SENSE 'N' SCIENCE

HIDDEN PATTERNS

Explore how the world is filled with hidden patterns- tessellations, symmetry in biology and much more...

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EDITOR'S NOTE

We are clueless about the very thing that surrounds us: nature. From the rhythm of our breathing, to the way the sunlight chooses the same window every morning; everything we have thought to be random, turns out, is not. Each wave that crashes the shore, every hexagon in a honeycomb, all of it is a smaller piece in a bigger puzzle; too small for any one of us to pause and notice.

In this edition of Sense 'n Science, we encourage you readers to take that pause and slow down, look closer, and discover the hidden patterns that have been shaping us all along.

We the editors, core team and fellow students have put together a compilation of fascinating research exploring the same.

"The universe is full of magical things patiently waiting for our wits to grow sharper."
— Eden Phillpotts

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Patterns in leaves
Uncovering hidden meanings

Hrithika Jariwala- 8A
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Leaves, we encounter them in our daily lives, and there's no doubt that it's the most robust organ of a plant, but have you noticed the patterns within them? You might assume they're simply nature's doodles, but they actually hold significant meaning, all the way from intricate vein patterns to mesmerising phyllotaxis. All impact how the plant processes.

The arrangement of leaves on a stem, also known as phyllotaxy, actually helps scientists and wildlife experts identify the species of the plant. The proper arrangement of leaves is essential for photosynthesis. There are three main types of phyllotaxy. The first type is alternate; in this, a single leaf originates from a node. For instance, this type of phyllotaxy is found in china rose, mustard, and sunflowers. The second type is opposite. In this type, two leaves originate from each node and they are opposite to each other. This is often found in guava, jasmine, mint, etc. The third type is whorled. In this, more than two leaves form at each node and form a whorl. This is found in alstonia, hydrilla, galium, and other plants.

Firstly, parallel venation is a pattern where veins run straight and parallel from the leaf's base to its top, quite like the stripes on a flag! This pattern exists in monocots like grasses, lilies, and banana leaves. It's efficient for long, narrow leaves, ensuring fast transportation without branching. For instance, grass consists of many thin shoots, each resembling a leaf strip. The veins in the blade provide strength, allowing it to bend in the wind.

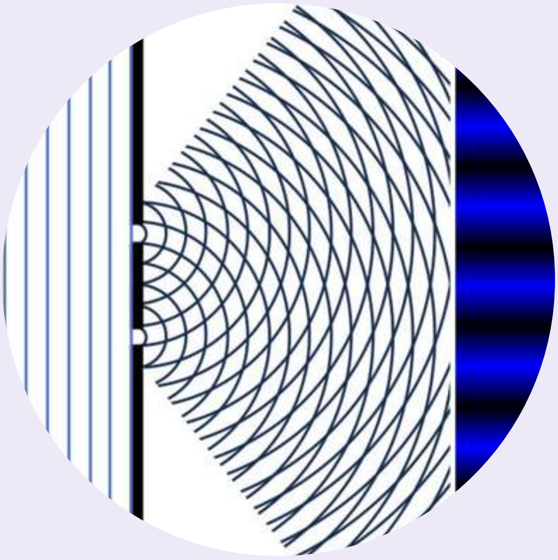
Reticulate venation, found in plants like roses and maples, has a net-like vein structure with two subtypes: pinnate and palmate. Pinnate venation features a central midrib with branching veins, as in oak and cherry leaves, aiding nutrient and water transport and support. Palmate venation has primary veins radiating from a central point, like in maple leaves. Both types efficiently deliver resources and provide support.

Why do these patterns exist? Evolution has greatly influenced these patterns so that these plants can support themselves in their habitats. For example, parallel veins are efficient for rapid growth in wet tropical environments, as they help water move faster and they don’t need strong, complex veins. While reticulate patterns lend the leaf durability in dry and less predictable surroundings by giving it the strength to withstand damage. As well as that, these patterns of leaves can also show the family tree of plants. Scientists dealing with plants use these features to identify plant species.

Thus, when you walk in the park again, look at different leaves more closely and compare their patterns, and enjoy nature’s architecture. The complexity of the seemingly simple and everyday world is revealed to one in this tiny but very effective way!

Interference of Light
Double-slit experiment

Rishabh Shah- IBDP 1B



The double slit experiment directly connects us to the unique world of quantum physics. The setup for the experiment looks simple: shine a beam of light through 2 narrow slits and observe the screen behind them. However, this seemingly uncomplicated setup has caused physicists to work for over 2 centuries, in order to find an answer that is universally accepted.

The procedure consisted of directing a source of particles, typically electrons, towards a barrier containing two narrow slits. Behind this barrier is a detector which can record when a particle arrives. Without any measuring instruments, the distribution of the particles forms an interference pattern. Bright and dark fringes for light, or alternating bands of high and low detection density for particles, indicate that the particles associated with each slit behave like waves. In a variant of the experiment, particles are passed through one at a time. Even so, the interference pattern gradually appears, demonstrating that each particle does not behave like an ordinary object with a fixed path but rather contributes to a wave-like distribution.

