Wonders

Literature Anthology

McGraw Hill Education

Genre • Expository Text

THE STORY OF SNOW

The Science of Winter's Wonder

by Mark Cassino with Jon Nelson
illustrations by Nora Aoyagi

Essential Question

Where can you find patterns in nature?

Read about how patterns in snow crystals form.

Go Digital!

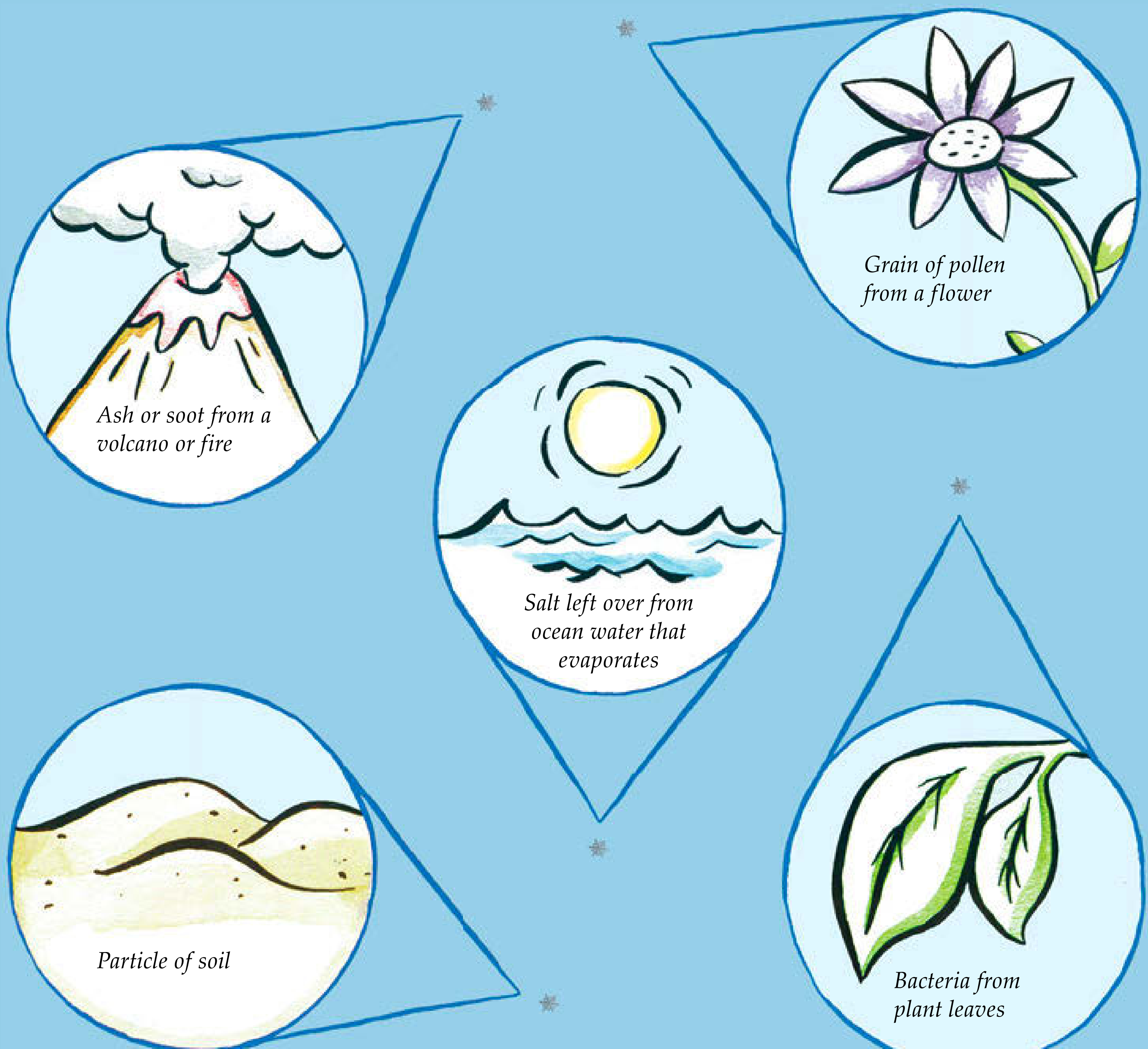
Our story starts on a winter day,
high up in the sky,
in a cloud that is
very, very cold.

