Name ________________________________

A Leader in the Environmental Movement

Fill in the circle by the correct answer. Then answer questions 3, 4, and 5.

1. Which pair of words are antonyms?
   Ⓐ significant, controversial
   Ⓑ devote, establish
   Ⓒ captivated, fascinated
   Ⓓ beneficial, harmful

2. The article implies that Carson loved ________ as much as she loved nature.
   Ⓐ farming
   Ⓑ publishing
   Ⓒ writing
   Ⓓ teaching

3. What approach would you use to prove that Carson's claims were justified?

   ____

   ____

4. What questions would you ask a scientist who supports the use of DDT?

   ____

   ____

5. What context clues can you find to help you define the word "controversial"?

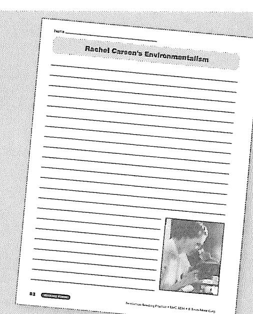
   ____

   ____

Write About the Topic

Use the Writing Form to write about what you read.

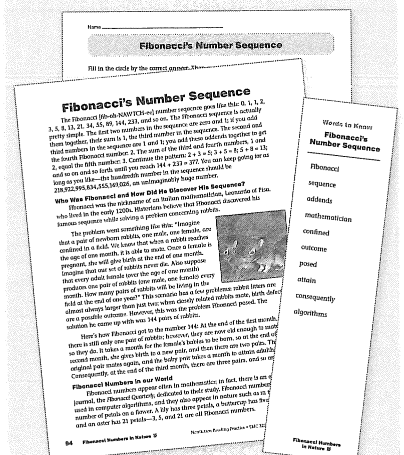
Compare and contrast the two quotations in the article (the one from Carson's book and the one in paragraph 4).


Rachel Carson's Environmentalism

Fibonacci Numbers in Nature

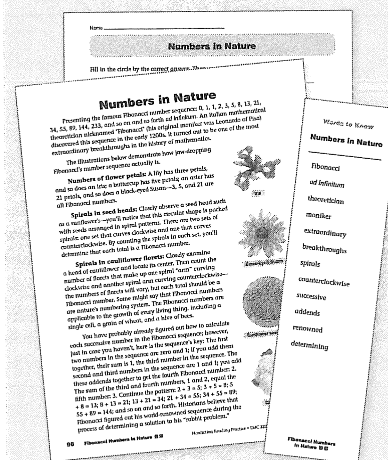
Level 1 ■

Words to Know list, Reading Selection, and Reading Comprehension questions



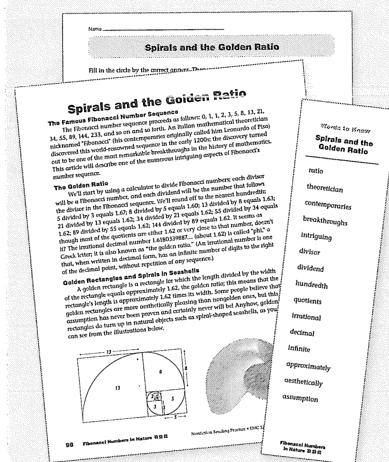
Level 2 ■ ■

Words to Know list, Reading Selection, and Reading Comprehension questions



Level 3 ■ ■ ■

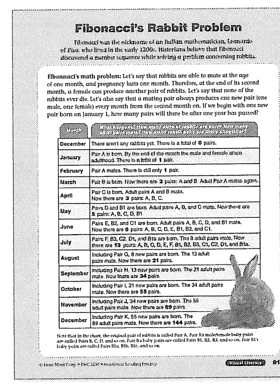
Words to Know list, Reading Selection, and Reading Comprehension questions



Assemble the Unit

Reproduce and distribute one copy for each student:

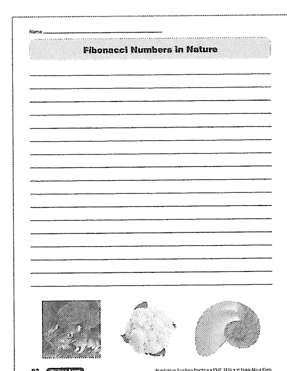
- Visual Literacy page: Fibonacci's Rabbit Problem, page 91
- Level 1, 2, or 3 Reading Selection and Reading Comprehension page and the corresponding Words to Know list
- Graphic Organizer of your choosing, provided on pages 180–186
- Writing Form: Fibonacci Numbers in Nature, page 92



Visual Literacy

Introduce the Topic

Read aloud and discuss the "Fibonacci's Rabbit Problem" text and chart on the Visual Literacy page. Explain that solving his rabbit problem led mathematician Fibonacci to discover his famous number sequence: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, and so on.



Writing Form

Read and Respond

Form leveled groups and review the Words to Know lists with each group of students. Instruct each group to read their selection individually, in pairs, or as a group. Have students complete the Reading Comprehension page for their selection.

Write About the Topic

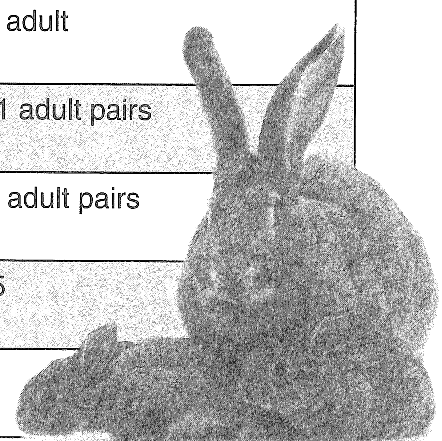
Read aloud the leveled writing prompt for each group. Tell students to use the Graphic Organizer to plan their writing. Direct students to use their Writing Form to respond to their prompt.

Fibonacci's Rabbit Problem

Fibonacci was the nickname of an Italian mathematician, Leonardo of Pisa, who lived in the early 1200s. Historians believe that Fibonacci discovered a number sequence while solving a problem concerning rabbits.

Fibonnaci's math problem: Let's say that rabbits are able to mate at the age of one month, and pregnancy lasts one month. Therefore, at the end of its second month, a female can produce another pair of rabbits. Let's say that none of the rabbits ever die. Let's also say that a mating pair always produces one new pair (one male, one female) every month from the second month on. If we begin with one new pair born on January 1, how many pairs will there be after one year has passed?

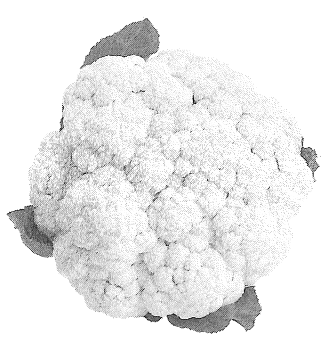
Month	What happens? How many pairs of rabbits are born? How many adult pairs mate? How many rabbit pairs are there altogether?
December	There aren't any rabbits yet. There is a total of **0** pairs.
January	Pair A is born. By the end of the month the male and female attain adulthood. There is a total of **1** pair.
February	Pair A mates. There is still only **1** pair.
March	Pair B is born. Now there are **2** pairs: A and B. Adult Pair A mates again.
April	Pair C is born. Adult pairs A and B mate. Now there are **3** pairs: A, B, C.
May	Pairs D and B1 are born. Adult pairs A, B, and C mate. Now there are **5** pairs: A, B, C, D, B1.
June	Pairs E, B2, and C1 are born. Adult pairs A, B, C, D, and B1 mate. Now there are **8** pairs: A, B, C, D, E, B1, B2, and C1.
July	Pairs F, B3, C2, D1, and B1a are born. The 8 adult pairs mate. Now there are **13** pairs: A, B, C, D, E, F, B1, B2, B3, C1, C2, D1, and B1a.
August	Including Pair G, 8 new pairs are born. The 13 adult pairs mate. Now there are **21** pairs.
September	Including Pair H, 13 new pairs are born. The 21 adult pairs mate. Now there are **34** pairs.
October	Including Pair I, 21 new pairs are born. The 34 adult pairs mate. Now there are **55** pairs.
November	Including Pair J, 34 new pairs are born. The 55 adult pairs mate. Now there are **89** pairs.
December	Including Pair K, 55 new pairs are born. The 89 adult pairs mate. Now there are **144** pairs.