When detectors are positioned at the slits to determine the path taken, the process is altered. The interference pattern vanishes and the distribution on the screen changes to one consistent with conventional particles travelling through individual slits once "which-path" information is obtained. The interference is restored when the detectors are removed. Numerous experiments involving photons, electrons, atoms, and even complex molecules reveal the same behaviour, proving that the effect is not specific to any one kind of particle.

Although the mathematical framework behind the experiment is solid, the deeper explanation remains unsettled. Quantum mechanics describes exactly how the wavefunction evolves and why interference appears only when path information is unknown, but it does not spell out what the wavefunction truly represents. Researchers agree on the calculations but not on the interpretation.

Some views treat the wavefunction as a real physical entity, while others see it as a tool that encodes possible outcomes. The Many Worlds interpretation argues that every outcome occurs in separate branches of the universe, whereas pilot-wave theory suggests that a real guiding wave steers each particle along a definite route. All of these interpretations match the same experimental data, and no test so far has singled out one as the correct explanation.

For this reason, the double slit experiment is considered fully understood in its predictions but still unresolved in its deeper explanation. We can reproduce the interference pattern with great accuracy, yet we cannot determine with certainty what happens to a particle between emission and detection. The experiment remains valuable not only due to its precision and repeatability but also because it reveals the limits of our classical intuition and inspires new ways to think about the quantum world.

Prime numbers in nature

Uncovering hidden meanings

Ryan Bathwal- IBDP 1C

To argue against people who claim an intelligent mind designed nature, people often point to the leftovers: parts of nature that seem useless but still hang around. Think of the human appendix, the tiny back legs inside a boa constrictor snake, or the thorns on domesticated roses that don't really protect the plant anymore. But that is exactly why it feels even more striking to find a pattern in nature that looks almost like pure math shaped by one of evolution's strangest forces: perfect timing.

Take, for example, cicadas. Some kinds rise from the ground in huge swarms every 13 or 17 years (both prime numbers). That isn't an accident. These long, prime-number cycles help cicadas avoid predators whose life cycles are shorter and more regular. If a cicada group comes out every 13 years, it won't often line up with predators that peak every 2, 3 or 5 years, because 13 can't be divided by those numbers. So the cicadas are less likely to appear when predator populations are at their strongest. The cicadas that follow these prime schedules are more likely to survive and have offspring.

The same idea also reduces fighting between different cicada groups. A 13-year group and a 17-year group meet only once every 221 years, so they almost never compete for the same food and environment. Prime numbers, then, become the cicada's evolutionary shield, against both predators and rivals.

Sometimes, though, you have to look for primes hiding behind composite numbers. Some bamboo species flower all at once after 30, 60 or even 120 years. Those numbers aren't prime, but they are built from small primes multiplied together. When millions of bamboo plants bloom and drop seeds at the same time, seed-eaters like rodents simply can't eat them all. Then, during the long gap between flowering years, predator populations shrink because there's not much to feed on.

