Amazing numbers in nature

UNIT A6

This unit looks at the occurrence of some number patterns in the living world.

Using this unit

This unit deals with the variation of living things in more depth than is usual and uses some mathematical processes on real data (either manually or using ICT) in order to explore some surprising patterns in the natural world.

In addition, it attempts to give pupils an opportunity to experience something of the wonder, variety and beauty of the natural world. As they consider the patterns and order found there, they are encouraged to reflect on whether the natural world exists as a result of 'accidents' or the work of a creator.

A very good web site on 'Fibonacci Numbers and Nature' can be found at http://www.ee.surrey.ac.uk/Personal/R.Knott/Fibonacci/fibnat.html

There is scope in this unit for cooperation with colleagues in the Maths department.

Links with KS3 programme of study

- Use of a wide range of methods, including diagrams, tables, charts, graphs and ICT, to represent qualitative and qualitative data (Sc1 investigative skills).
- Environmental and inherited causes of variation within a species (Sc2 life processes and living things).

Moral and spiritual aims

- To promote wonder at some of the patterns in nature and to stimulate reflection on how they come to be there.

TEACHER'S NOTES

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Notes on the activities

1. Variation

1.

Feature	Your hand	Hand of person next to you	Inherited or environmental?
No. of scars			E
No. of fingers/thumbs	5	5	I
No. of freckles			E
No. of hands	2	2	I
No. of bones per finger	3	3	I

(E = Environmental, I = Inherited)

2. The sunflower seedhead

Colour photographs providing more detail are included in the CD-ROM. The web site mentioned earlier (http://www.ee.surrey.ac.uk/Personal/R.Knott/Fibonacci/fibnat.html) also provides more detail and helpful drawings.

If actual specimens of sunflowers in seed are difficult to acquire, other composite flowers can be used or the same effect can be obtained by using a pineapple or pine cones.

1. Patterns of spirals.
2. No, some are in a clockwise direction, some anticlockwise.
3. 2

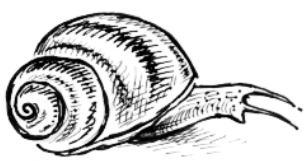
4. Fibonacci numbers everywhere!

1. 3 2. 2 3. 8
4. Count some! 5 or 8 are typical answers. 5. 8
6. The plant survey activity could be a practical one where the pupils collect their own data from actual specimens instead of using the table provided. Alternatively, the CD-ROM, which provides examples of flowers with Fibonacci patterns, could be used as a secondary source.

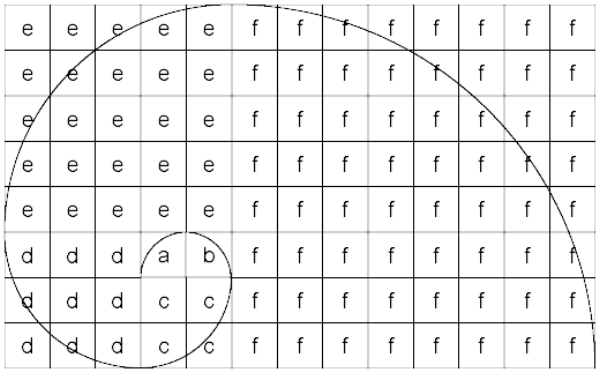
5. Fibonacci spirals in nature

Further examples of spirals in nature are found on the CD-ROM.

1. Pupils need specimens of twigs where the leaves can be seen clearly spaced out along a stem e.g. privet.



2. The completed spiral is shown below. The pupils will need to shade a square or block of squares for a (1), b (1), c (4), d (9), e (25) and f (64) and then ink in the outer edge. Then finally they can add the spiral by drawing the successive quarter circles.



3.

Block of small squares	a	b	c	d	e	f
Length of side of block (count the side of a small square as a unit)	1	1	2	3	5	8

TEACHER'S NOTES

Amazing numbers in nature

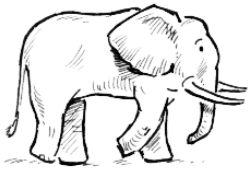
UNIT A6

Have you ever met someone who looks exactly like you? Probably not, unless you are an identical twin. We are all members of the same species, and yet we all look different in many ways.