Note that in the chart, the original pair of rabbits is called Pair A. Pair A's male/female baby pairs are called Pairs B, C, D, and so on. Pair B's baby pairs are called Pairs B1, B2, B3, and so on. Pair B1's baby pairs are called Pairs B1a, B1b, B1c, and so on.

Name ______________________________

Fibonacci Numbers in Nature


Words to Know

Fibonacci's Number Sequence

Fibonacci

sequence

addends

mathematician

confined

outcome

posed

attain

consequently

algorithms

Fibonacci Numbers in Nature ■

Words to Know

Numbers in Nature

Fibonacci

ad infinitum

theoretician

moniker

extraordinary

breakthroughs

spirals

counterclockwise

successive

addends

renowned

determining

Fibonacci Numbers in Nature ■ ■

Words to Know

Spirals and the Golden Ratio

ratio

theoretician

contemporaries

breakthroughs

intriguing

divisor

dividend

hundredth

quotients

irrational

decimal

infinite

approximately

aesthetically

assumption

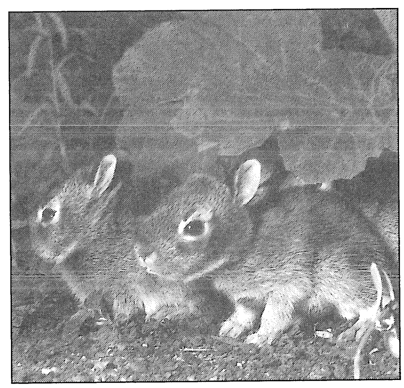
Fibonacci Numbers in Nature ■ ■ ■

Fibonacci's Number Sequence

The Fibonacci [fib-oh-NAWTCH-ee] number sequence goes like this: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, and so on. The Fibonacci sequence is actually pretty simple. The first two numbers in the sequence are zero and 1; if you add them together, their sum is 1, the third number in the sequence. The second and third numbers in the sequence are 1 and 1; you add these addends together to get the fourth Fibonacci number: 2. The sum of the third and fourth numbers, 1 and 2, equal the fifth number: 3. Continue the pattern: 2 + 3 = 5; 3 + 5 = 8; 5 + 8 = 13; and so on and so forth until you reach 144 + 233 = 377. You can keep going for as long as you like—the hundredth number in the sequence should be 218,922,995,834,555,169,026, an unimaginably huge number.

Who Was Fibonacci and How Did He Discover His Sequence?

Fibonacci was the nickname of an Italian mathematician, Leonardo of Pisa, who lived in the early 1200s. Historians believe that Fibonacci discovered his famous sequence while solving a problem concerning rabbits.


R.E. Naddy, Superior National Forest

The problem went something like this: "Imagine that a pair of newborn rabbits, one male, one female, are confined in a field. We know that when a rabbit reaches the age of one month, it is able to mate. Once a female is pregnant, she will give birth at the end of one month. Imagine that our set of rabbits never die. Also suppose that every adult female (over the age of one month) produces one pair of rabbits (one male, one female) every month. How many pairs of rabbits will be living in the field at the end of one year?" This scenario has a few problems: rabbit litters are almost always larger than just two; when closely related rabbits mate, birth defects are a possible outcome. However, this was the problem Fibonacci posed. The solution he came up with was 144 pairs of rabbits.