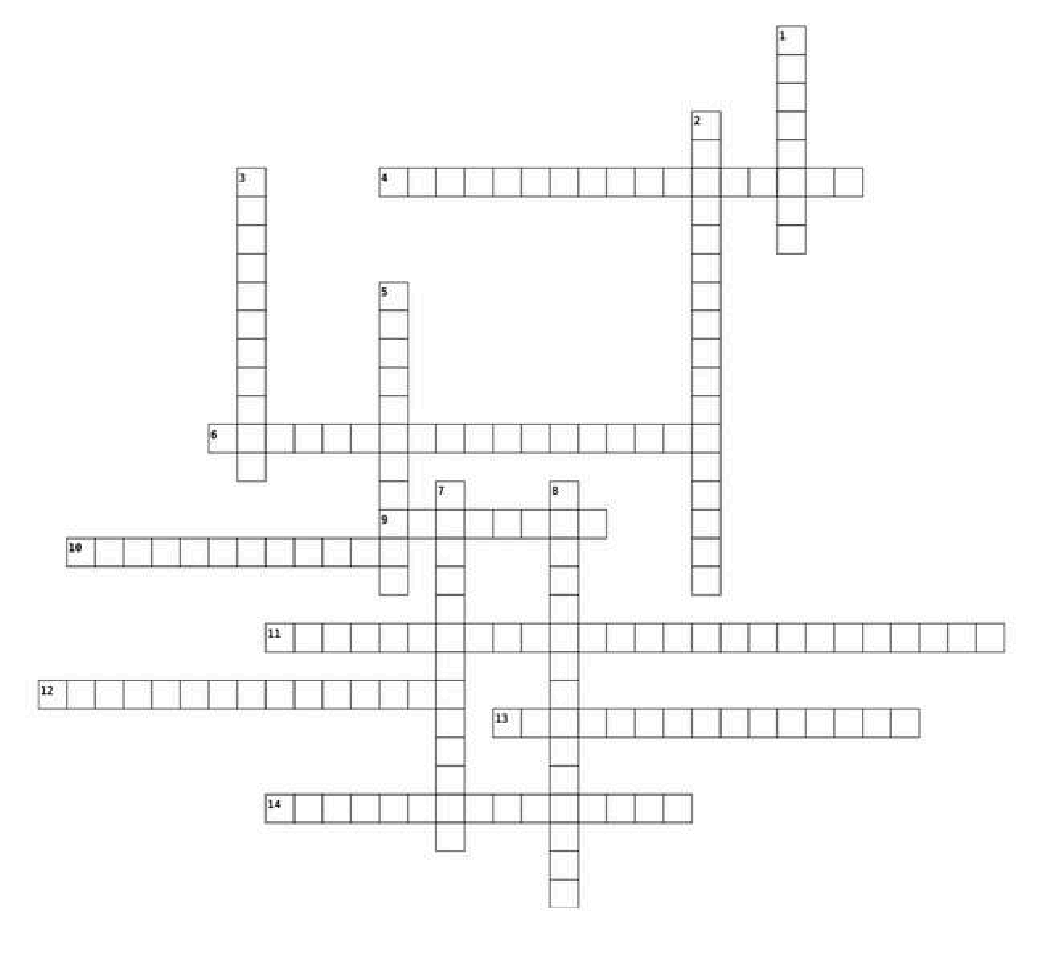
Over many generations, these flowering cycles can also shift in a simple way: by multiplying. Plants that bloom at exact multiples of the group's cycle still stay in sync, but plants that bloom off-cycle lose the safety of mass flowering. Over time, the cycles that survive are the ones that keep the shared rhythm, often numbers made from combinations of small primes.

So these examples give us a glimpse of species acting as if they're playing a game of mathematics with nature.

But there's another way to think about nature too: as something orderly, predictable, and ruled by laws. And here, prime numbers still bother us. They aren't random, but they also don't follow an easy pattern. Yes, we can list primes in order. But no one knows a formula that lets you jump straight to the nth prime without doing the work in between. You can't simply skip to the 1000th prime without finding the earlier ones first. In that sense, primes are a kind of paradox: perfectly ordered, yet stubbornly hard to predict, strangely like nature itself.

Crossword puzzle

Patterns in nature



DOWN

1. Bright wavy shapes made by bending and focusing light, like on the bottom of a pool.
2. A number that shows how detailed or complex a fractal shape is.
3. How leaves, seeds, or petals are arranged on a plant, often in spiral patterns.
5. A point where one path or outcome suddenly splits into two.
7. How living things grow and develop into their shapes.
8. The basic ways atoms can be arranged evenly in a crystal.

ACROSS

4. A tightly organized shape made of hexagons, like a honeycomb.
6. A number pattern where each number is the sum of the two before it.
9. A movement, like sliding or rotating, that keeps a shape the same size.
10. A special number found in nature and art that looks naturally balanced and pleasing
11. A chemical process that creates patterns like stripes and spots on animals.
12. A shape that uses the least amount of surface area possible, like a soap film.
13. When something looks similar to itself even if you zoom in or out.
14. A way that space naturally divides into cell-like shapes based on distance.

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Patterns in animal behaviour
Uncovering hidden meanings

Kshamya Hundia -9B

Animal Behaviour, or Ethology, shows that predictable patterns in animal actions can be explained through evolution. The patterns exist because animals have to face the challenge of survival and reproduction. A study of these patterns helps us understand how different life forms have adapted over time for the purpose of survival and reproduction in various environments.

The foundation: Innate vs. Acquired

Animal behavior originates from two basic types of sources: inherited, or innate, and acquired, or learned.
Instinctive or innate behaviour is innate, meaning it is present at birth or hatching, and does not depend on experience or learning. Such behaviour is highly reliable for rapid survival

A fixed action pattern is an unchangeable sequence of behaviors triggered by a specific stimulus called a "sign stimulus" or "releaser."
Classic Example: The Graylag Goose Egg Roll When a mother goose sees an egg outside of her nest, in this case the sign stimulus, she starts the FAP with the rolling of the egg with her beak. It is such an automatic behavior that even when the egg is pulled away from her mid-roll, she will continue in the rolling motion until she reaches the nest.

Animals employ two kinds of innate movements in order to orient themselves toward or away from environmental stimuli:
Taxes (Directional): Directional movements, for example, a moth moving directly towards the source of light. Positive phototaxis
Kinesis (Non-Directional): Changes in an animal's activity level that do not occur in any particular direction.