This is the story of snow.

Clouds are mostly made of air, which we can't see. Then there is water vapor (water in the form of a gas), which we also can't see. We do see the billions of tiny droplets of liquid water and ice crystals that float in the cloud. They reflect light, making the cloud **visible**.

Snow begins with a speck.

Clouds are mostly made of air and water, but there are also bits of other things, like tiny **particles** of dirt, ash, and salt. Even living bacteria can float in the wind and end up in a cloud. A snow crystal needs one of these "specks" to start growing. These specks are all much smaller than the eye can see. But if you could see them...



The speck becomes the center of a snow crystal.

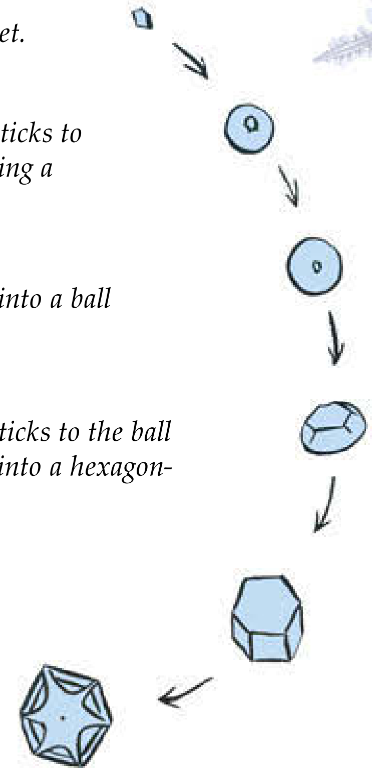
When a speck gets cold enough, water vapor will stick to it. If you had a microscope that could see such small things, here is what you would see...

Water vapor sticks to the cold speck, making the speck wet.

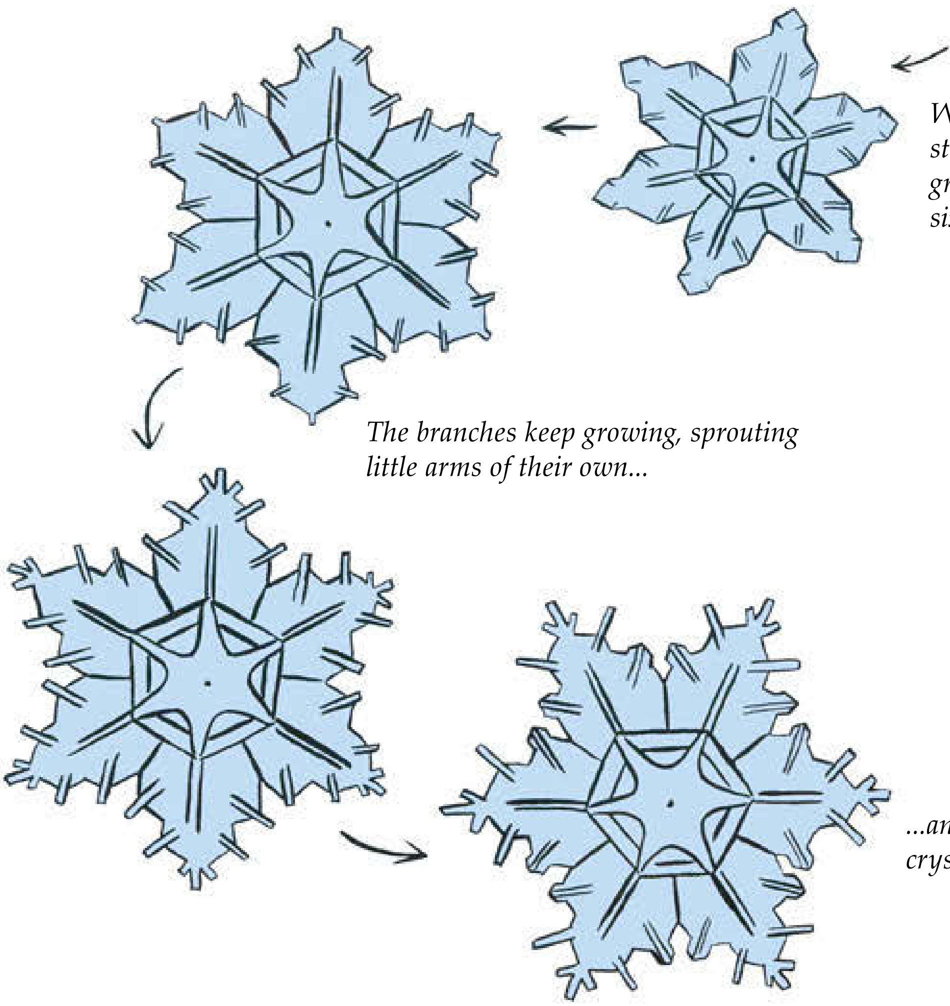
More water vapor sticks to the wet speck, forming a water droplet.

