

JANTAR MANTAR

CHILDREN'S SCIENCE OBSERVATORY

English Bi-Monthly

Volume 25 Issue 5 September - October 2025 Rs. 30.00



"Kelping Tendencies"

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Humpback whales are frequently photographed with clumps of seaweed on their head. Many people have also recorded that whales play with seaweeds, roll them in and toss them over their bodies. Some whales even pass the seaweeds to one another.

The practice of putting seaweeds on their heads has fascinated researchers. Some scientists playfully call them “Seaweed wigs”, while some others call it “seaweed hats or seaweed caps”. Humpback whales, Northern right whales, Sperm whales, Gray whales and Southern right whales do it. This behaviour is called “Kelping”, because whales prefer to use the kelp seaweed as hats.

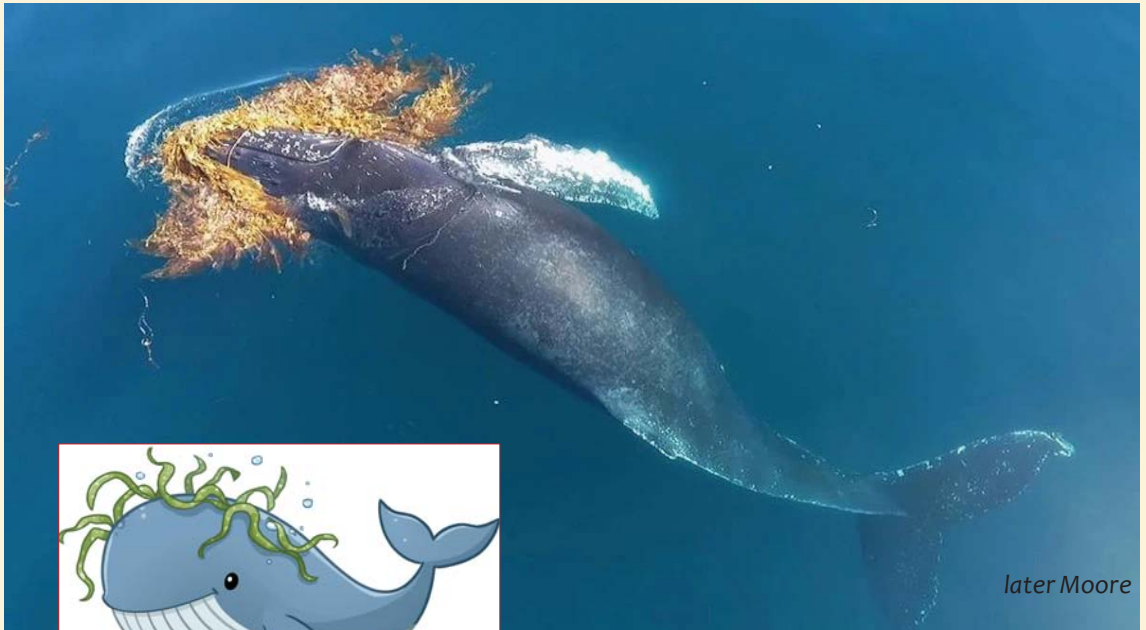
Why do whales do it?

Since we cannot go up to these massive yet gentle creatures and ask them, “Buddy, why are you doing this?” (Oh! How I wish we could talk to these animals), the next best thing to do is to conduct a thorough behavioural research. That is exactly what a group of Griffith University scientists did in 2023. They realised that at the most basic level, it is a playful activity, but they also point out that like most of the play activities in the animal kingdom, it has a lot of benefits.

Many whales have a sensory system on their head, so some scientists say that keeping seaweeds on the head might give a nice

Olaf Meynecke/Lorinnah Hesper/Kristin Campbell





sensation - in other words, whales might be using seaweeds to tickle themselves!

Scientist Olaf Meynecke says that this seaweed can be used as a scrubber to clean that part of the head. It can be used to scratch itches or even brush off parasites from the skin. Imagine that a parasite is bothering you but you do not have a hand to flick it away, how frustrating it would be! No wonder the whales use the leathery seaweeds on their bodies as body scrubbers.

Some scientists point out that kelping is also an important aspect of a social activity. Whales tend to share kelp with each other, like exchanging gifts.

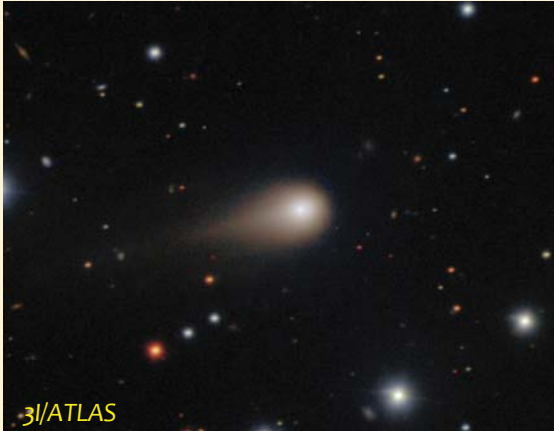
While these are some initial insights, scientists are conducting more studies to know the extent of this behaviour and all the possible benefits.

Modern technology and whale research

A few decades ago, research like this could not have happened. It is very difficult to observe whales in their full view and record their behaviour. The introduction of drones and advancements of technology have helped in capturing high resolution images and track the whales wherever they go.

The advent of social media is also a very important tool in identifying patterns across the world. As whale watchers eagerly share their photos, scientists who study whales are able to observe behavioural patterns and easily gather a large amount of data. Scientist Olaf Meynecke says that the social media pictures of Kelping whales were very helpful to him during his work.

Do you like whales? What do you like the most about them? Write to JM and let us know what you think!



A comet from another Sun

Kamal Lodaya

On 1 July, 2025, a new comet was discovered by the *Atlas* telescope in Rio Hurtado, Chile, South America. (This **Asteroid Terrestrial-impact Last Alert System (ATLAS)** has been set up to catch asteroids approaching Earth). The comet was approaching from the direction of the **Milky Way galaxy**, in the constellation of Sagittarius (*Dhanu*).

It had been accidentally observed earlier during May and June. From this data we know two amazing things. First, that it is the fastest moving object we have seen in our solar system, travelling at over 2 lakh km per hour. This is faster than the speed of our fastest planet Mercury going around the Sun. Second, this means that it is coming from *outside* the solar system. Sometimes the Sun sends comets outside the solar system when they venture too close. This comet has possibly been sent off by the star which it is coming from. The star cannot be

identified since there are too many stars in the direction of the Milky Way.

The comet has the name “31/Atlas”. It is not coming close to Earth as it shoots through our solar system (closest on 29 October). It passes closer to Venus, Mars and Jupiter, which are on the other side of the Sun then; see projected track of the comet in the figure. Already NASA’s *Hubble* telescope has seen the usual fuzzy head (where ices are vaporizing) and a faint tail of dust. These



ices are from the planetary system where the comet came from. They are now vaporizing because the now-nearest star, our Sun, is heating them.

The Webb telescope shows an unusually large amount of carbon dioxide vapour,

ice grains vaporizes. This vaporization outside the comet's nucleus has not been seen in most comets.

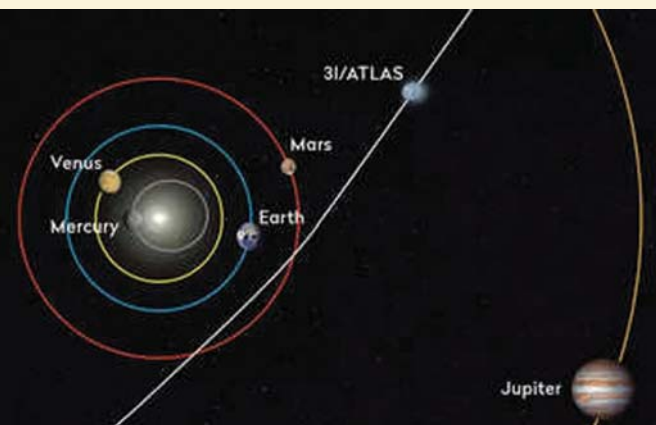
Cyanide and nickel, unusually without iron, are seen in the ultraviolet spectrum from the *Very Large Telescope* in



El Sauce telescope construction

8 times that of water. Along with carbon dioxide escaping the comet, grains of dust and water-ice grains are thrown into space. The dust grains form a tail. The *Swift* telescope suggests that hundreds of kilometres out in space in the comet's fuzzy head, the water in the

Antofagasta, Chile. US graduate student **Rohan Rahatgaonkar** and colleagues speculate that the weathering of *nickel tetracarbonyl*, an organic compound not seen in comets earlier, can account for the nickel detection. Hydrogen cyanide is seen by the *Maxwell* radio telescope in



Trajectory of 3I/Atlas

Mauna Kea, Hawaii. In the observed spectrum from this comet, traces of metallic elements (including nickel) are lower than in the Sun, so the comet could be from a star older than the Sun. This is because older stars in our galaxy have less heavy metals than younger ones. It would be wonderful (but unlikely) if from a detailed spectrum we can identify the originating star.

The comet's nucleus is not yet visible. It is estimated between 0.3 and 5 km in diameter, most likely below 1 km. The tail will grow but the comet will not be visible to the naked eye.

The high speed means that it would take too much fuel to launch a space probe which can catch up with the comet and photograph it. There are proposals to redirect probes already in space, such as NASA's *Juno spacecraft* which has been orbiting Jupiter for a long time. Again Juno does not have enough fuel to

power its way to the comet. Other probes like *Psyche* (on its way to asteroid Psyche) and *Juice* (going to the moons of Jupiter), or those orbiting Mars, can try to take pictures of this comet. Psyche was 4 crore km away on 4 September. NASA has not released any pictures. The **Mars Reconnaissance Orbiter**, **Mars Express** and **ExoMars** attempted observation on 2 and 3 October. *Juice* is closest on 4 November.