Example: Woodlice move randomly and quickly in dry air until they reach a humid area, where their movement speed slows down. They change their movement speed based on moisture level but do not know the location of the moisture beforehand.

Acquired behaviour is learned and altered during an animal's lifetime due to its life experiences. This allows many ways for an animal to interact and adapt with its local environment.

Learning is most useful for animals that have complex, dynamic environments or those with long lifespans.
The simplest form of learning is that of habituation-learning to ignore a repeated stimulus that provides neither positive nor negative useful information.
Example: A city squirrel runs away when a bus passes. After many days, the squirrel becomes habituated to the bus noise, saving the "panic energy" for real dangers.
Imprinting is an irreversible learning experience that occurs during a very short, specific period in early life called the sensitive or critical period.
Example: Ducklings and goslings imprint on the first big, moving object presented to them-that is, they form an enduring relationship and follow it. Konrad Lorenz showed this when he demonstrated that very young ducklings would imprint on him.

Associative learning involves linking one event or stimulus with another.

- Classical Conditioning: Learning to connect a neutral stimulus (such as a sound) with a meaningful one (such as food)
- Operant Conditioning (Trial-and-Error Learning): Learning to associate a voluntary act with its consequence (Reward or Punishment).

Whether innate or learned, a behaviour has an obvious evolutionary function. It is these functions that determine the major patterns observed in the wild.

1. Foraging and Feeding Patterns

These behaviors focus on the procurement of sufficient energy to live. According to Optimal Foraging Theory, animals develop ways of maximizing net energy intake, balancing energy spent against energy gained.

Example: A crow choosing which size of clam to spend time breaking, based on which effort yields the most calories.

2. Defensive and Anti-Predator Patterns

Avoiding being eaten is a primary driver of behavior.

Aposematism - WARNING: bright colours (distinctive markings) or loud buzzing/ vocalizations that signal danger to would-be predators.

Mobbing: A coordinated, aggressive pattern by a group of prey animals, such as small birds, to harass a predator, such as an owl, to drive it away from a nesting area.

3. Reproductive Patterns

These patterns are often highly specialized and driven by sexual selection, where traits that improve mating success are favoured.

Courtship Rituals: these are stereotyped patterns of movement, sound, or display which denote species identity, sex, and fitness; for example, the intricate dances of the Blue-footed Booby.

Mate Choice: A pattern whereby one sex-usually the female-assesses a mate based on the quality of display, territory, or physical traits and selects based on those assessments.

Animal behavior represents the practical result of evolution-a strategy honed for survival and reproduction. Decoding the core rules of innate and learned behaviours, functional imperatives, and social coordination, we understand that behaviour is a basic means whereby species achieve life success. Ethology shows that understanding behavioral patterns is central to grasping mechanisms of life persistence and adaptation, and can successfully lead us to the persisting question, how did we come to exist?

Spirals in Galaxies

Shaambhavi Tiwari- 9A

Consider the night sky full of stars; it appears as though they are randomly scattered. However, on the larger side of the universe, there are stunning patterns, and one of the most fascinating patterns is that of galaxies, particularly their spiral structure. Far from being haphazard, galaxies more often than not follow graceful and mathematical shapes on their path, indicating some latent forces at work in the universe.

The Beauty of Spiral Galaxies:
Spiral galaxies represent one of the most prevalent categories in the universe, constituting approximately 70% of the discovered galaxies. Our Milky Way is an example of such a spiral galaxy. Flat rotating disk structure with stars, gas, and dust makes up the core bulge of older stars. Spiral arms emanate from the center and curl elegantly like massive cosmic whirlpools.

Why Do Spirals Form?:
One might be tempted to suppose that the spiral arms consist of the identical stars that revolve together, much like the blades of a fan. However, the spiral structure is not even semi-permanent; it resembles a density wave more than anything else. As cars go in and out of various crowded parts of a highway, so do the stars move in and out of these arms as they circle the center of the galaxy. The arms are brighter because they are regions of higher gas density, where the clouds of gas compress and lead to the formation of new, hot, luminous stars. It is these young stars that illuminate the arms, making the spiral structure apparent.

The Hidden Mathematics:
Galaxies ' spirals often resemble the golden spiral, which is part of the Fibonacci sequence. That mathematical shape can be seen in seashells, hurricanes, and sunflower seed arrangements. The spirals of galaxies are not perfect examples of the golden spiral, but does their similarity imply that the universe acts according to some natural laws in growth and movement? Probably; Who knows?

A Clue to Cosmic Evolution:
Spiral patterns reveal the life cycle of a galaxy to an astronomer. Spirals represent a high rate of star formation; hence, the galaxy continues to evolve. Over billions of years, some spiral galaxies may become more and more amorphous and lose their structure to become elliptical, while others keep forming new stars.