The droplet freezes into a ball of ice.

More water vapor sticks to the ball of ice, and it grows into a hexagon-shaped ice crystal.

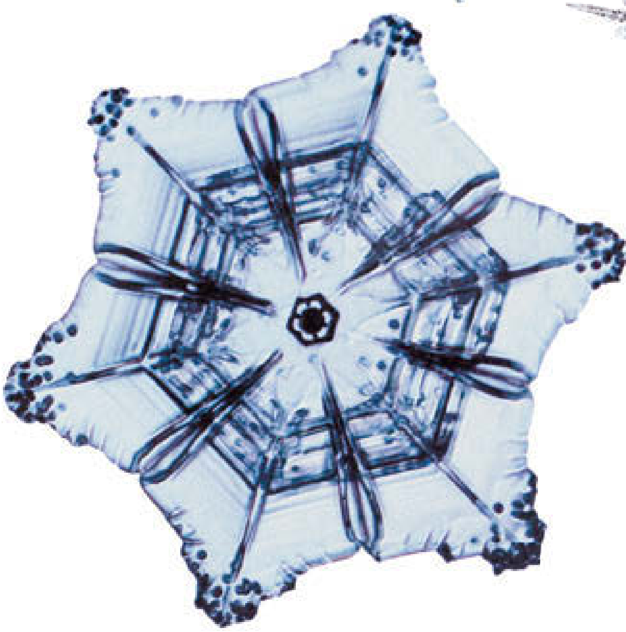


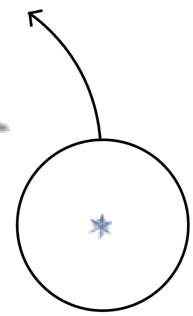
Water vapor continues to stick to the crystal. Faster growth on the corners causes six branches to sprout.



The branches keep growing, sprouting little arms of their own...

...and a beautiful snow crystal is born!





Actual size!

These photographs of real snow crystals are shown much larger than their actual size. The crystals were collected during many different snowfalls.

As the snow crystal gets bigger and heavier, it starts to fall to earth. It keeps growing as it falls through its cloud, taking on its own special shape. The shape depends on how *wet* the cloud is and how *cold* it is. A snow crystal can start to grow one way, but then grow another way when it passes through a wetter or colder part of its cloud. The crystal stops growing soon after falling below the clouds.

STOP AND CHECK

Ask and Answer Questions How does a snow crystal take shape? Go back to the text to find details that support your answer.

Snow crystals can be stars.

One common snow crystal shape is the star. Star-shaped snow crystals usually have six arms reaching out from a center point. The center point is the home of the speck that started the crystal. The six arms look alike, but they are almost never *exactly* alike.

Parts of a snow crystal can break during the fall to earth, causing the arms to look different.

Star-shaped snow crystals are called dendrites *(which means "tree-like shapes"). They form when a cloud is full of* **moisture***, and when the temperature hovers around 5 degrees Fahrenheit (-15 degrees Celsius).*

Snow crystals can be plates.

Plate crystals are thin like star crystals, but they don't have arms. The simplest kind of plate is a hexagon with six straight sides. More complicated plates have points where arms almost grew.

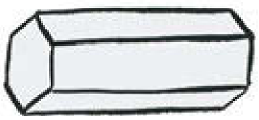
This is the simplest kind of plate crystal, a hexagon. Plates form when there's not enough moisture in the cloud for stars to form, and when the temperature conditions are a few degrees warmer or colder than the temperature range that stars require.