Here's how Fibonacci got to the number 144: At the end of the first month, there is still only one pair of rabbits; however, they are now old enough to mate, so they do. It takes a month for the female's babies to be born, so at the end of the second month, she gives birth to a new pair, and then there are two pairs. The original pair mates again, and the baby pair takes a month to attain adulthood. Consequently, at the end of the third month, there are three pairs, and so on.

Fibonacci Numbers in our World

Fibonacci numbers appear often in mathematics; in fact, there is an entire journal, the *Fibonacci Quarterly,* dedicated to their study. Fibonacci numbers are used in computer algorithms, and they also appear in nature such as in the number of petals on a flower. A lily has three petals, a buttercup has five petals, and an aster has 21 petals—3, 5, and 21 are all Fibonacci numbers.

Name ____________________________________

Fibonacci's Number Sequence

Fill in the circle by the correct answer. Then answer questions 3, 4, and 5.

1. Fibonacci numbers are called a "sequence" because the numbers ________.
   - Ⓐ are unimaginably huge
   - Ⓑ do not follow a particular order
   - Ⓒ can only be applied to rabbits
   - Ⓓ follow a particular pattern

2. How do we find the number that comes after **233** in the Fibonacci sequence?
   - Ⓐ We add 144 plus 233 for a sum of 377.
   - Ⓑ We add 89 plus 144 for a sum of 233.
   - Ⓒ We subtract 233 from 377 for a difference of 144.
   - Ⓓ We subtract 144 from 233 for a difference of 89.

3. Who do you think might read the *Fibonacci Quarterly*, and why?

   ____

   ____

4. In your own words, explain how the Fibonacci "code" works.

   ____

   ____

5. What conditions in Fibonacci's number sequence are unrealistic?

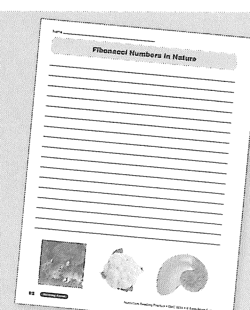
   ____

   ____

Write About the Topic

Use the Writing Form to write about what you read.

Did the Fibonacci number sequence solve a problem or help people better understand the world? Explain your answer.



Numbers in Nature

Presenting the famous Fibonacci number sequence: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, and so on and so forth *ad infinitum*. An Italian mathematical theoretician nicknamed "Fibonacci" (his original moniker was Leonardo of Pisa) discovered this sequence in the early 1200s. It turned out to be one of the most extraordinary breakthroughs in the history of mathematics.

The illustrations below demonstrate how jaw-dropping Fibonacci's number sequence actually is.

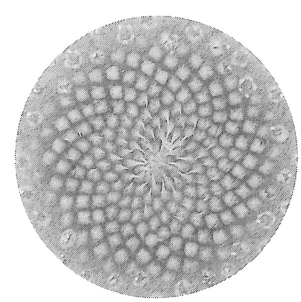
Iris

Numbers of flower petals: A lily has three petals, and so does an iris; a buttercup has five petals; an aster has 21 petals, and so does a black-eyed Susan—3, 5, and 21 are all Fibonacci numbers.

Spirals in seed heads: Closely observe a seed head such as a sunflower's—you'll notice that this circular shape is packed with seeds arranged in spiral patterns. There are two sets of spirals: one set that curves clockwise and one that curves counterclockwise. By counting the spirals in each set, you'll determine that each total is a Fibonacci number.

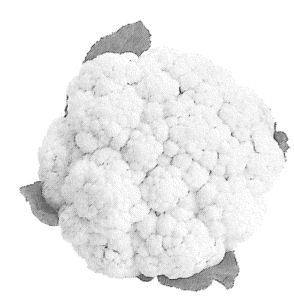
Black-Eyed Susan

Spirals in cauliflower florets: Closely examine a head of cauliflower and locate its center. Then count the number of florets that make up one spiral "arm" curving clockwise and another spiral arm curving counterclockwise—the numbers of florets will vary, but each total should be a Fibonacci number. Some might say that Fibonacci numbers are nature's numbering system. The Fibonacci numbers are applicable to the growth of every living thing, including a single cell, a grain of wheat, and a hive of bees.