The Significance of these Spirals :
The spiral structure of these galaxies is not just beautiful to look at, but it is also crucial to science. Astronomers can learn more about star formation, the impact of dark matter, and the life cycle of galaxies by examining the form, motion, and brightness of spiral arms. The structure of our own Milky Way, which we cannot see from the outside, is also better understood by scientists thanks to spirals. Spiral galaxies thus act as natural laboratories that show how cosmic forces sculpt the cosmos.
In conclusion, Spiral galaxies are more than just beautiful cosmic designs. By examining such spirals throughout the universe, scientists can learn more about the past, present, and future of our own spiral galaxy, the Milky Way. These expansive and beautiful patterns serve as a reminder that the universe is shaped by order, mathematics, and strong, invisible forces beneath the night sky's seeming randomness.

Arms that swirl in a
cosmic dance,
Stars and dust in a
glowing trance.
A home for billions,
turning endlessly—
What am I, spinning
through eternity?

Tesselations inherent strength

Why nature loves the hexagon

Kahaan Modi- 10D

The honeycomb is one of the most fascinating examples of tessellation in nature. It is made of repeating hexagons that fit together crisply. There are no gaps or overlaps. When we study this patternclosely, we realise it's not only beautiful to look at, it is extremely efficient as well.

The hexagon component of the honeycomb solve an important geometric problem. It encloses the maximum area using the least possible perimeter. For honeybees, this means they use the smallest amount of wax for their hives. This saves a lot of energy with an increased capacity for honey storage. The 120 degree angles of each hexagon spread weight evenly making the entire comb strong and stable.

This same hexagonal pattern appears in many places in nature. When lava cools slowly after an eruption, it can form tall hexagonal basalt columns. Insects have compound eyes made of tiny hexagonal lenses that help them see more efficiently. Some reptiles also have hexagonal scale patterns that help cover their bodies evenly without weak gaps. This gives them both protection and flexibility.

Humans have learned from this design through biomimicry. Today, even cardboard packaging uses a honeycomb pattern instead of plastic bubble wrap to protect fragile items. It is light, strong, and uses flat yet expandable material. I saw tessellation in use in architecture to make the magnificent Vessel at Hudson Yards in New York. It felt like a giant, human built honeycomb. Closer to home in Ahmedabad, while learning about our history, I learned that the stone lattice of Siddhi Sayed ni Jali also uses tessellation. This shows how repeating geometric patterns have inspired strength and beauty for centuries. We are reminded of the power of nature. It inspires humans in various fields of science, design and countless others.

Sand dune transformations

Prisha Roy- AS levels

Sand dunes are the sculptures of the earth, created gradually and almost imperceptibly by the air. Indeed, sand dunes can be found both along the seashore and in the desert, but in each case the wind selecting small particles of sand from a surface and taking them away is the starting point of the story. And grain by grain, a little heap of sand grows, developing a gentle slope on the side from where the wind comes and a steeper slip face on the side covered with tiny avalanches of sand which slide down.

A single process can account for an amazing variety of dunes. Crescentic dunes, the most common and fastest moving, are curved in the form of a broad letter C, their opening towards the wind. Their natural, curved slip face makes them look almost hand-carved. Where winds from two mostly opposite directions are of about equal strength, one can observe long linear dunes. These narrow ridges are compared to ribbons, and sometimes they bend into gentle, snake-like curves.
The origin of the word star dunes is the place where the wind direction is confusing. Several pointed arms extend from a central peak; each arm represents the direction of a different wind. Such dunes can have towering, dramatic shapes that dominate the Sahara and other deserts as they grow upward instead of sideways.

The dunes are like a book telling a story. Just near the beach, embryo dunes are small and bright, only a few metres high. Farther from the sea, the dunes get higher as plants, especially hard marram grass, both protect the sand with their strong roots and stabilise the dunes, while at the same time allowing plant material and microorganisms to darken the formerly yellow sand to grey. Between the dunes, slacks can be found-low depressions shaped by the wind. In some places, these go so deep that they reach the water table and form wet, salty hollows.
All dune landscapes are a result of ceaseless change and developments brought about by the unending dialogue of wind, sand, and time. They may sometimes give an impression of being stationary, but dunes are always on the move, always making their own changes. To observe them is to observe their slow, elegant performance-even to the extent of a single grain of sand.

Peaks and troughs, crests and falls, I move and shift as wind blows, made of many tiny smalls. What am I?

NEUTRAL NETWORK PATTERNS IN THE BRAIN

Meha Timbadia- IBDP 1C

When we think, remember, or even daydream, the brain is doing something remarkable behind the scenes: it is creating patterns. These patterns—formed by billions of neurons communicating through trillions of connections—are what scientists call neural networks. Unlike the artificial neural networks used in computers, the brain's networks are alive, constantly adapting, and shaped by our experiences.