At the same time, we are also all similar in many ways. Why do most people grow five fingers on each hand and five toes on each foot? Is five a special number?

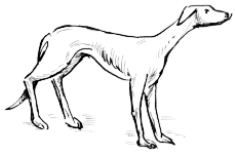
In fact, the number five is amazingly common in the natural world, along with several other numbers. This unit will help you to discover some surprising facts about numbers in the natural world.

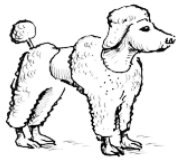
1 Variation



This elephant looks very different from this mouse. They are from different species. Now look at the two dogs. They have enough similarities to class them together as the same species, but they still look rather different. Where differences between animals of the same species occur, this is called *variation*.

Variation may be caused by genes *inherited* from parents. Variation may also have *environmental* causes, i.e. it may be due to circumstances and conditions of upbringing.





1. Look at one of your hands. Now compare it with a hand of the person next to you and complete the table below.

Feature	Your hand	Hand of person next to you	Inherited or environmental?
No. of scars			
No. of fingers/thumbs			
No. of freckles			
No. of hands			
No. of bones per finger			

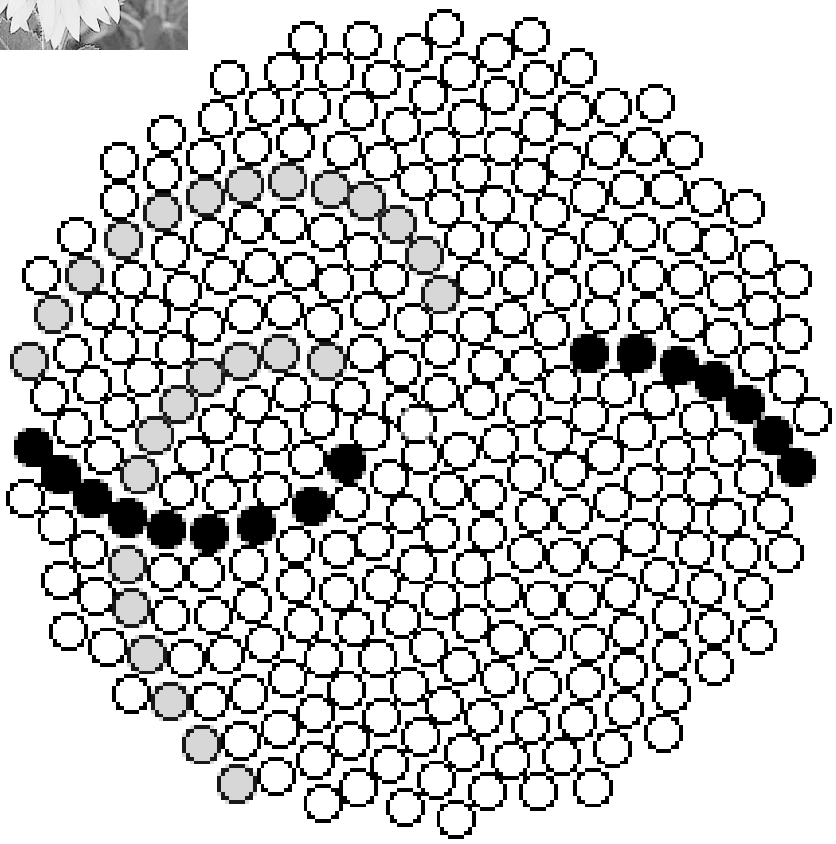
2. Look at the numbers in your table for features that are inherited. Which of these numbers occur in the list below? Circle them.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

These numbers are special and they occur again and again in nature. In fact, the natural world is full of mathematical surprises!

2 The sunflower seedhead

Look closely at this photograph of a sunflower seedhead and the simplified diagram.



1. Can you describe the pattern of the seed arrangement?

2. If you look closely, you will find that there are several sets of these patterns (spirals). Do they all go in the same direction?

