DIY Science – Meandering Maths

Discover symmetry, fractals, Fibonacci numbers, and more in flowers and leaves, and measure the height of trees using a simple geometrical trick.

Safety

When doing science activities outdoors, wear sun protection and comfortable, closed-in shoes. Beware venomous creatures such as spiders, snakes, and wasps. Always treat the natural environment with care and try to leave it as you found it.

What you need

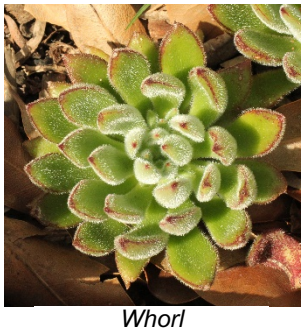
An area of nature with a variety of trees and other plants, such as a backyard, garden, park, local bushland, or national park.
Finding patterns: A camera for taking photos of plants, or paper and pencil for drawing.
Measuring a tree: A helper, ruler, and tape measure.

What to do

Finding patterns: Look for geometrical patterns in flower petals and the arrangements of leaves on stems and record the results in the table on the following page. For example: bilateral symmetry; radial symmetry; spirals; whorls (patterns of spirals); fractals (small shapes repeated in larger shapes); tessellations (closely fitting shapes in a regular pattern).

Radial symmetry

Spiral



Whorl

Fractal

Measuring a tree: Practise on a small tree. Hold the ruler vertically, at arm's length, and move closer to or further away from the tree until the bottom end of the ruler lines up with the base of the tree and the top of the ruler lines up with the top of the tree. Standing very still, keep the bottom of the ruler lined up with the base of the tree, but turn the ruler sideways so it is horizontal.

Ask your helper to stand alongside the tree and move to the side until they line up with the end of the ruler. Make sure the helper stays the same distance from you as you are from the tree. With the helper standing still, measure the distance between the helper and the tree using the tape measure. This distance is approximately equal to the height of the tree.

What's happening?

Mathematical patterns in nature continue to provide a puzzle for scientists, however evidence is emerging that the patterns form at a microscopic cellular level during a plant's development, creating the macroscopic (large) patterns we can see.

From a particular point of view, you see an optical projection of a tree. In the projection, the height of the tree and the distance to an object in the same plane as the tree are in the same proportion.

Results

Draw plants or paste photographs in the table. Drawing was an essential scientific skill prior to the age of photography and it is still a great way of developing observational skills.

Plant name: _____ **Geometrical pattern:** _____	**Plant name:** _____ **Geometrical pattern:** _____
Plant name: _____ **Geometrical pattern:** _____	**Plant name:** _____ **Geometrical pattern:** _____

Did you know?

A fractal is a complex pattern, with small shapes being repeated to form similar shapes on a larger and larger scale. In nature, there is a physical limit to the scale of a fractal, but in mathematics the complex structures can be infinitely small and infinitely large.

The Fibonacci series starts with 1 and 1, and the following numbers are calculated by adding the previous two numbers, to give: 1, 1, 2, 3, 5, 8, 13, 21, 34, and so on. Numbers from this series turn up again and again in natural structures, including in the shapes of spirals in plants and animal shells.

The 'Golden Ratio' can be found by taking a number from the Fibonacci series and dividing it by the previous number. For example, $34 \div 21 = 1.619\ldots$, and for higher numbers in the Fibonacci series, the result becomes closer and closer to the Golden Ratio, $\varphi = 1.618033\ldots$. As well as appearing in nature, the Golden Ratio is used by designers, artists, and architects to create aesthetically pleasing works.

Find out more

- Create drawings of plants using the Fibonacci series: http://web01.splash.abc.net.au/web/splash#!/media/1003944/are-plants-mathematicians-
- Build fractals and explore a range of fractal patterns using online activities: http://thewessens.net/ClassroomApps/Main/chaosgame.html
- Explore geometry while taking funny photos using forced perspective: https://expertphotography.com/forced-perspective-photography/