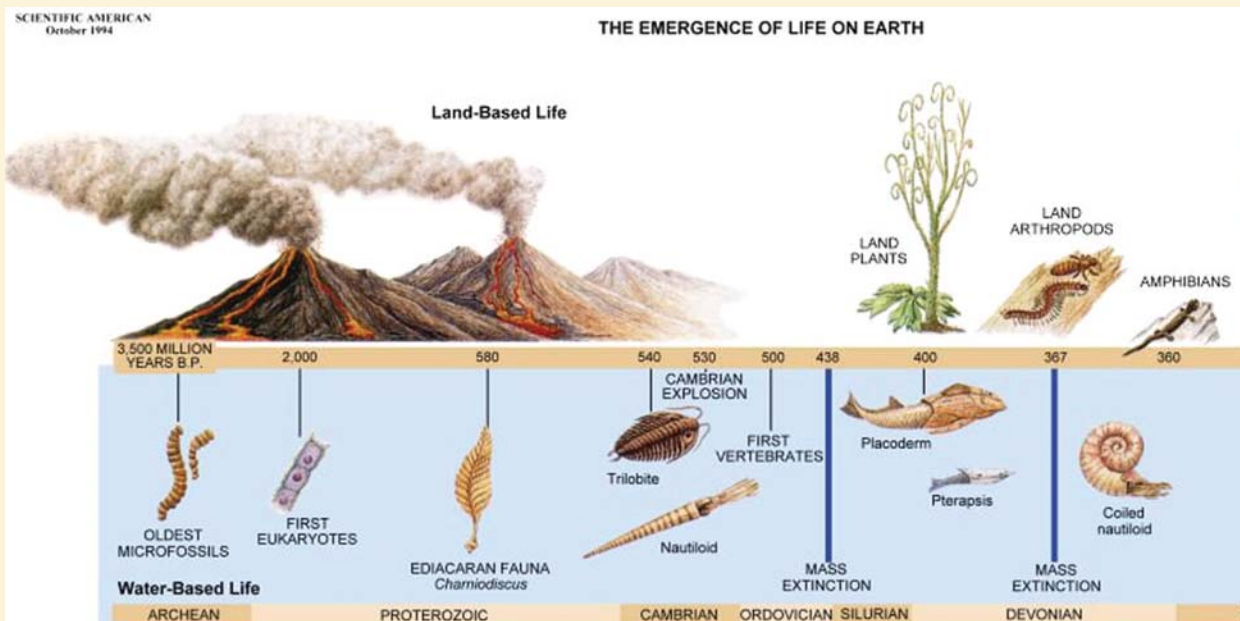
If you can think of a cleverer idea to snap this racing object, please write to us and we will send your idea across to our friendly neighbourhood astronomer. Wouldn't we all like to see a close up of a visitor from another Sun?

Astronomer **Rosemary Dorsey** of the *University of Helsinki* has a different thought. She thinks that interstellar objects (which come from outside our Solar System) like 3I/Atlas are quite common in the Milky Way. We found one in 2017 and then a comet in 2019. (That's why this comet is labelled "3I", the third visitor from interstellar space!) Possibly there are such objects at any time in our solar system. Because they are dark we find it difficult to see them. She estimates that during the next 10 years the new *Vera Rubin telescope* located on the mountain tops east of La Serena, Chile, will find as many as 20 such objects.



Cells growing together

Zareena, Mookayi and Mari



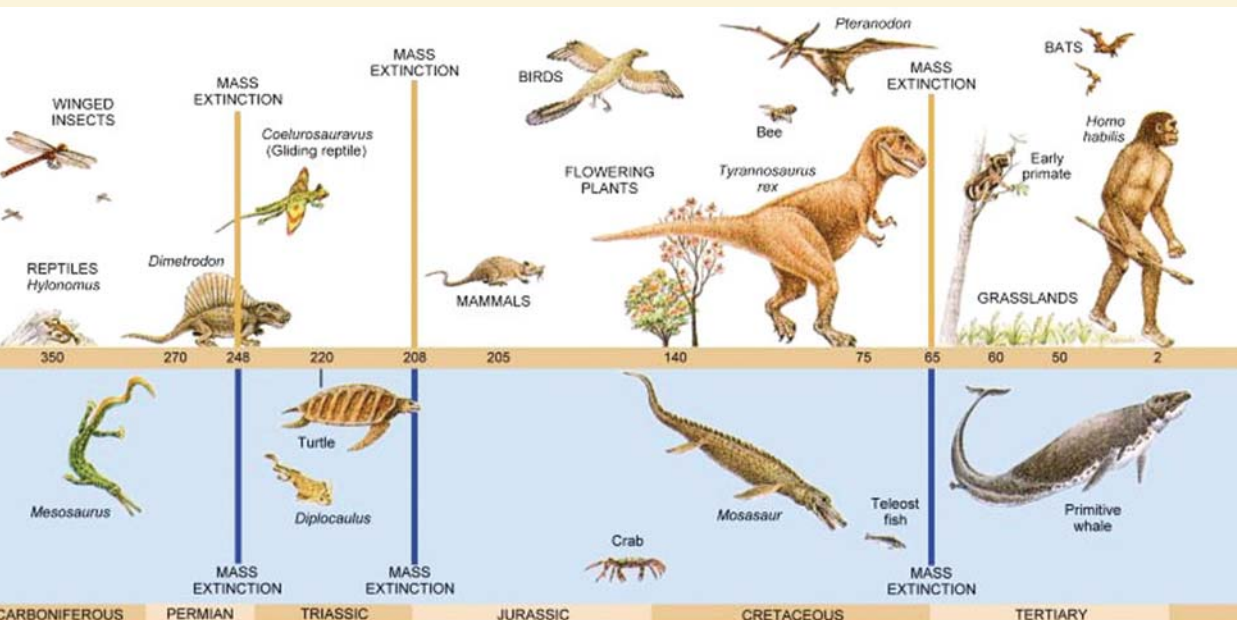
The afternoon sun lazily came into the living room. And rested upon lots of paper, markers, and open laptops. Zareena, Mookayi, and Mari were huddled on the floor, their science project spread out before them. They

had decided to take up exploring how single cellular organisms evolved to give multicellularity across the tree of life.

Mookayi sighed and lay down. “I just don’t get the first step. Why would a

The theory of Evolution, in brief

The theory of evolution states that populations of organisms change through the process of *natural selection*, where individuals with traits better suited to their environment are more likely to survive and reproduce. These beneficial, heritable traits become more common in a population over generations, leading to the diversification of life. Evolution relies on *genetic variation* within a population, which is introduced through random changes like DNA mutations and recombination. The theory of evolution states that all life on Earth shares a common ancestor, from which all species have descended over billions of years through a process called “descent with modification”. This implies that single celled organisms evolved into multi-cellular ones over time. This is another amazing feature: during the development of an animal, the *cells differentiate into the specialised tissues* and organs of the organism. Scientists are still learning how this happens.



perfectly happy single-celled creature decide to stick to another one? What's in it for it?"

"Maybe it was not a decision," Zareena said thoughtfully, scrolling through an article on her tablet. "Maybe it was more like... an accident that turned out to be really useful."

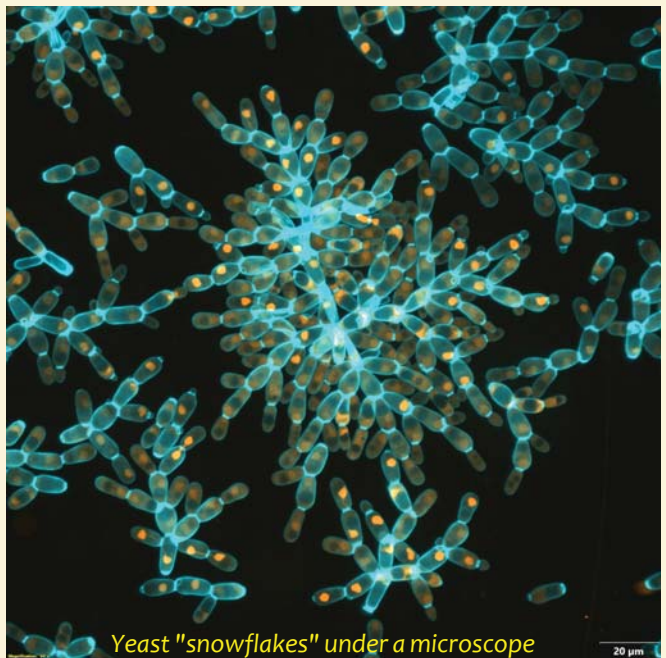
Just then, from the kitchen Mari's mother, Usha, entered with a plate of vadas. Usha was a biologist, and her work at the university involved staring into microscopes at tiny cells all day.

"How's the detective work going?" she asked, setting the plate down in the center of their circle.

"We're stuck on the very beginning, Amma," Mari admitted, taking a vada. "How did multicellularity even start?"

Usha's eyes lit up. "Ah, the ultimate team-building exercise. Well, you're in luck. Scientists have been playing evolution in fast-forward to try and answer that exact question." She sat down with them, and the three closed in, looking forward to hear her.

"Imagine you're a single-celled yeast," Usha began. "You live in a test tube of tasty liquid. Every day, the scientist gives you fresh food, but only if you can sink to the bottom quickly. Who do you think



Yeast "snowflakes" under a microscope

has the advantage?"

"The heavier ones?" Mookayi guessed.

"Exactly! And what's heavier than one cell? A cluster of cells!" Usha explained how scientists had done this experiment of spinning down the cells and taking the ones that were down and starting a fresh culture for them to grow. They found that in just a few weeks, the yeast evolved to stick together after dividing — forming beautiful, branching clusters that looked like a snowflake. These snowflake clusters sank faster and survived. "And the most amazing part," Usha continued, "is that these clusters started acting like a single organism. They had a juvenile phase before they could reproduce, and some cells even

sacrificed themselves—a process called *apoptosis*—to help the whole cluster make more offspring. It was like they had evolved a tiny society.”