3. Choose one of the seeds on the outside edge of the seedhead. How many spirals does this seed belong to?

You should have found that the seed belongs to two spirals - one going clockwise and one going anticlockwise.

4. Choose three seeds on the edge of the sunflower diagram and trace the clockwise and anticlockwise spirals with two different colours.

3 Leonardo Fibonacci

How many seeds are there in the head of a sunflower? Too many to count? Some scientists were so fascinated by numbers that they actually counted them all and have found more surprising patterns.

One such man was Leonardo Fibonacci. He was a rich Italian merchant who lived in Pisa in the thirteenth century. His hobby was mathematics and he described a special set of numbers which became known as the Fibonacci sequence.

The FIBONACCI SEQUENCE begins 1, 1, 2, 3, 5, 8, 13, 21, ...

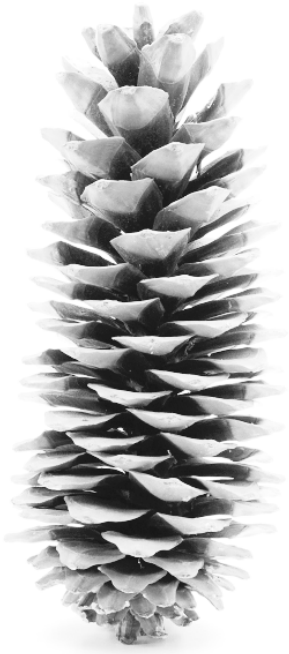
.....

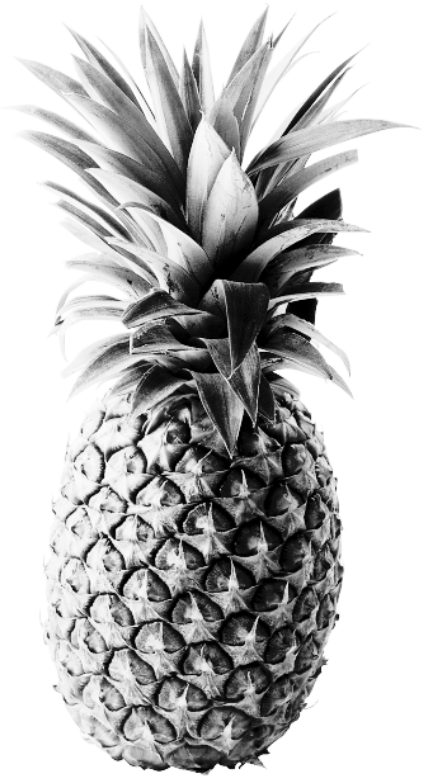
Can you see a pattern? If so continue the sequence.

(Hint: try adding together two numbers next to each other in the sequence...)

If you could count the number of seeds on the sunflower head you would find that the number of clockwise spirals is a Fibonacci number and the number of anticlockwise spirals is a Fibonacci number. These two Fibonacci numbers are next door to each other in the Fibonacci sequence. And guess what ... the total number of seeds in a seedhead is a Fibonacci number!

If you can get a sunflower seedhead you could check it out for yourself. If not, pineapples and pine cones also display these patterns and you could try looking at one of these.





4 Fibonacci numbers everywhere!

The Fibonacci sequence is not just a mathematical curiosity - it occurs very frequently in the natural world.

1. How many parts does a clover leaf usually have?
2. How many wings on a fly?
3. How many legs on an octopus?
4. How many seeds in an apple?
5. How many arms on a starfish?

Look back at the numbers you found for inherited features of your hand. They also occur in the Fibonacci sequence!