The points on this plate crystal are the beginnings of arms that were just starting to develop when the crystal fell out of its cloud and stopped growing.

Snow crystals can also be columns.

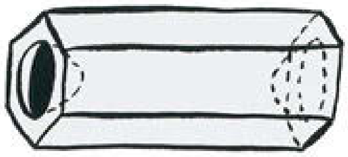
Column-shaped snow crystals are shaped like pencils. They're not flat like stars and plates. Columns can form high in the clouds and at very cold temperatures. They are *very* tiny, and when they fall, they make for very slippery snow.

A column has six sides. These are the three types:



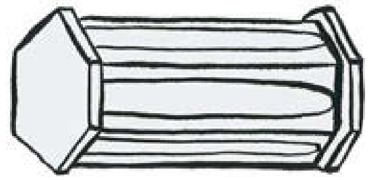
Solid column

These are the smallest type of column.



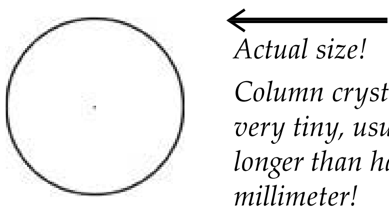
Hollow column

These are longer and more common than solid columns.



Capped column

The caps on each end of these columns can be plate crystals or star crystals.



Actual size!

Column crystals are very tiny, usually no longer than half a millimeter!

Capped columns like this one develop when a column crystal moves into a part of its cloud where the temperature is right for plates or stars to grow at the ends. The two end caps can grow to different sizes, as you can see here.

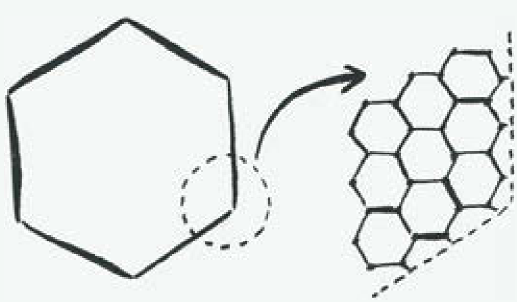
STOP AND CHECK

Ask and Answer Questions How are hollow column crystals different from other types of column crystals? Use the diagrams and text to find the answer.

6 is the magic number for snow crystals.

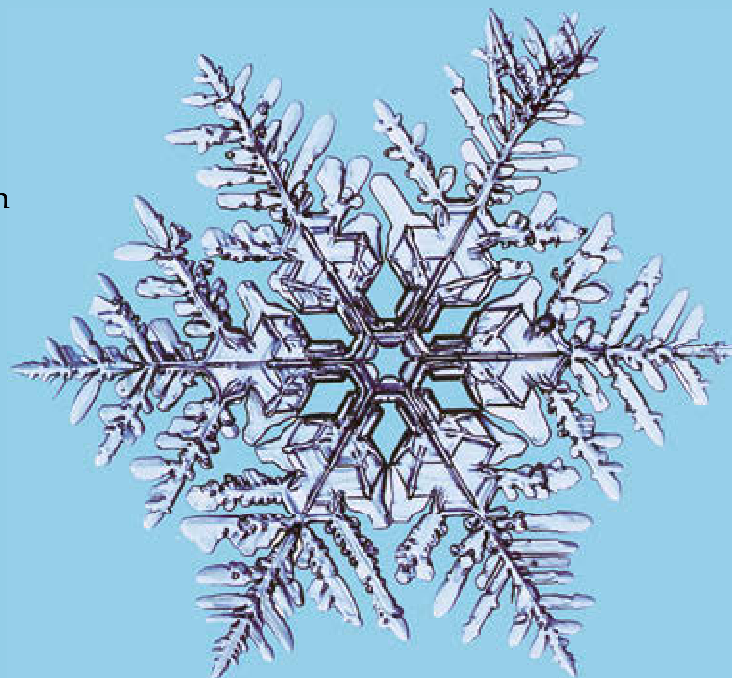
This is because of the nature of water. Water molecules (the smallest units of water) attach themselves into groups of six, which usually leads to crystals with six arms or six sides.

