
mathsinside

PLANT GROWTH

Understanding plant shapes with the help of mathematics

Most people admire flowers for their beauty and don't give a second thought as to how a flower has grown into a particular shape. Researchers at the John Innes Centre are now making breakthroughs in understanding how flowers and plants can form intricate 3D shapes from small initial shapeless masses of cells. They are gaining an amazing insight into the actual mechanism of how plants grow and they are doing this with the help of mathematics.

One of the key ideas behind flower formation is to do with what researchers call 'growth conflicts'. A growth conflict is where different parts of the flower grow at different rates, causing the flower to form the final 3D shape which we are familiar with.

To understand how growth conflicts work, researchers have realised that the flower will display both elastic and plastic behaviour as it grows. If part of a flower is displaying elastic behaviour this means that it is behaving a bit like a spring – stretch is proportional to the force applied. However a flower also needs to display plastic behaviour if the shape is going to be permanent. Plastic behaviour is where a material retains its shape once it has been deformed – a bit like stretching a bit of plasticine – it stays in the shape which you have moulded. This combination of elastic and plastic behaviour allows a flower to stretch and grow, setting into its new shape.

To find out exactly how this growth works, researchers have created mathematical models which simulate the growth of flowers, helping the researchers to understand the underlying pattern of genes which is controlling behaviour. To create these computer simulations, researchers have used the mathematical equations which govern elastic and plastic behaviour.

Elastic behaviour is governed by what is known as Hooke's Law, whereas plastic behaviour is controlled by more advanced mathematics such as partial differential equations.

Hooke's Law

$$F = k \times e$$

F = Force measured in newtons (N),

k = Spring constant in newtons per metre (N/m) which depends on which material is being used

e = Extension in metres of the spring or material

By modelling the growth of flowers using a mathematical model, researchers are able to test their hypotheses and discover the growth behaviours which produce flowers that are actually observed in nature. This new research has now cast light on a previously mysterious and unknown process, and has been made possible by the use of mathematics. Therefore next time you see a daffodil in spring, take a moment to wonder at the forces which have governed its amazing growth.

https://www.jic.ac.uk

John Innes Centre
Unlocking Nature's Diversity

LONDON MATHEMATICAL SOCIETY
EST. 1865

Institute of mathematics & its applications

SELECTED FOR THE ROYAL SOCIETY SUMMER SCIENCE EXHIBITION 2016

mathsinside