“So gravity just... forced them to become multicellular?” Zareena asked, amazed.

“In a way, yes. It showed that the first step—sticking together—can happen surprisingly easily.”

A few days later, the three were back at their project. This time, Mookayi was excitedly showing them pictures of a tiny, wiggling creature called “Paramecium”. “Look! Another experiment used a predator! This little single celled fellow eats single-celled algae. But if the algae cells clump together, they’re too big to eat!”

Usha, who was nearby reading a book, pitched in. “That was a brilliant experiment,” she said. “It tested a very old idea: that getting bigger is a way to avoid being eaten. It’s like how a single sheep is vulnerable, but a whole herd is safer. The algae that evolved in these experiments started forming little balls of cells, some held together by a jelly-like glue, and they were much better at surviving alongside the predators.”

“So it wasn’t just gravity, it could have been predators, too?” Mari asked.

“It could have been!” said Usha. “It shows there might be many paths to the same destination.”

A week later Zareena burst into Mari’s house, holding her notepad high like a trophy. “You are NOT going to believe this! It’s called the MuLTEE! The Multicellularity Long-Term Evolution Experiment! They have been doing it since 2018!”

For the next hour, the three and Usha went over the details. Scientists at the Georgia Institute of Technology, led by a researcher named **William Ratcliff**, had started an incredible project. They began with single-celled snowflake yeast and grew them in shaking incubators. Every single day for over three years—that’s more than 3,000 generations of yeast!—they selected the largest clusters to start the next culture.

“But how did they get so big and tough without falling apart?” Mookayi wondered.

Usha helped them understand the incredible results. “At first,” she explained, “the yeast cells became long and stretchy. This reduced the crowding inside the cluster, like people standing in a line instead of a tight crowd, which stopped them from pushing each other apart. But that alone would not make them huge.”

Then Usha pointed to the fascinating part. To see inside the big, dense clusters, the scientists had to use a super-powerful electron microscope. “And they discovered a brand-new trick the yeast used!” she said, her voice showing excitement. “The branches of the yeast cells didn’t just stick together—they became physically entangled. They grew around each other like vines in a jungle, wrapping and twisting. Even if one connection broke, the whole structure held together because it was a tangled web. It made the yeast clusters 10,000 times tougher!”

“What were they like?” Mari asked, in disbelief.

“They went from being invisible specks to the size of a fruit fly!” Zareena read from the article. “They contained over half a million cells! And the material changed from being weaker than jelly to as strong and tough as a piece of wood!”

Just as they thought the story was complete, Mookayi, who had been quietly searching on her laptop, looked up “I think I found a new clue about our own ancestors.” She turned the screen around. It showed a news article from the University of Chicago. “Scientists found that animals have a special set of proteins that help cells divide in a way

that leaves them connected. This might be how our earliest animal ancestors developed tissues and a special ‘germline’—the cells that make eggs and sperm.”

Usha nodded in agreement. “That was a huge piece of the puzzle! It suggested that a simple change in the machinery of cell division—a mutation that made cells ‘forget’ to fully separate—could have been the key that unlocked the entire animal kingdom. And the MuLTEE shows us how, once that happens, simple groups can evolve the toughness

Will Ratcliff



Convergent Evolution

The ability to form a multicellular structure arose multiple times in different branches of life, a process known as convergent evolution. Multicellularity evolved through various routes, with organisms using different methods to form and maintain multicellular bodies. In fact, it is known that multicellularity evolved independently at least 25 times across different lineages of bacteria, archaea, and eukaryotes (creatures with a proper cell nucleus including animals, fungi, algae, and plants). Each time this occurred through different *evolutionary pathways*. Clearly this repeated evolution of multi-cellular life forms was advantageous; such creatures had increased complexity and a longer lifespan.

needed to become large, complex organisms.”

“So,” Zareena said slowly, “we have the quick gravity experiment, the predator experiment, the years-long MuLTEE, and the protein story... but we still don’t know which one, or what combination, actually happened millions of years ago?”

Usha said gently, “There is yet no one answer, and there may never be only one answer! Actually, multicellularity evolved multiple times throughout life’s history. The initial bacterial forms of multicellularity emerged around 3 billion years ago in cyanobacteria-like organisms. When the evolution of complex, macro-scale multicellular life happened is debated. The earliest eukaryotic fossils suggest multicellularity dates to at least 1.56

billion years ago. The more well-known macroscopic forms like animals and plants appeared later, with some evidence suggesting a rise in multicellularity around 600 million years ago”.

Mari smiled, looking at her friends. “I like that. It means the mystery isn’t over.”

“It means,” Mookayi added, “that maybe one day, we’ll be able to work on these questions.”

Zareena, Mookayi and Mari decided to write up what they had learnt – that going from single celled organisms to multicellular forms of life has happened multiple times during the evolution of the tree of life. And the reason was simple – networking and team effort gave better rewards than working alone.

Brain eating amoeba

(*Naegleria fowleri*)

Dr. Thirunavukkarasu

Dharmalingam,

Salem

What is *Naegleria fowleri*?

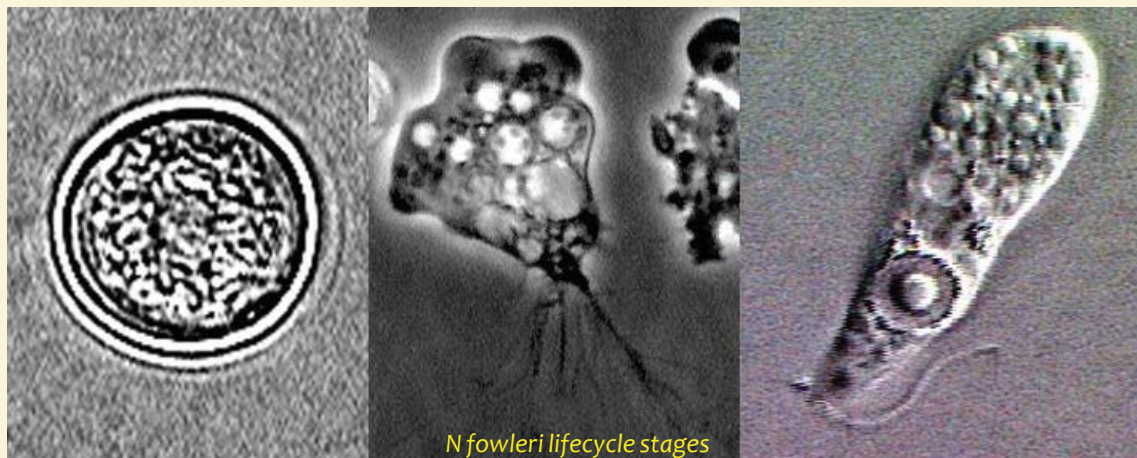
Naegleria fowleri is a single-celled amoeba that causes a very rare but sudden and dangerous life-threatening infection. It is commonly called a “brain-eating amoeba” because it attacks the brain and causes **primary amoebic meningoencephalitis** (PAM). The organism was named after **Malcolm Fowler**, an Australian pathologist at Adelaide Children’s Hospital, who first documented PAM in 1965, 60 years ago. Cases of this infection have recently been

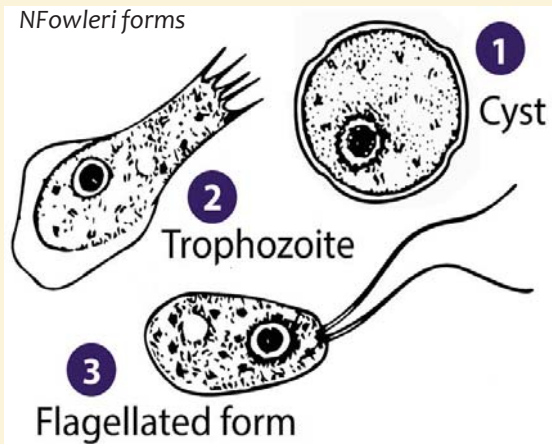
seen in South India, especially Kerala.

Life cycle of the amoeba

Although it is labelled as “amoeba”, it can also behave as a flagellate, that is, an organism that uses a tail or whip-like feature for movement. It can be seen in three distinct stages over its life cycle (see figure which shows the stages as seen under a microscope). When it is not active (dormant), it is visible as a **cyst**. In this capsule-like form, the amoeba can withstand inhospitable conditions such as food scarcity, overcrowding, and cold temperatures below 10°C. When conditions improve, the amoeba emerges through the pore (ostiole) at the center of the cyst.

The **trophozoite** stage is the infective phase for humans, during which the organism can actively feed and replicate. The trophozoite attaches to the special tissue in the nose that is responsible for smell, called the *olfactory epithelium*. From here it uses the nerve cells that are responsible for smell (olfactory





receptor neurons) to enter the brain. This reproductive stage starts at around 25°C and thrives best around 42°C, that is, during really hot summers. The trophozoite develops a temporary arm called *pseudopodia* to move; see figure. While they feed on bacteria in water, when they enter a human brain, they appear to enclose and eat up the blood cells and damage the tissues.

The **flagellated** stage of *N. fowleri* is pear-shaped and biflagellate (with two flagella); see figure. This stage can be inhaled into the nasal cavity, typically during activities such as swimming or diving. Once inside the nasal cavity, the flagellated form transforms into a trophozoite within a few hours.

While it does not form cysts in solid human tissue, where only the trophozoite stage is present, the flagellate form has been discovered in cerebrospinal fluid (a clear, colorless fluid that cushions and protects the brain and spinal cord, provides nutrients, and removes waste).