A perfect star or plate snow crystal has six-fold symmetry. That means, if you divided the crystal into six pie wedges, each pie wedge would have the same shape.



Water molecules attach to each other in six-sided rings, like six kids holding hands. When many of these hexagonal rings are joined together, a larger hexagonal crystal is formed.

So much can happen during a snow crystal's fall to earth, it is rare that one will turn out perfectly. If a droplet of water passes close to one arm of a snow crystal, that arm can start to grow faster. Before long, that one arm will be a lot longer than the others!

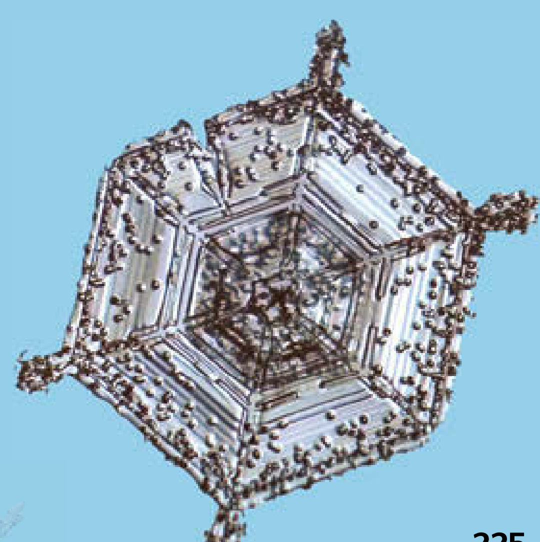


A snow crystal can be a twin!

A snow crystal can have twelve arms. This is a twin crystal, which happens when two crystals start from the original speck and form on top of each other.

A snow crystal can have bumps!

If there are enough water droplets near the crystal, some can strike the crystal and freeze on **contact**. This gives the crystal little bumps called rime.



Many snow crystals make one snowflake.

Often, snow crystals bump into each other and get stuck together. When this happens, snowflakes form. Hundreds or even thousands of snow crystals can be found in a single snowflake.

Two snow crystals stuck together.

Snowflakes we see falling from the sky are usually clumps of snow crystals like these. Individual crystals (which are sometimes also called "snowflakes") can fall on their own, but they are much smaller and harder to see.

Snow crystals can't keep growing after they fall from the clouds. And when a crystal stops growing, it immediately starts to wither. Soon, the arms of the crystal break down and the crystal's shape becomes rounded. This means that if you want to see a snow crystal, you need to catch it in the air, or find it very soon after it lands.