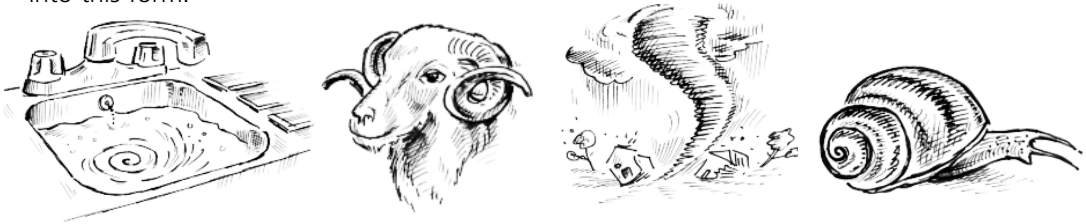
6. Class A carried out a survey of common British plants. Their results are in the table below. Put a circle around each number in this table which can be found in the Fibonacci sequence (1, 1, 2, 3, 5, 8, 13, 21, 34, 55, . . .).

Name	No. of sepals	No. of petals	No. of stamens	No. of stigmas	No. of seeds
Clover	5	5	10	1	1
Milkwort	5	3	8	2	2
Orchid	5	5	1	2	Many
Primrose	5	5	5	1	Many
Harebell	5	5	5	3	Many
Yellow Iris	0	3+3	3	3	Many
Daisy	5	5	5	1	1

7. Find some flowers or pictures of flowers for yourself and see how frequently these numbers occur.

5 Fibonacci spirals in nature

The spiral is a common pattern found in the natural world and many things grow naturally into this form.



1. Look at a stem which has several leaves on it, e.g. from a privet hedge. Hold it at the bottom. Notice that the leaves are not arranged exactly symmetrically. Now imagine you are a snail which has decided to visit each set of leaves in turn starting at the bottom. Turn the stem till the bottom set of leaves are sticking out sideways. Now turn the stem 1/4 of a turn until the next set of leaves is sticking out sideways. Work your way up the stem looking at each set of leaves in turn. Your silvery trace is a spiral!

What is more surprising is that this pattern is based on Fibonacci numbers, too!

5 Fibonacci spirals in nature continued ...

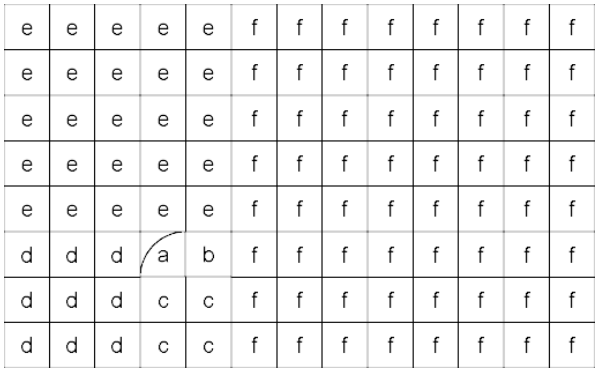
2. You can draw this kind of spiral, using Fibonacci numbers.

On the grid below, start at square a.

- Shade the square labelled 'a' in one colour and go around the outside edge in ink.
- Next colour the square labelled 'b' in a different colour, and mark its edge in ink.
- Now colour all the 'c' squares (a different colour again) and mark around the edge of the block in ink (this is a larger square made from 4 squares).
- Repeat for all of the 'd' squares, then for all of the 'e' squares and finally for all of the 'f' squares.

Now ...

- Starting at the square 'a', draw a quarter circle from the bottom left corner to the top right corner (this has been done for you).
- Now do the same for the 'b' square: draw a quarter circle from the top left corner to the bottom right corner.
- Then, for the square made up of four 'c' squares, draw a quarter circle from the top right corner to the bottom left corner.



- Then, for the square made up of nine 'd' squares, draw a quarter circle from the bottom right corner to the top left corner.
- Do the same for the blocks of 'e' and 'f' squares.

The shape you are making is a Fibonacci spiral and it could be continued indefinitely.

3. Complete the table below. (By now you may not be surprised to find that you have a familiar pattern of numbers!)

Block of small squares	a	b	c	d	e	f
Length of side of block (count the side of a small square as a unit)	1					

By accident or by plan?

You have been looking at how Fibonacci numbers occur in the natural world. Can you think of any other kinds of pattern which occur naturally?

Do you think that the beauty and recurring patterns found in nature happened by accident or do they suggest to you some evidence of a creator who had a plan and a purpose for everything?

Is it harder to believe that patterns in the natural world occur by accident or because of the work of a creator?