The main characteristics of this amoeba are:

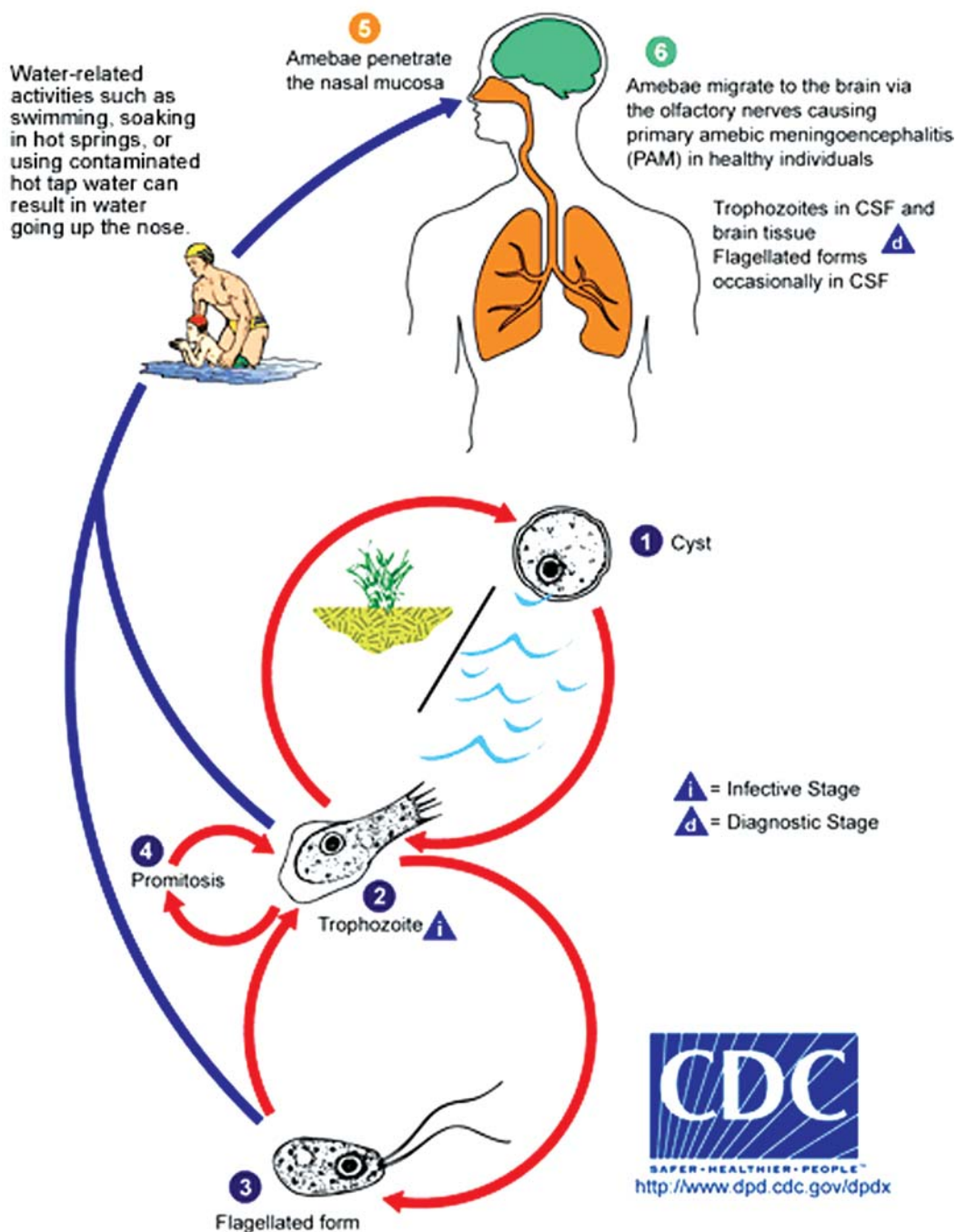
- **Microscopic size:** It is a unicellular (single-celled) organism that can be seen only under a microscope.
- **Habitat:** It grows in warm, freshwater bodies such as lakes, rivers, ponds, and hot springs. While it cannot survive in swimming pools that are chlorinated, they do grow in pools that have not been adequately sterilised. The photo shows the once-popular **Roman Baths** in Bath, England, closed for bathing since 1978 due to the presence of *N. fowleri*.
- **Brain attack:** It enters the human body through the nose and attacks the brain and meninges.
- **Life-threatening:** The infection causes death 97% of the time, but early detection and treatment can save lives.

How does the infection spread

Naegleria fowleri infection occurs in the following ways:

- This amoeba thrives in freshwater at a temperature of 25°C–40°C, especially during the summer months. Contaminated water enters the body through the nose during swimming.
- It does not spread between humans, so you cannot get the infection from touching or being close to an infected person. You cannot get infected if you swallow the infected water as well.

Naegleria fowleri



Symptoms

Symptoms of this infection are similar to flu or meningitis (inflammation of the membranes covering the brain). In the early stages, symptoms include severe headache, fever, nausea and stiffness of the neck. After 5 days, loss of balance and mental confusion is seen, with coma and death in two weeks. Since the

been carrying out awareness campaigns about this amoeba. The Department of Health has issued the following warnings to reduce the risks caused by this amoeba:

- **Nose protection:** Use nose clips while swimming in hot water to avoid entry through the nose.
- **Awareness campaigns:** Disseminate information about Amoeba in schools, swimming pools, and public water bodies.
- **Water Maintenance:** Proper chlorine disinfection and pH level maintenance should be ensured in public swimming pools and water parks.
- **Research and monitoring:** The health department continues to conduct research to improve methods and treatments for this amoeba.

Amoebic meningitis is sporadic, and while the chances of getting it are low, there are measures

people can take to reduce their risk. As the saying goes, “Awareness is the best prevention”; having the correct information can save lives. Stay safe in hot waters and avoid water entering through the nose. Seek immediate medical attention if symptoms appear.

death rate is high, early detection and prompt treatment are critical. However, it is important to note that this is still a very very rare infection, infecting less than 10 people a year.

Statistics in 2025

In India, especially in hot states like Kerala and Tamil Nadu, the health department has



Roman baths, England

Science News

Headlines

- A dinosaur fossil so large, it broke the road during transport!
- Gigantic iceberg breaks free in Antarctica, revealing fish nest beneath
- Two tiny genetic shifts helped early humans walk upright
- Spider web ‘decorations’ may help pinpoint location of captured prey

For more details on some of these articles, read on.

● A dinosaur fossil so large, it broke the road during transport!

Scientists in Argentina have described a new long-necked dinosaur, **Chucarosaurus diripienda**, that stretched about 100 feet. It lived around 90 million years ago in **Patagonia**, at the southern end of South America (parts of Argentina and Chile).

The find adds a big piece to the puzzle of South America’s giant plant-eaters. It is not the largest ever found, but it is large enough to sharpen how researchers think about sauropod body design. Lead researcher **Fernando E. Novas**, of the Bernardino Rivadavia Natural Sciences Museum in Buenos Aires and CONICET, said that the partial skeleton, about 166 million years old, came from Río Negro province and includes hip and limb

elements. The dinosaur’s thigh bone, called femur, is nearly 2 meters long! The limb bones are unusually slender. These appendicular bones, limb bones from shoulders to toes, vary more than expected and carry signals useful for classifying relatives.

“The weight destabilized the vehicle and caused an accident,” said Novas. No one was seriously hurt, and the bones survived the impact thanks to their density. The asphalt did not fare as well under the weight of the fossil blocks, which says something about the scale of these fossils.

Field crews protected the blocks with plaster jackets, then hauled them from the steppe to the capital for study. That journey, inch by inch, is a standard part of turning hard rock into data. In the lab,



careful preparation exposed the muscle scars and joint surfaces that carry the evolutionary signals. From there, anatomical measurements fed the tree-building analysis and the final diagnosis of a new genus and species.

The *Chucarosaurus diripienda* belongs to the **titanosaur**, plant-eating dinosaur group. It would have a long-neck and browse high vegetation. Its long tail likely served as a deterrent against large predators patrolling the same habitats.

The femur, tibia, and ischium reveal a mix of strength and lightness. Slender shafts paired with big muscle scars suggest sturdy support without unnecessary bulk. The fossils came from the Huincul Formation in the Neuquén Basin. This

Late Cretaceous rock unit in northern Patagonia has yielded a rich mix of dinosaurs and croc-line reptiles. Río Negro has not produced many giants of this scale. Filling that geographic gap helps test ideas about how climate and plants shaped sauropod diversity across Patagonia.

Mass is not measured directly, so researchers rely on mass estimation, techniques that convert bone measurements into weight. Different methods, from limb scaling to 3D models, can yield different numbers and confidence ranges. One analysis estimated its weight at roughly 69 tons. So the animal sits near the upper limit for land-dwelling vertebrates.



A68 Iceberg

● Gigantic iceberg breaks free in Antarctica, revealing fish nest beneath

Researchers in Antarctica have discovered a strange collection of icefish nests. The scientists were on expedition in the Weddell Sea looking for Sir Ernest Shackleton's lost ship, the *Endurance* (which sank in 1915 and was discovered in 2022) when they found the nesting grounds in a remote area which had, until recently, been underneath a large ice shelf.

When the 5,800-square-kilometre A68 iceberg calved (broke off) from the *Larsen C Ice Shelf*, scientists were finally able to access the seabed beneath. It wasn't easy. "As with a lot of Antarctic research we battled the cold, sieving

freezing cold mud on the back deck for hours," says **Dr Michelle Taylor**, head of science at Ocean Census. But the challenge was worth it as they found something spectacular. Using an underwater robot called '*Lassie*' to explore the seafloor, they discovered more than 1,000 dimples arranged in neat patterns in the sand.

