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Sunflower with 34 petals, a Fibonacci Number.

Mathematics is our way of explaining the chaotic world around us with a system of numbers. You may be surprised to learn that many mathematical concepts are abundant in nature. But which is the case? Does math mimic nature or does nature mimic math?

During the European Renaissance, math (and music) were called perfect arts. Let us, for a moment, focus our attention on plants. Plants, and all other forms of life, have evolved through adapting to their surroundings. Sunflowers, for instance, face the sun by way of a special growth-regulator on the shady side of the plant that causes it to grow faster than the sunny side, causing the plant to bend. This is a product of millenia of evolution. Let's take another look at the sunflower; this time at the flower itself. Have you ever noticed how tightly-packed the seeds are in the center of the flower? We could easily assume that this is another product of perfection through evolution; the flower packing its seeds in neat spirals eminating from the center. But, alas, that isn't the case. It's an example of the Fibonacci Series (and Lucas Series) appearing in nature.

To further examine this concept, we will continue examining flowers. Did you know, for instance, that most daisies have 34, 55 or 89 petals? Those numbers should be familiar to you; they are the 9th, 10th, and 11th Fibonacci Numbers. Have you ever wondered why four-leaf clovers are so rare? It's because four isn't a Fibonacci Number. Here is a list of flowers with number of petals:

Number of Petals	Flower
3 petals (or 2 sets of 3)	lily (usually in 2 sets of 3 for 6 total), iris
5 petals	buttercup, wild rose, larkspur, columbine (aquilegia), vinca
8 petals	delphinium, coreopsis
13 petals	ragwort, marigold, cineraria
21 petals	aster, black-eyed susan, chicory
34 petals	plantain, daisy, pyrethrum
55 petals	daisy, the asteraceae family
89 petals	daisy, the asteraceae family

There are exceptions to this list. Most fall into two categories; a doubling of the number of petals, and/or a version of the Fibonacci Series called the Lucas Series (2, 1, 3, 4, 7, 11, 18, 29, 47, 76, etc.). Mutations and variations from species to species also account for exceptions but when the number of petals are averaged, the number will usually be a Fibonacci or Lucas Number.

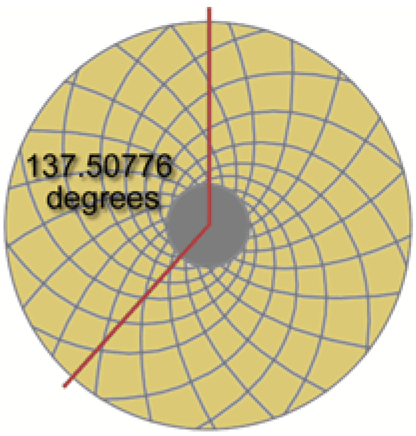

Diagram of a seed head with the golden angle, about 137.5 degrees, inscribed.

- By far the most fascinating appearances of the Fibonacci Series in nature are the spirals that can be seen in everything from sunflowers to pine cones to pineapples. We are about to explain that this phenomenon comes not from perfection through evolution (which is, in itself, oxymoronic) but from the dynamics of plant growth. To begin to understand how these spirals come to be, one must go back to the beginning; to where flowers and fruits and seeds start: the apex. The apex is the tip of the shoot of a growing plant. It is the bud on the end of a stem on a tree and the bulb of a flower before it blooms. Around the apex grow little bumps called primordia. As more primordia develop, they are pushed farther and farther from the apex and they develop into the familiar features of a plant, be it a leaf, a flower, or parts of a fruit. Let us consider a sunflower with primordia growing from the center. The first primordia to develop end up being farther from the apex than later primordia. Therefore, it can be deduced from this in what order the primordia appeared. As it happens, if one took the first and second primordia and measured the angle between them with the center of the seed head as the vertex, the angle would be very close to 137.5 degrees (see *above*).

- That angle is very important in describing how primordia form the spirals we see. It is, in fact, known as the golden angle. Here's where the Fibonacci Series comes in. Take two consecutive Fibonacci Numbers and divide the smaller by the larger. Then multiply by 360 degrees. Let's try 55/89 * 360 = 222.472... . We can round that degree measure to 222.5 degrees. Remember from trigonometry that angles can be measured internally or externally, so if you subtract it from 360 degrees to convert it, you get 137.5 degrees, the golden angle. In other words, $360(1-\varphi)$ = 137.5... .

- Another appearance of the Fibonacci Series in seedheads like the one shown above, pincones, pineapples, etc., is that the number of spirals going in each direction is a Fibonacci Number. In the diagram above, for example, there are 13 spirals that turn clockwise and 21 curving counterclockwise. On all other sunflowers, the number of clockwise and counterclockwise spirals will always be consecutive Fibonacci Numbers like 21 and 34 or 55 and 34.