extend Your Knowledge

3. Choose a human characteristic that is not mentioned in this Topic and write a short paragraph explaining why it occurs in some individuals.
4. Reflexes are behaviours that are controlled by the human nervous system. Research some examples of reflexes and design an experiment to find out if reflexes vary in human populations.

Career **CONNECT**

The study of genetics has allowed us to understand our world and ourselves in new ways. Today, there are many careers that relate to genetics. A partial list is provided here. Brainstorm with your classmates to add to the list. Then choose the career that most interests you and research this job. To find out about this career, you may speak with someone who does this job, or conduct research on the Internet or in the library. Write a paragraph about some of the things you would do if this were your career.

Careers in Genetics

lab technician

bioinformatics specialist

genetics counsellor

evolutionary biologist

human genetics professor

bacterial genetics researcher

legal adviser on issues in genetics

philosopher/ethics adviser

biotechnologist

INTERNET **CONNECT**

www.mcgrawhill.ca/links/sciencefocus9

To begin your research on a career in genetics, go to the web site above. Click on **Web Links** to find out where to go next. Find out what kind of education you would need to follow the career you are researching. How many years of study would be needed to do this job? Present your findings to the rest of the class.

Pause & Reflect

Red-green colour blindness, the inability to identify certain shades of red and green, is a minor genetic disorder. Many others are more serious. Do you think everyone should be tested for possible genetic disorders? Do you think none should be? Think about these questions and write your thoughts about this complex issue in your Science Log.



TOPIC 4 **Review**

1. Is the variation in weight in human populations an example of discrete or continuous variation? Explain your answer.
2. Is human skin colour purely an inherited trait? Explain your answer.
3. **Thinking Critically** If you one day decide to have children, which of your traits are your children likely to inherit? Which of your traits are they unlikely to inherit? How do you know?
4. Describe what happens when cells divide uncontrollably.
5. Why do scientists use studies of twins to learn about human characteristics? Consider the study of the twin firefighters. What are some reasons that could explain why these two men would choose the same style of haircut and sunglasses?
6. **Thinking Critically** Evidence suggests that the tendency to develop certain cancers is genetic. How is it possible for someone who has inherited this tendency to live a long, healthy, and cancer-free life?