At first, they didn't know what they were looking at. But they were so clear, and clean, in obvious contrast to the surrounding carpet of green phytoplankton. Putting together the clues – the size, shape, and the fact that there were fish nearby – they realised that these were the nests of **icefish** called the *yellowfin notie*.



Icefish are remarkable for surviving in freezing water temperatures in Antarctica. This white-blooded fish (or icefish) has icy white blood, a phenomenon that puzzled scientists for decades. It lacks the red blood cells essential for oxygen transport in humans. Instead, it carries blood proteins that act like antifreeze and prevent ice crystal formation in its organs. That's how it survives not just the cold of the Antarctic, but it can also live out of water for more than two months!

Most of the 1,036 nests were inactive but 72 of them had larvae in the nest or nearby. The fish live deep on the dark, cold Antarctic seabed and build small, circular nests in the fine sediment, and

then the males guard the eggs for around four months. Their main threat comes from predators on the seafloor, like brittle stars and predatory worms, which try to eat the eggs.

The geometric patterns might be a way the fish protect themselves from predators. By arranging their nests in these tight groups, the fish in the centre are protected by the neighbours surrounding them. Larger, stronger fish usually live in the outer nests as these are more likely to be able to defend themselves from predators.

These large nesting areas are also important for the ecosystem around them. "These fish are habitat builders, creating vast nesting aggregations

which will support the wider biodiversity of the Antarctic,” says Connelly. The team from the Weddell Sea Expedition 2019 say the discovery of this unique habitat shows how important it is for the area to be designated as a Marine Protected Area.

● **Two tiny genetic shifts helped early humans walk upright**

Two small genetic changes reshaped the human pelvis, setting our early ancestors on the path to upright walking, scientists say. One genetic change flipped the ilium — the bone your hands rest on when you put them on your hips — by 90 degrees. The rotation reoriented the muscles that attach to the pelvis, turning a system that was used for climbing and running on all four legs into one for standing and walking on two legs. The other change delayed how long it takes for the ilium to harden from soft cartilage into bone, evolutionary biologist **Gayani**

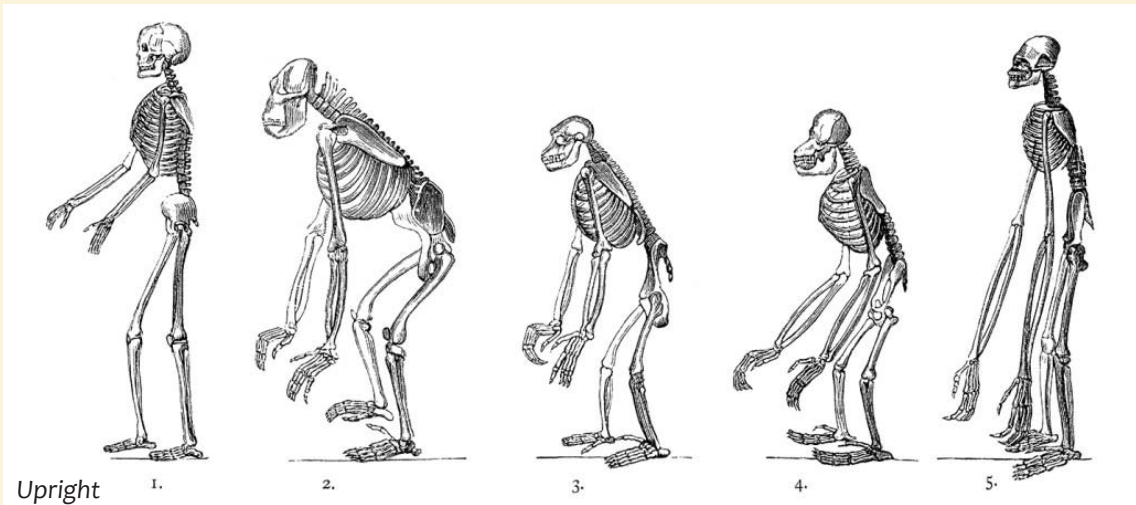
Senevirathne of Harvard University and colleagues report in the Journal **Nature**. The result: a distinctive bowl-shaped pelvis that supports an upright body.

While non-human primates can walk upright to some extent, they typically move on all fours. The figure shows the skeletons of a human, gorilla, chimpanzee, orangutan and gibbon stand next to one another in this

anatomical sketch. Scientists have uncovered two genetic shifts in humans that differentiate the pelvis from those of our primate relatives, allowing us to walk upright newly identified changes to human pelvic development were essential for creating and shifting muscles (that are usually on the back of the animal, pushing the animal forward), to the sides, helping us stay upright as we walk.

The researchers examined tiny slices of developing pelvic tissue from humans, chimpanzees and mice under a microscope, and paired those findings with CT imaging. Human ilium cartilage grows sideways, not vertically as it does in other primates, the team found. What’s more, the cartilage transitions to bone more slowly than in nonhuman primates and in other human body parts. Together, these shifts allow the pelvis to expand sideways and maintain its wide, bowl-like shape as it grows.

A genetic analysis linked the shifts to biological on-off switches that control gene activity. In humans, cartilage-forming genes turned on in regions of the growing ilium that prompted the bone to grow horizontally. Bone-forming genes turned on later and in different spots, delaying the hardening process and letting the cartilage expand sideways. The extra growing time helps



shape the short, wide pelvis that gives humans stability on two legs.

Because developmental genes are largely the same across primates, the team infers that the gene-rewiring activity happened after humans diverged from chimpanzees during the process of evolution. One of the most significant things about this change is it shows how critical it was to establish the ability to stand on one foot at a time, which lets us walk on two feet.

The team's research didn't begin as an evolution story. Funded by the National Institutes of Health, the scientists were studying how the pelvis and knees form to better understand hip disorders. It was geared towards biomedical research, understanding how you build a pelvis and why it's different from other primates, and more importantly, why it leads to disease. Ironically, the changes that made walking possible might also

have made our hips more vulnerable to osteoarthritis, which is far more common in humans than in other primates.

● Spider web 'decorations' may help pinpoint location of captured prey

For a long time, scientists have wondered why spider webs sometimes feature "extra touches" known as stabilimenta; see picture on back cover. Many spider species build spiral wheel-shaped webs (orb webs) to capture flying prey, and many can incorporate stabilimenta into the web structure. These "decorations" may look like zigzagging threads spanning the gap between two adjacent "spokes," or threads arranged in a circular "platform" around the web center. The purpose of stabilimenta was unclear. Various suggestions proposed include water collection, body temperature regulation, and balancing insect

attraction with deterrence of predatory wasps or birds.

Another novel possibility has recently been explored: that when a prey “hits” the web, the impact causes the web to vibrate. These stabilimenta may aid spiders by influencing the way these vibrations propagate. **Gabriele Greco** and colleagues from Sweden observed different stabilimentum geometries constructed by wasp spiders, *Argiope bruennichi*. Based on these structures, the researchers then ran numerical simulations to explore how stabilimenta affect prey impact vibrations.

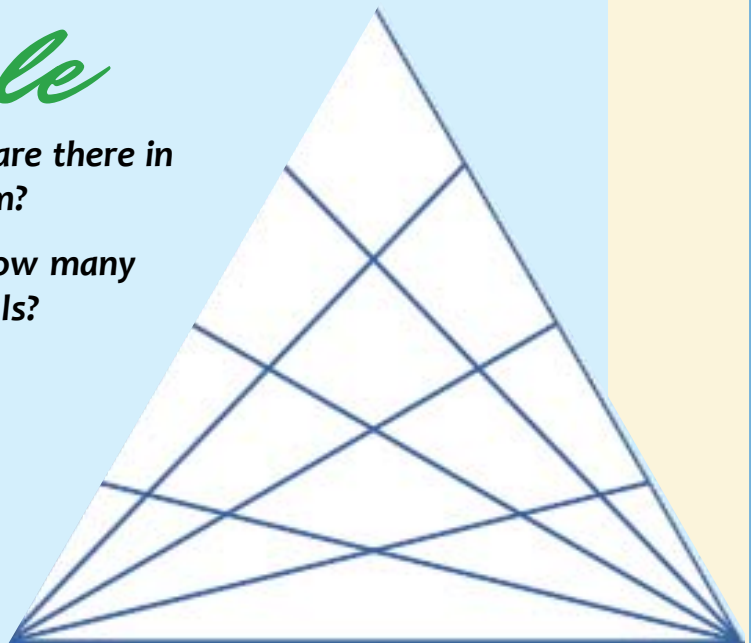
They found that spider web decorations may help pinpoint the *location* of captured prey so that the spider could easily move to that location. While these findings deepen understanding of stabilimenta, this study could influence the design of web-inspired synthetic materials. By combining field observations and simulations, the work inspires designs for bio-inspired materials with tunable elastic properties.

Sources: Earth.com, BBCdiscoverwildlife.com, sciencenews.org, phys.org

Shapes Puzzle

How many triangles are there in this diagram?

Bonus question: How many quadrilaterals?



Solution on page 34;
From Mathsisfun.com

Do You Know

1. Why is photosynthesis important for life on Earth?
2. Why is there a differential in a car (or lorry)?
3. You have heard of temperature of $+50^{\circ}\text{C}$ or -50°C . Is there an absolute zero of temperature?
4. Sometimes when you have a cold, you can lose balance or feel wobbly. Why?

Answers in the next issue of JM.

Answers to Last Issue's Do You Know?

1. What is the Ring of Fire?

Ans: See separate article on this question.