I spark when you think and
connect when you learn,
Billions of branches in
twisting turns.
From memory to motion, I
run the show—
What am I?

While it's easy to ignore a single neuron's contribution to brain processing, thousands of neurons firing together in concert will result in the formation of discrete gestalts or patterns. To recognize someone's face, remember a childhood event, or learn anything new, these patterns for processing information. The brain does not store information as an index card in a filing cabinet; rather, a memory or thought is created when the specific combination of neurons firing at the same time creates a unique pattern for that memory or thought. In other words, the pattern is the information.

Neuroplasticity, which is the ability of the neural patterns that comprise a brain's processing circuitry to change over time, is one of the most interesting features of these neural patterns. Neuroplasticity allows the neural circuitry of a brain to re-arrange itself based upon the learning, memory, and experience of the individuals who reference that brain's processing circuitry. For example, when we learn to play the piano by practicing (and/or watching ourselves play) and/or when we study for an examination by reading information in school and/or studying for an exam, the network of neurons most commonly associated with a skill or information gets stronger due to the increase in the number of connections between the neurons. Conversely, when we are not actively learning to use the neuron network, the network connection will get weaker and, in many cases, lose their ability to transmit information effectively. Neuroplasticity explains how people can learn new languages, partially recover from injuries, and develop new skills as they adapt to a new environment.

The rhythms used by neural networks are similar to how the human brain uses brainwaves, which provide an electrical signature of when large groups of neurons are firing simultaneously. Different brainwave rhythms will occur when we sleep, focus on something, and make decisions, and scientists are beginning to explore how the breakdown of these rhythms occurs in neurological conditions. Irregular neural activity is evident in the neurological conditions of epilepsy, schizophrenia, and Alzheimer's Disease, and understanding these aberrant patterns may lead to the development of more effective therapies.

This area of research is exciting because it combines biological and technological facets of how we think, react, and perceive the world around us. In a sense, artificial intelligence has borrowed concepts from the basic hardware architecture of the human brain; however, the current state of development is far less advanced than the actual neural structures present within the human brain. The result of an individual's thought process is a product of the combined billions of minute electrical signals generated over time as each individual creates the fabric that eventually becomes all thoughts that define one's personality.

WORD SEARCH

H	L	C	F	X	P	F	F	G	F	E	E	R	J	C	F	A	F	R	X
O	Y	O	A	G	T	C	Y	C	L	I	C	I	Q	B	J	U	Y	M	Q
N	A	M	G	M	T	A	R	I	W	L	I	P	G	F	K	T	Q	R	S
E	K	H	P	A	O	Y	Q	K	R	R	B	P	U	I	A	F	W	D	K
Y	R	B	O	Y	R	U	X	E	V	B	I	L	W	B	K	E	W	G	Z
C	M	E	B	D	V	I	F	S	G	T	T	E	E	O	Q	M	Q	D	U
O	P	K	P	V	W	H	T	L	J	Q	C	S	Z	N	Z	S	Y	Q	C
M	B	T	X	E	E	A	P	H	A	Y	E	H	G	A	R	D	Y	V	U
B	J	B	E	T	T	Z	F	W	M	G	Q	M	S	C	C	H	B	N	Q
F	H	S	K	S	U	I	J	W	S	I	E	D	R	C	V	M	Z	Z	V
R	Z	T	O	U	S	T	T	L	V	R	C	Q	C	I	P	G	I	B	L
A	I	R	Z	A	H	E	W	I	L	P	Z	S	S	S	J	U	W	I	D
C	K	I	N	B	M	V	L	T	O	G	R	I	E	E	I	B	S	O	M
T	U	P	G	H	N	D	I	L	U	N	O	Z	L	Q	L	O	N	D	F
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L	Y	S	Z	S	A	D	H	P	T	T	T	J	S	E	V	E	P	X	M
C	U	P	A	T	T	E	R	N	S	Q	I	M	O	N	J	K	N	E	L
S	P	I	R	A	L	F	H	O	G	Y	G	O	S	C	X	Q	I	C	C
J	D	X	A	S	Y	M	M	E	T	R	Y	Q	N	E	X	R	P	T	E
S	N	N	G	C	L	A	A	A	L	P	R	H	A	L	S	Y	Q	F	X

STRIPES
SYMMETRY
CAMOUFLAGE
TESSELLATION
REPETITION
FRACTAL
RIPPLES

CYCLIC
FIBONACCI SEQUENCE
LOGARITHMIC SEQUENCE
HONEYCOMB
SPIRAL
PATTERN

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Golden ratio in biology

A Little Bit Of φ-Magic!

Parishi Kavi- 11 GB
Science

Have you ever noticed how some things in nature seem to look perfectly designed? The simple swirl of a seashell, the perfectly shaped petals of sunflowers, or the simple yet eye-catching structure of a pine cone, all of them seem to follow a mysterious pattern. That pattern is known as the Golden Ratio, and believe me, it's far more fascinating than it appears. Consider it the number that nature prefers: 1.618..., and it continues endlessly, much like nature itself.