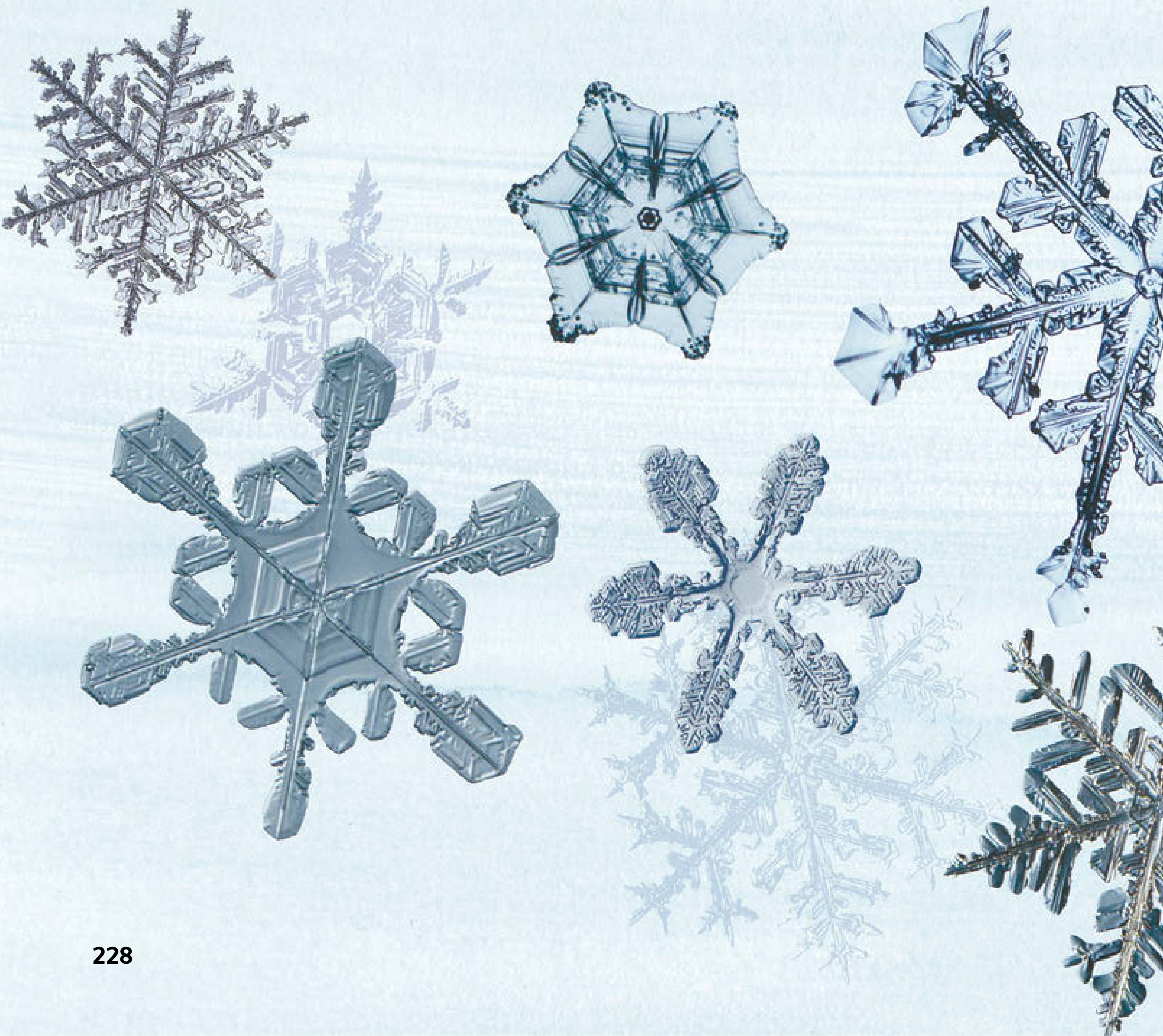
When they're not in the clouds, surrounded by the water vapor they need to grow, snow crystals quickly start to **erode**. *Try catching one on your sleeve or glove to see the crystal* **structure** *at its best.*

STOP AND CHECK

Summarize How does a snow crystal change after it falls from a cloud? Use the strategy Summarize to help you.

Are no two snow crystals alike?

Some simple plate crystals may appear exactly alike, as seen through a high-quality microscope. When it comes to more complicated snow crystals though, odds are that no two are exactly alike. But then, no two leaves, flowers, or people are exactly alike, either! Snow crystals are like us—we're each different, but we have a lot in common.



About the Authors and Illustrator

Mark Cassino is a fine art and natural history photographer. He first became interested in snow crystals when he noticed them land on his windshield as he was driving. Before long, he was photographing individual crystals to show these tiny structures close up.

Jon Nelson is a teacher and physicist who has studied clouds and snow crystals for over 15 years. He has many opportunities to observe them because he likes exploring outdoors, including rock climbing and taking walks on icy mornings.

Nora Aoyagi loves drawing interesting creatures from well-known folk stories. Here, she uses her techniques to help illustrate the story of snow. Nora works in many different mediums, including painting, printmaking, and drawing.

Authors' Purpose Why do the authors use so many different images of snow crystals to illustrate their text?

Respond to the Text

Summarize

Use the most important details from *The Story of Snow* to summarize what you learned about patterns in snow crystals. Use details from your Main Idea and Key Details Chart.

Main Idea
Detail
Detail
Detail

Write

How does the way Mark Cassino presents information help you understand snow crystals? Use these sentence frames to organize text evidence.

Mark Cassino organizes information by . . .
He uses text features to . . .
This helps me understand. . .

Make Connections

Talk about patterns you can find in snow crystals. **ESSENTIAL QUESTION**

How do photographs of snow crystals reveal patterns? What can people learn by finding patterns in nature? **TEXT TO WORLD**

Genre • Expository Text

Compare Texts

Read about a series of numbers that can be found in nature.