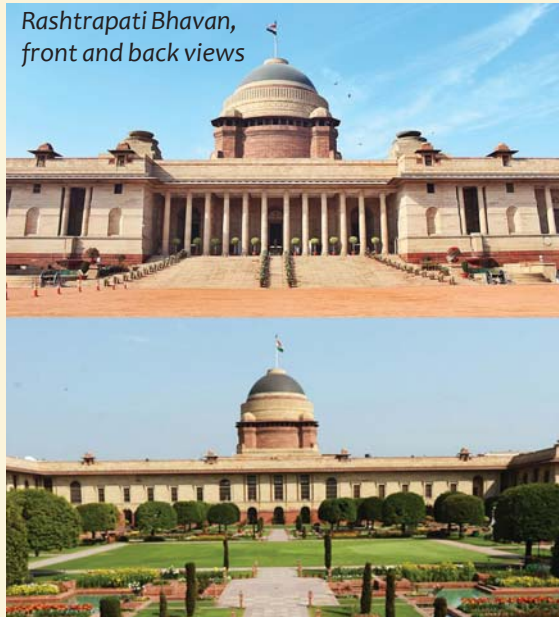
2. India is a sovereign socialist secular democratic republic. What is the difference between democratic and republic?

Ans: Democracy is an abstract name for a system and republic is the more concrete result of that system, that is, it specifies the nature of that democracy. We will give examples below.

India is a **democracy** because its government is a *representative* one where power comes from the people (who elect the representatives in Parliament). It is also a **republic** because its head of state is an elected president,

not a hereditary king. So it is both a democracy and a republic. Democracy emphasizes rule by the people, while republic emphasizes the rule of law and an elected head of state under a constitution. The constitution limits the majority's power and protects minority

Rashtrapati Bhavan,
front and back views





rights, a key feature of India's republicanism.

Democracy: The word comes from the Greek *demos* and *kratos*, meaning “rule by the people”. It is a system where supreme power is vested in (resides with) the people (actually, all the adults in India!). How do they exercise this power? It can be directly or indirectly through a system of representation. This is what happens when we vote in the periodically held free and fair elections: we elect people who represent our view, and make decisions on our behalf, so the belief is that in a democracy, the power is actually with the people.

Republic: The word comes from the Latin *res publica*, meaning “public matter”. It is a form of government where the head of state is an elected or nominated president. So, for example,

the United Kingdom (Britain and Northern Ireland) is a democracy but not a republic because it has a king.

How is this President elected? The elected members of both houses of the Parliament at the Centre—Lok Sabha and Rajya Sabha—and the elected members of the State Legislative Assemblies (also the Union Territories) whom we have elected, together form an *electoral college* which elects the President. The constitution limits the government's power and protects citizens' rights. It was adopted on 26 Jan, 1950, and that is why we celebrate Republic day!

So India's political system is a “democratic republic” because it combines these two principles. The power flows from the people (democracy), and the structure of the state includes an elected head of state and is bound by a constitution (republic). Our present President, Smt Droupadi Murmu, resides in the Rashtrapati Bhavan in Delhi, the capital city of India.

The republic aspect ensures that the will of the majority cannot override fundamental rights, as the constitution provides a legal framework that protects all citizens. In particular, it assures the following:

. *Absence of a privileged class:* All public

offices, including the highest ones, are open to every citizen without discrimination.

. *Rule of Law and a Constitution:* The government operates within the constraints of a written Constitution, which is the supreme law of the land. The Constitution safeguards individual rights and ensures checks and balances, protecting minorities from the potential “tyranny of the majority” where the will of the majority is imposed on the minority, that could occur in a pure (direct) democracy without constitutional limits.

. *Sovereignty vested in the people:* The state’s authority is derived from the

people, and no one holds public power as a proprietary (private) right.

3. *We are familiar with cyclones. Do we also have tornadoes in India?*

Ans: Yes, India also experiences tornadoes, although they are rare compared to other countries.

Tornadoes are a violently rotating column of air touching the ground, usually attached to the base of a thunderstorm. Tornadoes are nature’s most violent storms, arising from powerful thunderstorms. They can devastate a neighborhood in seconds. Winds of a tornado may reach 500 kilometers per hour. As it moves, it can damage a path more than a kilometer



Tornado (Water spout) in Indian Ocean

wide and 80 km long. Hail is very commonly found very close to the tornadoes.

Some tornadoes are clearly visible, while rain or nearby low-hanging clouds obscure others. Tornadoes develop extremely rapidly, and may dissipate just a quickly. Most tornadoes are on the ground for less than 15 minutes.

Before a tornado hits, the wind may die down and the air may become very still. A cloud of debris can mark the location of a tornado even if a funnel is not visible. Tornadoes generally occur near the trailing edge of a thunderstorm. It is not uncommon to see clear, sunlit skies behind a tornado.

In India, they most often occur in the eastern states of West Bengal, Odisha, and Jharkhand during the pre-monsoon season (March to June), and have also been reported in the northwest region of the country.

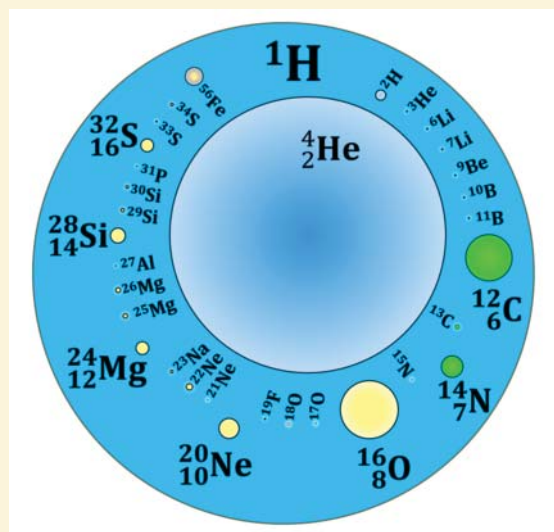
Only about 12 tornadoes have been recorded in India over 30 years between 1976 and 2010. Most tornadoes in India are deadly, with an average of 80 people killed per tornado. The deadliest Indian tornado on record hit areas near Belda in W. Bengal on March 24, 1998, killing 250 people. The Bay of Bengal region is a hot-spot for these storms, although states like Punjab, Haryana, and New Delhi have

also recorded tornadoes. They most frequently occur during the pre-monsoon season, especially in March and April.

Many tornadoes in India have been deadly, with significant property damage caused by strong winds. They are often associated with severe thunderstorms that develop when moist, low-level winds converge with dry, upper-level air.

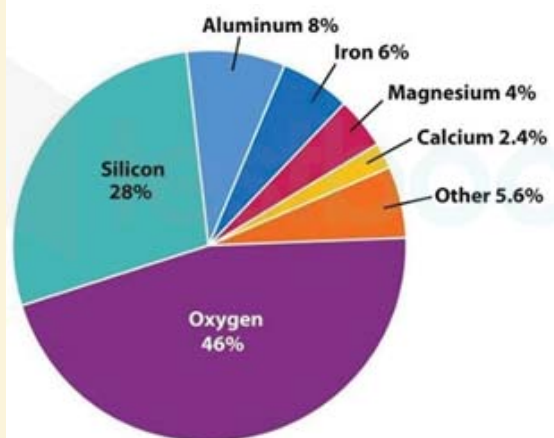
4. What is the most abundant element on Earth? In the Universe?

Ans: The most abundant element on Earth's crust (on the surface, which is what we see) is **oxygen** (about 46%). This is because most of the minerals found in the Earth's crust are in the form of oxides, such as silica (sand) etc. If you include the entire Earth, the most abundant element is **iron**, which is in the core of the Earth.



Isotope abundance universe

Elemental Composition of the Earth's Crust



5.97×10^{24} kg. Roughly the core of the Earth is contained in half the radius of the Earth. By mass, it is composed mostly of iron (32.1%), oxygen (30.1%), silicon (15.1%), magnesium (13.9%), sulphur (2.9%), nickel (1.8%), calcium (1.5%), and aluminium (1.4%); with the remaining 1.2% consisting of trace amounts of other elements. What about in the entire Universe?

The abundance of chemical elements in the universe is dominated by the large amounts of **hydrogen** and **helium** which were produced during **Big Bang nucleosynthesis** when the Universe itself was formed. The remaining elements, making up only about 2% of the universe, were largely produced by the explosions of stars as supernovae and certain red giant stars.

Lithium, beryllium, and boron, despite

their low atomic number, are rare because, although they are produced by nuclear fusion, they are destroyed by other reactions in the stars.

The elements from carbon to iron are relatively more abundant in the universe because of the ease of making them in supernovae. Elements of higher atomic numbers than iron (element 26) become progressively rarer in the universe, because they increasingly absorb stellar energy in their production. Also, elements with even atomic numbers are generally more common than odd ones in the periodic table, due to energy considerations too complicated to explain here.

There are 80 known stable elements, and the lightest 16 comprise 99.9% of the ordinary matter of the universe. These 16 elements are the ones from hydrogen through sulphur.

Hydrogen and helium are estimated to make up roughly 74% and 24% of all baryonic matter in the universe respectively. Despite comprising only a very small fraction of the universe, the remaining “heavy elements” can greatly influence astronomical phenomena. Only about 2% (by mass) of the Milky Way galaxy’s disk is composed of heavy elements.

Compiled from various sources

The Ring of fire

The Ring of Fire (also known as the Pacific Ring of Fire, the Rim of Fire, the Girdle of Fire or the Circum-Pacific belt), is a tectonic belt of volcanoes and earthquakes. The word tectonic refers to physical movements and chemical changes over time in the Earth's crust, its uppermost layer. It is about 40,000 km long and up to about 500 km wide and surrounds most of the Pacific Ocean; see figure.