The Golden Ratio, commonly denoted by the Greek letter φ (phi), occurs when the ratio of two amounts equals the ratio of their total to the larger quantity. Seems intricate? To simplify: if nature composed poetry, φ would be her preferred rhyme pattern.

Even pine cones, hurricanes, galaxies, and at times human faces correspond with this ratio. It's no surprise that artists and architects enjoy exploring it, but the most fascinating aspect is that it occurs in nature, without any intentional design. It's almost as though biology and mathematics are secretly best friends.

I guide the shells of snails
and the petals of flowers,
A number so perfect, it's
whispered by nature for
hours.
Neither whole nor simple,
yet patterns I create so grand,
What am I, found in
Fibonacci's hand?

A different remarkable instance is the Nautilus shell. Its spiral develops in such a manner that every new chamber is relatively bigger than the last, while the overall form stays consistent. It's as if the shell is growing while maintaining its "identity." This development trend aids the organism in preserving stability and floating ability.

Even pine cones, hurricanes, galaxies, and at times human faces correspond with this ratio. It's no surprise that artists and architects enjoy exploring it, but the most fascinating aspect is that it occurs in nature, without any intentional design. It's almost as though biology and mathematics are secretly best friends.

What makes the Golden Ratio captivating is not merely its existence, but its function. Adhering to this ratio, nature frequently attains peak efficiency, strength, and beauty simultaneously. It's as if the universe found a shortcut and applied it everywhere. The next time you gaze at a flower or hold a seashell, keep in mind, you're experiencing more than just nature. You're observing math in a different form. And who claimed that biology and math aren't compatible!

In the end, the Golden Ratio isn't just a number. It's a reminder that our world is full of hidden patterns waiting to be discovered, all you need is curiosity and a little bit of φ-magic!

DNA BASE SEQUENCES

Virja Patel- IBDP 1B

At first glance, DNA appears to be a long chain of four letters arranged in an almost endless sequence. Yet within this simple alphabet lies a remarkable world of patterns that guide the behaviour, identity and evolution of living organisms. Modern genetics has revealed that DNA is not only a carrier of coded information but also a text filled with signals, rhythms and structural cues that determine how life functions at its most fundamental level.

One of the most intriguing features of DNA is the presence of motifs. These are short repeating sequences that act like key phrases within a long paragraph. Cells use them to recognise where important processes should begin. A well known example is the TATA box, a short sequence that instructs transcription machinery where to start reading a gene. Although tiny in length, such motifs influence when a gene turns on, how strongly it is expressed and how cells respond to their environment.

Another hidden pattern is found in repetitive DNA. These are sequences that occur many times throughout the genome. Scientists once believed they served no purpose, but research now shows that repeats help organise chromosomes, maintain genome stability and create natural variation within populations. The same repetitive regions are used in genetic identification techniques such as DNA profiling because the number of repeats differs from person to person.

There are also regions known as CpG islands, where the letters C and G appear together far more often than expected. These areas play a central role in epigenetics, the system through which chemical marks control gene activity. When these CpG sites are methylated, the related gene may become silent. When they remain unmethylated, the gene is more likely to be active. This small pattern can influence development, cell identity and susceptibility to certain diseases.

With the help of modern computational tools, students and researchers can now explore these patterns directly. Platforms such as the MEME Suite identify motifs within seconds, while visual approaches like Chaos Game Representation transform DNA into geometric patterns that reveal deeper structure. These tools make it possible for young scientists to study the hidden language of DNA even outside a laboratory.
DNA is far more than a simple sequence. It is a carefully arranged text in which every pattern carries meaning. Discovering these patterns brings us closer to understanding how life writes its own story

I'm a twisted ladder
where letters form a
code,
A, T, C, G are the steps on
my road.
Copy me wrong, and cells
may complain—
What am I, the blueprint
inside every grain?

SEASONAL MIGRATION ROUTES

Why Every Species Travels Differently And Carve Their Own Paths!

Aarna Shah- 9C

Seasonal migration is a remarkable natural phenomenon where creatures travel vast distances between habitats to survive and thrive across changing seasons. This behaviour plays a crucial role in ecology —enabling species to find food, secure breeding grounds, and avoid harsh climatic conditions. While many people associate migration primarily with birds, this adaptive strategy extends across mammals, fish, reptiles, and even insects. This article explores why different species follow distinct seasonal migration routes across the globe and examines the key factors that shape these extraordinary journeys.

Migration patterns vary dramatically across the animal kingdom. The Arctic Tern undertakes perhaps the most extreme journey, traveling approximately 40,000 km annually from its Arctic breeding grounds to the Antarctic and back. This pole-to-pole migration allows the species to experience nearly continuous summer, maximizing food availability throughout the year.