FIBONACCI'S AMAZING FIND

What do the numbers 1, 1, 2, 3, 5, 8, 13, 21, and 34 have in common? These are the first numbers in the Fibonacci sequence, a series of numbers calculated over 800 years ago by a mathematician named Fibonacci. But that's not all they have in common. These numbers also can be found in nature. They can be found, for example, in the number of petals of flowers.

Numbers from the Fibonacci sequence can be found in the numbers of petals of many flowers.

Black-eyed Susan: 13 petals

Field Daisy: 34 petals

Buttercup: 5 petals

Iris: 3 petals

The Origin of Our Number System

Fibonacci was born in the late 12th century in the Italian town of Pisa. As a teenager, Fibonacci moved to live with his father in North Africa.

At the time, most Europeans used the abacus to do their calculations. They would write their answers in Roman numerals. In North Africa, Fibonacci learned about a different numbering system. It used Hindu-Arabic numbers such as 1, 2, 3, and 4. To share what he had learned, Fibonacci wrote a book that helped spread the use of the Hindu-Arabic numbers throughout Europe. This is the numbering system we use today.

Fibonacci is now considered one of the most important mathematicians of his era. One reason is his creation of the Fibonacci sequence.

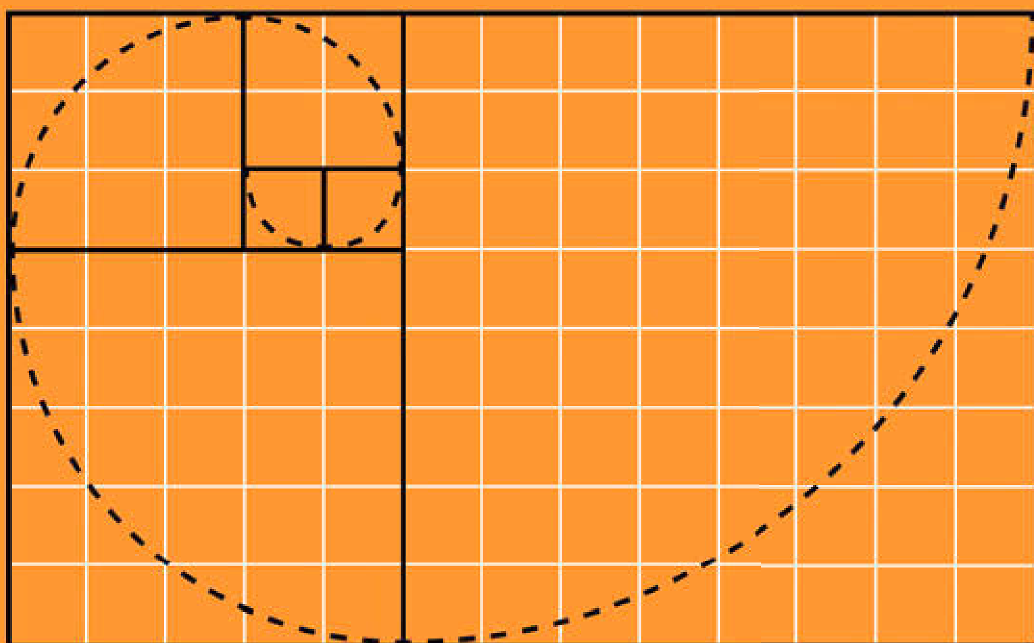
A Pattern of Numbers

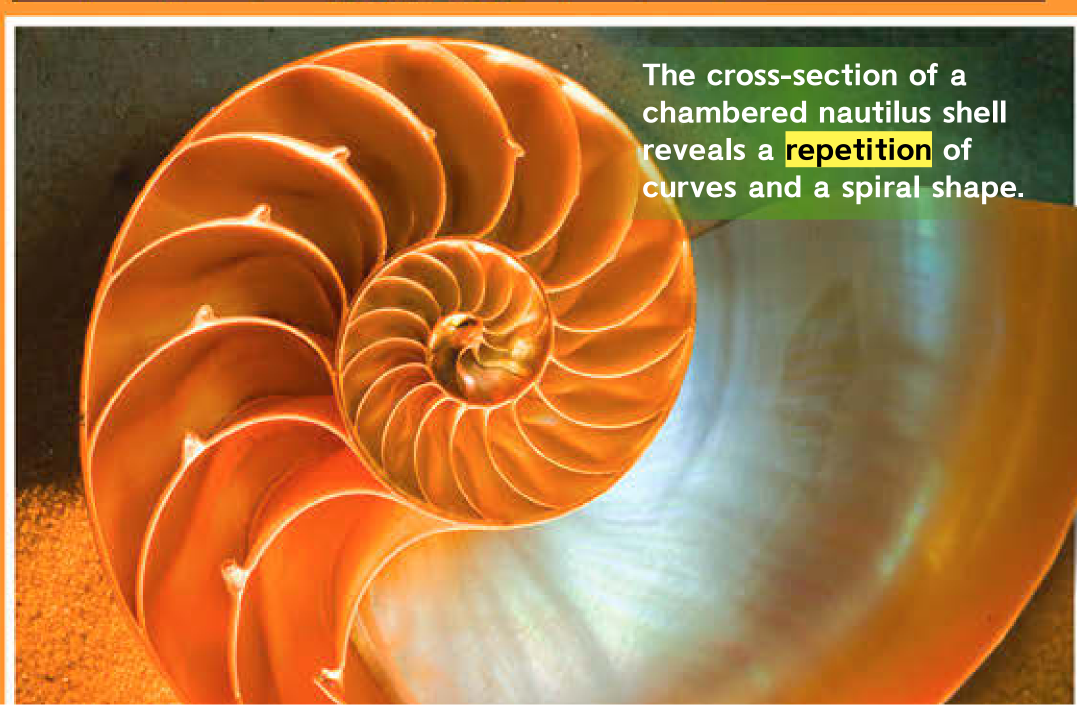
It all started with a number problem—about rabbits! Fibonacci wondered how a population of rabbits would grow if each month a pair of rabbits produced two baby rabbits. He calculated the number of pairs of rabbits there would be each month. The result was a series of numbers: 1, 1, 2, 3, 5, 8, 13, 21, and so on. He noticed that each number in the series was the sum of the two numbers that came before it (1+1=2; 1+2=3; 2+3=5; 3+5=8). He recorded this sequence in one of his books.

An abacus is a frame that has beads that slide on wires or in grooves. It was once widely used to do arithmetic.