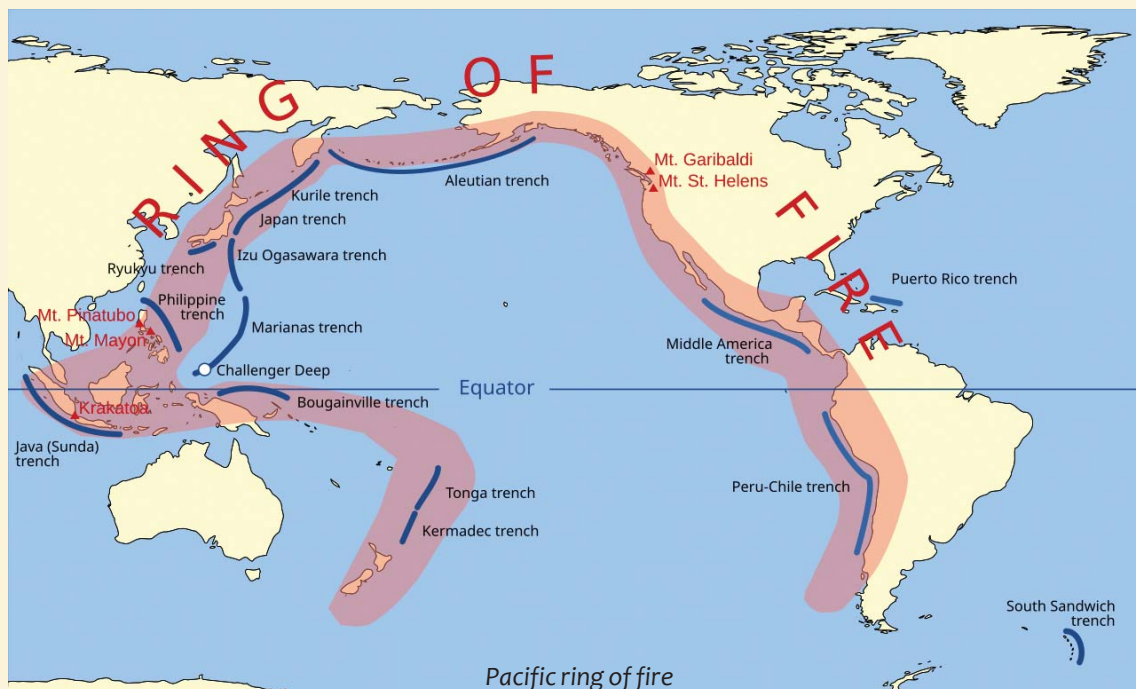
The Ring of Fire contains between 750 and 915 active or dormant volcanoes, around two-thirds of the

world total, so you can understand where its name came from. About 90% of the world's earthquakes, including most of its largest, occur within the belt.

The Ring of Fire is not a single geological structure. To understand it, we need to learn some new words in the field of Geology or Earth Science.

Lithosphere

The rigid outermost part of Earth (or any planet) is called the Lithosphere. In Earth, this consists of the outer crust and the upper mantle; see figure. Oceanic lithosphere is crust that exists in the ocean basins and is denser than continental lithosphere.



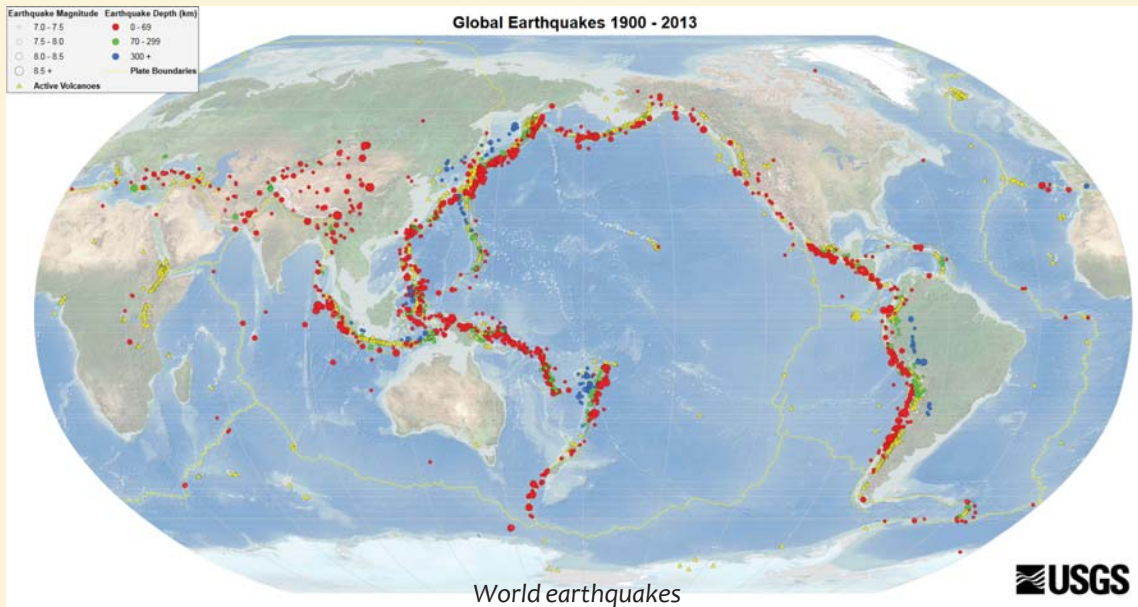


Plate Tectonics

Earth's lithosphere is fractured into seven or eight major plates (depending on how they are defined) and many minor plates or "platelets"; see figure.

Continental drift was a theory that was proposed about a 100 years ago, that Earth's continents move or drift relative to each other over geologic (very large) time scales. This theory was rejected because people could not figure out where the energy for such large movement could come from.

Later on, after advances in physics, scientists realised that the radioactivity of naturally occurring elements like uranium (U^{238}) and thorium (Th^{232}) and potassium (K^{40}) could generate enough heat. Along with the primordial

(meaning original) heat when the Earth itself was formed, this heat energy, amounting to about 45 Terawatts, flows constantly from Earth's interior to the surface. (1 Terawatt = 10^{12} watts; a light bulb requires about 20 watts). This massive heat is sufficient to power the movement of the continents, and is called *mantle convection*.

Today, the theory of plate tectonics has proved that the Earth's lithosphere is made of several tectonic plates which are actually moving (and so the continents that "sit" on these plates are also moving), and have been slowly moving since 3-4 billion years ago. Plate tectonics came to be accepted after it was validated in the mid to late 1960s. The processes that result in these plates and shape Earth's crust are called

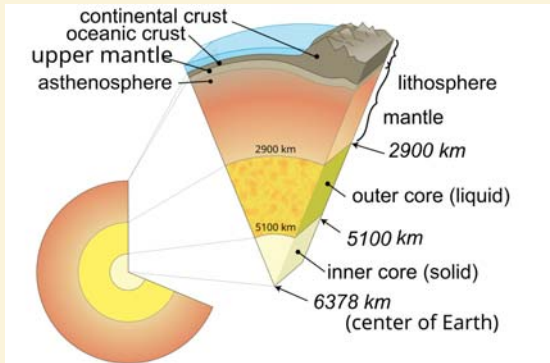


Plate boundaries

Where the plates meet, their relative motion determines the type of plate boundary (or fault). There are three types: convergent, divergent, or transform; see Box for details.

At convergent boundaries (see Box), two continental plates can collide and push upwards to form large mountain ranges such as the **Himalayas**. Another type of convergent boundary is a

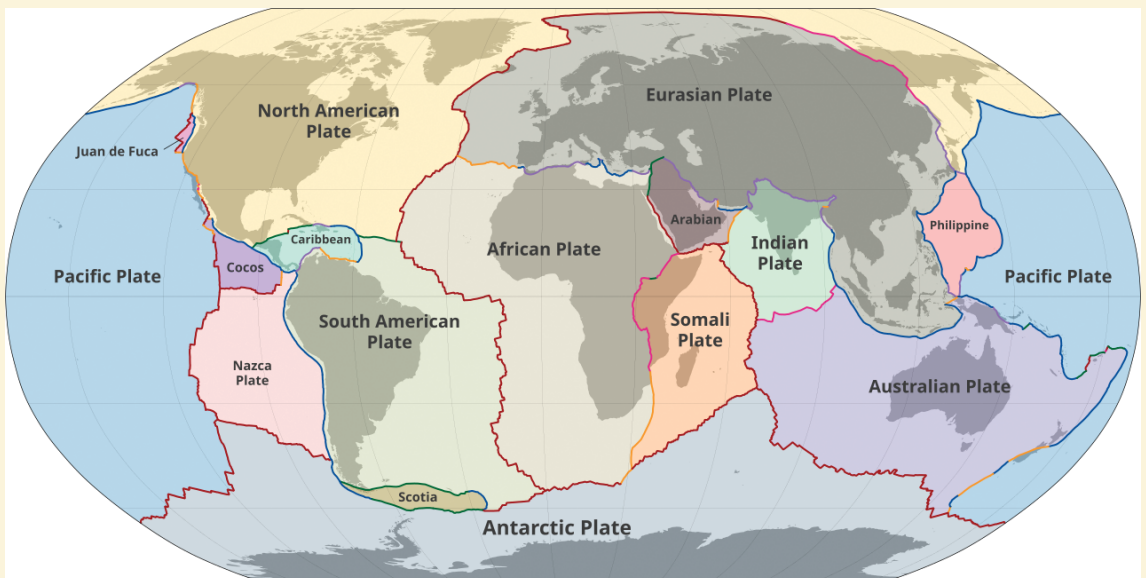
tectonics. The relative movement of the plates typically ranges from zero to 10 cm annually.