The Bar-tailed Godwit demonstrates another impressive strategy: some populations complete the longest known non-stop flights, covering over 11,000 km without rest—flying from Alaska to New Zealand or Australia across the Pacific Ocean.

Migration is not limited to birds. In Africa, massive herds of wildebeest migrate annually across the savanna, following seasonal rainfall patterns. These terrestrial migrants move between grasslands in search of fresh vegetation and water sources.

Research on little ringed plovers in Sweden reveals that migration routes differ between seasons. Autumn migration averaged 5,974 km, while spring routes were 5,612 km. Importantly, birds demonstrated different stopover strategies: in autumn, flight distances increased as the season advanced, whereas spring migration showed the opposite pattern.

Fish migrate to find food, safe breeding grounds, and the right water temperature. For example, salmon swim from the ocean back to rivers to lay eggs, traveling hundreds of kilometres upstream. Eels make long ocean journeys to the Sargasso Sea to spawn. Many fish follow ocean currents and use Earth's magnetic field to stay on the same route each year.

Reptiles migrate mainly for nesting and to stay in suitable temperatures. Sea turtles travel thousands of kilometres to return to the exact beach where they were born to lay eggs. In dry seasons, crocodiles move between rivers and wetlands to find enough water. Their routes depend on heat, sunlight, and familiar landscapes.

Insects migrate to escape harsh weather and to find food. Monarch butterflies fly nearly 4,000 km from Canada to Mexico each year. Locusts move in huge swarms following fresh vegetation after rainfall. Many insects use wind patterns and the sun to guide their long journeys.

These migration examples show how animals adapt to seasonal and environmental changes. The Arctic Tern travels to take advantage of summer food at high latitudes while avoiding polar winters. The Bar-tailed Godwit's nonstop ocean crossing reflects extreme energy efficiency where no stopovers exist. Wildebeest migrations demonstrate group movement in response to rainfall.

Migration enables species to maximize survival by strategically exploiting different habitats at optimal times, representing a time-minimizing strategy where animals adjust routes and stopover durations based on environmental conditions.

Seasonal migration routes illustrate how animals exploit temporal and spatial variations in the environment to survive and reproduce. Understanding these patterns provides insight into animal adaptation and evolutionary strategies.

As climate change alters resource distribution and habitat availability, preserving migratory corridors becomes increasingly critical for the survival of migratory species worldwide.

I move without legs, carry birds, whales and people across land and sea each year toward safer, warmer places—what am I?

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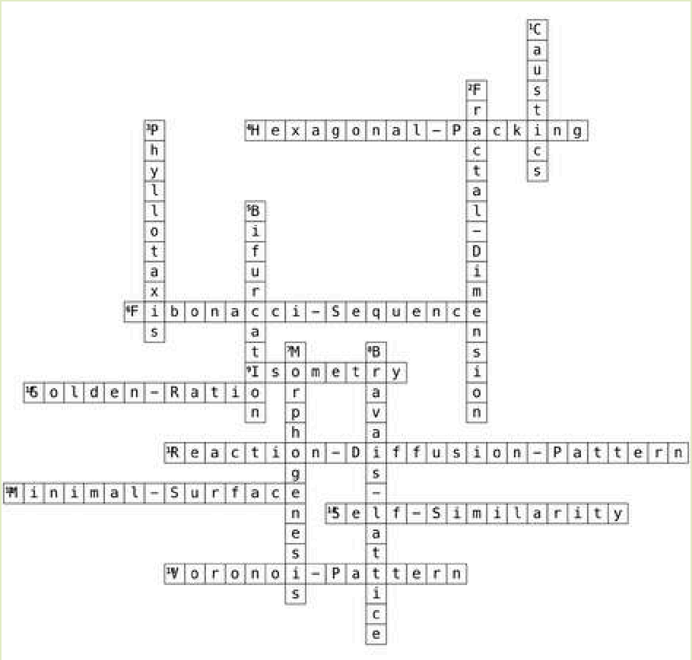
Answer key

Crossword Puzzle:



Riddle on page 15: A spiral galaxy

Riddle on page 18: A sand dune

Riddle on page 19: Neurons in the brain

Riddle on page 23: The golden ratio

Riddle on page 25: DNA

Riddle on page 28: Migration

Word Search:

These words are displayed diagonal, down, and forward.

(C, 10) STRIPES
(E, 19) SYMMETRY
(C, 1) CAMOUFLAGE
(C, 8) TESSELLATION
(B, 5) REPETITION
(A, 10) FRACTAL
(M, 1) RIPPLES
(G, 2) CYCLIC
(O, 3) FIBONACCISEQUENCE
(B, 1) LOGARITHMICSEQUENCE
(A, 1) HONEYCOMB
(A, 18) SPIRAL
(C, 17) PATTERN