Centuries later, people noticed these numbers in nature. Naturalists found that the growth pattern of some living things reflected Fibonacci numbers. For example, the chambered nautilus, a type of marine animal, adds a new chamber to its shell as it grows. Each additional chamber is the same shape as the previous one, but larger in size. This maintains the shell's overall shape. The diagram and directions below illustrate how this type of growth can produce a pattern that reflects the Fibonacci sequence.

On graph paper, draw a square with a side length of 1. Add another square with side length of 1 next to it. Then add a square above that has a side length equal to the sum of the side lengths of the two preceding squares (2). Add on three more squares using the same process, moving in a counterclockwise direction. Each square will have a side length that is a Fibonacci number. An arc drawn from the first square counterclockwise through the squares produces a spiral.





The cross-section of a chambered nautilus shell reveals a **repetition** of curves and a spiral shape.

Seth Joel Photography/Cultura/Getty Images

In Curves and Clusters

The spiral appears in many natural objects from seashells to clusters of seeds in flower heads. Leaves on some trees grow in a spiral. Pinecones and pineapples show a spiral **formation**. No one knows for sure why the spiral appears so often, but it seems to allow many seeds to grow in a small area and allow sunshine to reach most of the leaves on a plant or tree.

Fibonacci's amazing find led others to discover a surprising pattern throughout the natural world. When you look around, you, too, may recognize numbers from the Fibonacci sequence.


Spirals on a pinecone


Spirals of seeds in the head of a sunflower


Fern fronds unfold in the shape of a spiral.

Make Connections

Where can you find patterns in nature that reflect the Fibonacci sequence? **ESSENTIAL QUESTION**

How are patterns that reflect the Fibonacci sequence different from other patterns found in nature? **TEXT TO TEXT**