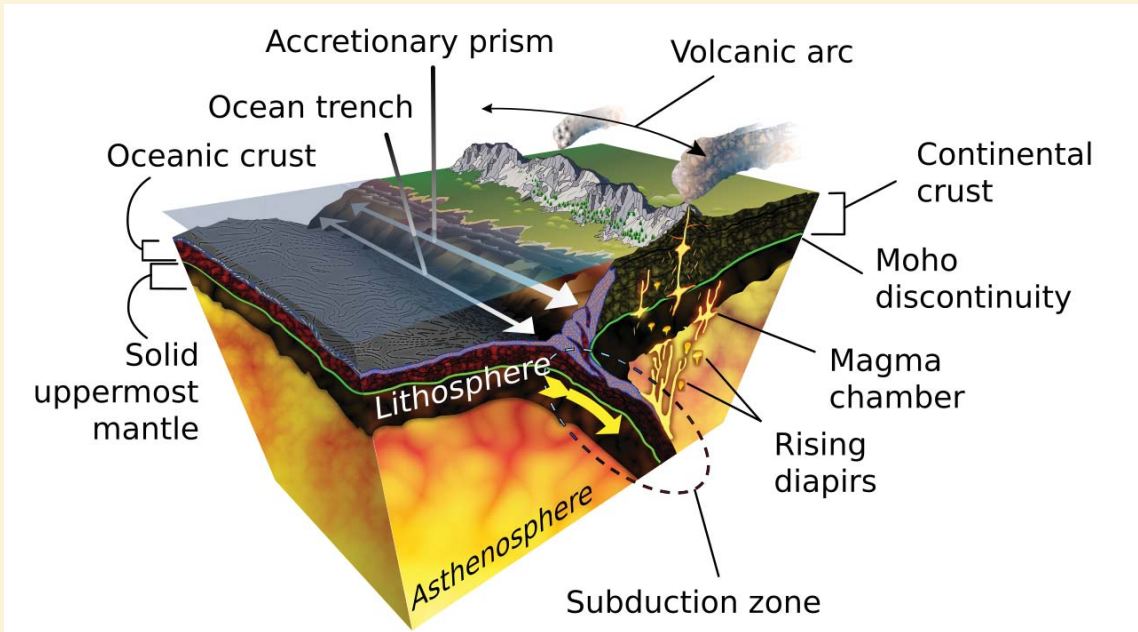
Types of Tectonic Plate Interactions

Convergent boundaries are areas where plates move toward each other and collide. These are also known as compressional or destructive boundaries.

Divergent boundaries are areas where plates move away from each other, forming either mid-ocean ridges or rift valleys.

Transform boundaries occur when two plates grind past each other with only limited convergent or divergent activity.

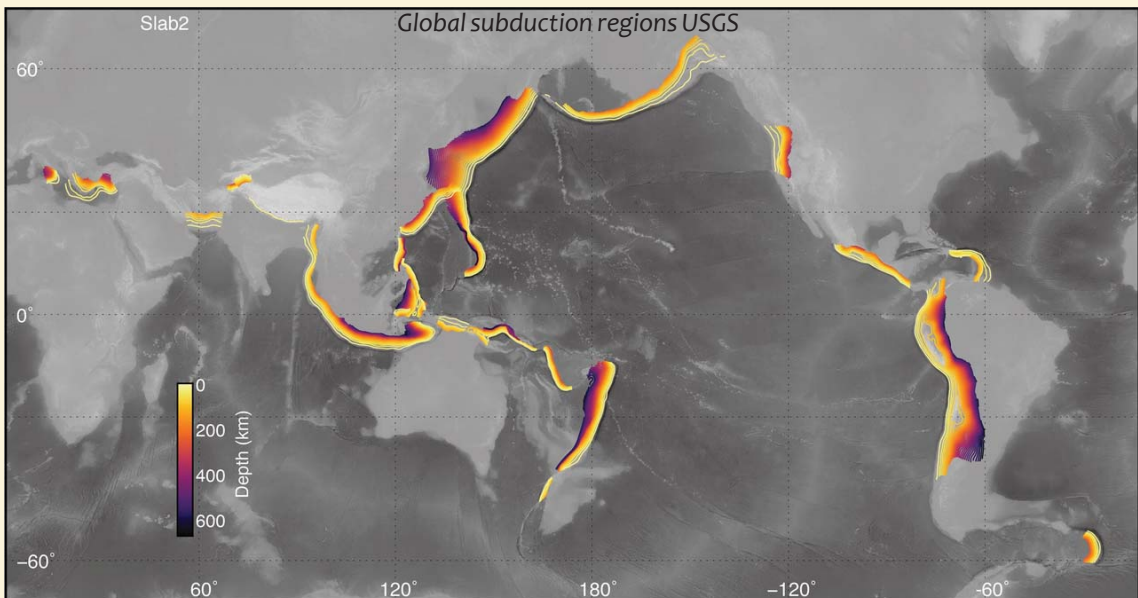




Subduction zone where an oceanic plate meets a continental plate and is pushed underneath it.

In general, if two plates meet, the heavier one will be pushed below. Since

ocean lithosphere is more dense, it is the one that is pushed below. So the oceanic lithosphere becomes a part of the Earth's mantle as it is pushed down; see figure. Subduction zones are marked by *oceanic trenches* shown in the figure. The



descending end of the oceanic plate melts and creates pressure in the mantle, causing volcanoes to form. The figure shows the subduction zones over the entire Earth.

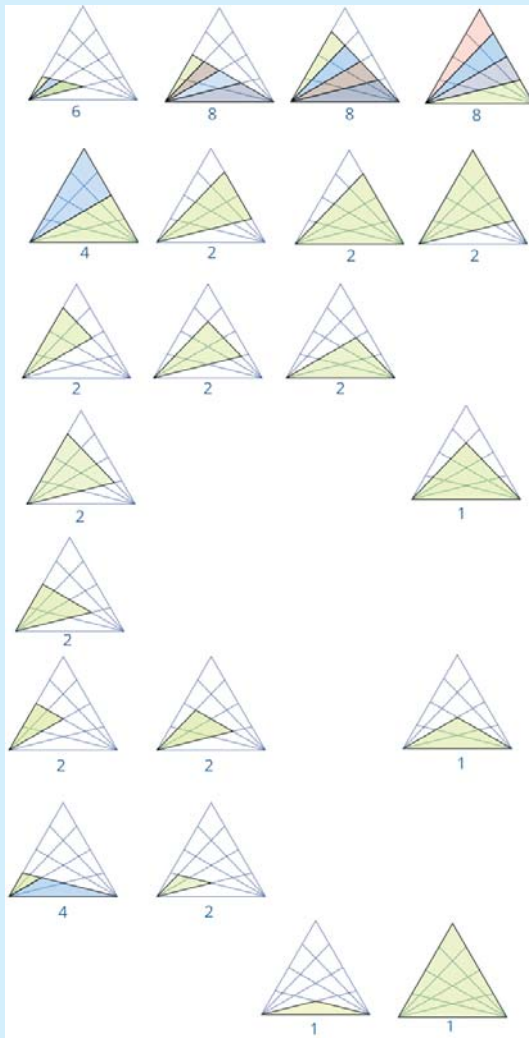
This is what mostly happens in the Ring of Fire. It was created by the subduction

of different tectonic plates at convergent boundaries around the Pacific Ocean. These include:

- . the Antarctic Nazca plate and Cocos plates subducting beneath the South American plate;
- . the Pacific and Juan de Fuca plates subducting beneath the North American plate;
- . the Philippine plate beneath the Eurasian plate;
- . and a complex boundary between the Pacific and Australian plate.

The interactions at these plate boundaries have formed *oceanic trenches* (depressions in the ocean floor), *volcanic arcs* (a belt of volcanoes on the surface above the subducting plate, parallel to the trench and further away), *back-arc basins* (under water) and *volcanic belts* (regions of volcanic activity where magma is created by partial melting of solid material in the Earth's crust and upper mantle due high temperatures produced in the collision). All these features are marked in the figure so it will be easier to understand them. In short, it has created the Ring of Fire.

The Ring of Fire has existed for



Solution to puzzle on Page 24: Ans: 64 Triangles: see the count in the various figures. Most counts are doubled due to symmetry. There are also 36 quadrilaterals.

more than 35 million years but subduction has existed for much longer in some parts of the Ring; many older extinct volcanoes are located within the Ring. More than 350 of the Ring of Fire's volcanoes have been active in historical times while the four largest volcanic eruptions on Earth in the *Holocene epoch* (current geological epoch) all occurred at volcanoes in the Ring of Fire. These occurred at *Fisher Caldera* (Alaska, 8700 BC), *Kurile Lake* (Kamchatka, 6450 BC), *Kikai Caldera* (Japan, 5480 BC), and *Mount Mazama* (Oregon, USA 5677 BC). Notice that we are mentioning the

countries where these are currently located, which may not have existed at the time of eruption!

Most of Earth's active volcanoes with summits above sea level are located in the Ring of Fire. So both volcanoes and earthquakes are common in this area. So the next time you hear of the *Agung*, *Sinabung* or *Dukono* volcanoes in Indonesia, or the *Mount Ruapehu* volcano erupting in New Zealand, or earthquakes in Japan or California, you will know that the Ring of Fire is living up to its name.

Sources: Wikipedia, also for the images

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Typeset at

Fineline

Design, Illustrations and Layout

Basheer

Rajeswari

Printed at

Sri Murugan Printers,
7/1, Boobegam 3rd St, Anna salai,
Chepauk, Chennai - 600 002.

Single copy Rs. 30/- Annual subscription Rs. 200/- Life Subscription Rs. 2000/-

Bank Details: Jantar Mantar, Indian Overseas Bank, Dr. RK Salai Branch, Chennai - 600004

AC No: 029101000031081 IFSC Code: IOBA0000291



*Spider's web decorated with stabilimenta.
See Science News for more details.*

Published by S.Subramani Published at 245, Avvai Shanmugam Salai, Gopalapuram,
Chennai-600 086 Printed by P.S.Kumaresan, Printed at SRI MURUGAN PRINTERS,
No.7/1, BooBegum 3rd Street, Chepauk, Anna Salai, Chennai-600 002.
Owned by Tamil Nadu Science Forum, Editor: Dr. D. Indumathi