Sunflower seed spirals

You have probably already figured out how to calculate each successive number in the Fibonacci sequence; however, just in case you haven't, here is the sequence's key: The first two numbers in the sequence are zero and 1; if you add them together, their sum is 1, the third number in the sequence. The second and third numbers in the sequence are 1 and 1; you add these addends together to get the fourth Fibonacci number: 2. The sum of the third and fourth numbers, 1 and 2, equal the fifth number: 3. Continue the pattern: 2 + 3 = 5; 3 + 5 = 8; 5 + 8 = 13; 8 + 13 = 21; 13 + 21 = 34; 21 + 34 = 55; 34 + 55 = 89; 55 + 89 = 144; and so on and so forth. Historians believe that Fibonacci figured out his world-renowned sequence during the process of determining a solution to his "rabbit problem."



Cauliflower

Name ______________________________

Numbers in Nature

Fill in the circle by the correct answer. Then answer questions 3, 4, and 5.

1. The Latin phrase *ad infinitum* in paragraph 1 means that the sequence ________.
   Ⓐ has a certain number of items
   Ⓑ can continue on forever
   Ⓒ has one million items
   Ⓓ stops and starts

2. The word "moniker" means ________.
   Ⓐ a profession
   Ⓑ an address
   Ⓒ a city
   Ⓓ a name

3. Explain why the author thinks the Fibonacci number sequence is "jaw-dropping."

   ____

   ____

4. Explain how this text's content is organized, paragraph by paragraph.

   ____

   ____

5. Explain how the illustrations help you understand the content of paragraph 2.

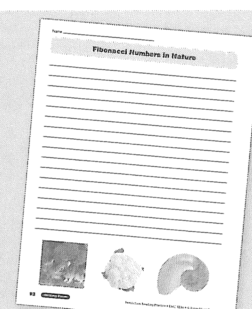
   ____

   ____

Write About the Topic

Use the Writing Form to write about what you read.

Are Fibonacci numbers important in nature?
Explain why or why not.


Fibonacci Numbers in Nature

Spirals and the Golden Ratio

The Famous Fibonacci Number Sequence

The Fibonacci number sequence proceeds as follows: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, and so on and so forth. An Italian mathematical theoretician nicknamed "Fibonacci" (his contemporaries originally called him Leonardo of Pisa) discovered this world-renowned sequence in the early 1200s; the discovery turned out to be one of the most remarkable breakthroughs in the history of mathematics. This article will describe one of the numerous intriguing aspects of Fibonacci's number sequence.

The Golden Ratio

We'll start by using a calculator to divide Fibonacci numbers; each divisor will be a Fibonacci number, and each dividend will be the number that follows the divisor in the Fibonacci sequence. We'll round off to the nearest hundredth: 5 divided by 3 equals 1.67; 8 divided by 5 equals 1.60; 13 divided by 8 equals 1.63; 21 divided by 13 equals 1.62; 34 divided by 21 equals 1.62; 55 divided by 34 equals 1.62; 89 divided by 55 equals 1.62; 144 divided by 89 equals 1.62. It seems as though most of the quotients are either 1.62 or very close to that number, doesn't it? The irrational decimal number 1.6180339887… (about 1.62) is called "phi," a Greek letter; it is also known as "the golden ratio." (An irrational number is one that, when written in decimal form, has an infinite number of digits to the right of the decimal point, without repetition of any sequence.)

Golden Rectangles and Spirals in Seashells

A golden rectangle is a rectangle for which the length divided by the width of the rectangle equals approximately 1.62, the golden ratio; this means that the rectangle's length is approximately 1.62 times its width. Some people believe that golden rectangles are more aesthetically pleasing than nongolden ones, but this assumption has never been proven and certainly never will be! Anyhow, golden rectangles do turn up in natural objects such as spiral-shaped seashells, as you can see from the illustrations below.