

Remembering the Count



Here's a look at the life and times of Benjamin **Thompson who** revolutionised the theory of heat and invented the contraption for filter coffee, among a host of other achievements

lished his work as An Experimental Enquiry Concerning the Source of the *Heat which is Excited by Friction* in the Philosophical Transactions of the Royal Society. That was the start of a scientific look at heat and work, which led to the laws of thermodynamics, the steam engine, petrol engine and all else!



fireplace" became state-of-the-art worldwide.

In a few years, Count Rumford left Bavaria for England and France, and followed a life as successful, both in science and commerce and as colourful in the arts and in amorous escapades. In 1796, he gave \$5,000 each to the Royal Society of Great

notoriety, Count Rumford would still be immortal for his invention of the "drip-pot coffee percolator". It is the simple arrangement of two containers, one above the other, with the base of the upper one pierced with little holes. Pure coffee powder is packed in the upper container and covered



PLUS POINTS

Underwater shrine



Mexican archaeologists have identified a stone "tetzacualco" — or shrine — that they think could have been constructed as a "miniature model of the universe".

The structure is located in a pond on the side of the Iztaccihuatl volcano near Mexico City, on a site termed Nahualac.

In some ancient Mesoamerican myths concerning the creation of the world, the crocodile monster Cipactli floated on the primal waters and from its body the earth and sky were created.

According to archaeologist Iris Hernández of the National Institute of Anthropology and History, who led the research, architectural elements placed in water sources in this manner appear to have been "an important part of Mesoamerican thought".

Hernández suggested that water flowing into the pond was controlled to create a visual effect that made it appear like the stone structure was "floating on the water mirror". A team began to excavate the site in 2016, finding a variety of signs of human activity at Nahualac. Those signs include ceramic fragments, parts of obsidian blades and organic remains such as charcoal and the mineral schist that may have been an offering of some sort. Nahualac consists of two main areas — the first of which is the shrine, built from stacked stones not held together with any kind of cement in pre-Hispanic times. The second area is found 150 metres away from the shrine, and there the archaeologists found ceramic materials associated with the rain god Tlaloc. The artefacts dated from 750-1150 AD. The researchers think the site in its entirety represents a ritual space in which a cult of Tlaloc was based, along with worship of other deities of the water and land.

A Rumford fireplace

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enjamin Thompson, who fled the US and became a Bavarian Count, did important work on the mechanical equivalent of heat.

Thompson was born in 1773 in a small town in Massachusetts. He went to the village school but often visited the Harvard College in Cambridge, nearby, to attend lectures, was fascinated by perpetual motion machines and took interest in eclipses. At the age of 18 he became a schoolmaster in the town of Rumford in Massachusetts and married a wealthy widow many years his senior. With her help and influence, he got a position in the New Hampshire Militia. But during the American Civil War, his strong pro-British convictions went down poorly with the popular rebel party and Thompson abandoned his wife and crossed lines to the loyalist forces.

During the rest of the war, apart from passing military intelligence to the British, using devices like invisible ink, he carried out lunar observations and conducted experiments, which were later acclaimed, on the speed of projectiles fired by cannon and the properties of gunpowder.

When he did go over to England after the war, he already had a reputation as a scientist and he was soon

elected a Fellow of the Royal Society.

During the next years in England, after what has been described as "unforgivable social climbing", he migrated to Bavaria, where he rose to a high position in the court and the military. He spent 11 years in Bavaria, applying his talents in reorganising the army and the administration of the state. It was during this period while working in the foundries that bored the barrels of the cannon that he made observations, which ran counter to the current theory of heat.

Heat, at the time, was considered to be a kind of fluid, an aether called caloric, which flowed in and out of materials. Caloric was considered to be indestructible and incapable of being created, perhaps the last of the Aristotelian ideas of the four essences of matter — earth, air, water and fire. The word, caloric, for the essence of heat, in fact, had been coined by Lavoisier, the French chemist who had proved that mercury got heavier when it burned, not lighter!

Thompson was able to see that labour was expended in driving the bit that bored the barrels, which in turn grew so hot that they could keep the cooling water continuously boiling. The conclusion was not difficult to reach, that the heat came from mechanical work, not any currents of caloric! In 1798, Thompson pubThompson made important con-

tributions to the administration of the Bavarian state and brought the scientific method to dealing with civic problems. One area was of engaging the impoverished peasant population of the country in paid work in state workhouses — to make uniforms for the army, which was itself in low morale. He developed a specially formulated "soup" that was economical and nutritious and was served both in the army and in the workhouses. This may be considered one of the earliest scientific steps in the domain of dietetics. The Bavarian State recognised his services and he was made a count. As his title, he took the name of his hometown, as Count Rumford.

Count Rumford, went on to be celebrated for many inventions, including the double boiler, a kitchen range, the pressure cooker, the folding bed and he became well known for important improvements that he made in the design of fireplaces.

The Rumford fireplace was tall and shallow to reflect more heat, and had a streamlined chimney. The design of the chimney helped eliminate turbulence and allowed the smoke to rise as an even stream without mixing and carrying away the least warm air from the heated room. This improved comfort and saved fuel.

In 1796 and in 1798, he wrote two papers detailing the improved design of the fireplace, which were widely read and in the 1790s the "Rumford



But even if there were none of these contributions to science or

promptly adopted by South Indians much to the joy of coffee drinkers. The writer can be contacted at response@simplescience.in





without an associated BRE. By itself, either type of core promoter is only capable of supporting a basal (low) level of transcription. However, most protein-coding genes have additional short sequences further upstream — upstream control elements — that the promoter's efficiency. Some of these upstream dements are common to many different genes; examples include the CAAT box (consensus sequence GCC-CAATCT in animals and yeasts) and the GC box (consensus sequence GGGCGG). The locations of these elements relative to a gene's startpoint vary from gene to gene. The elements within 100-200 nucleotides of the startpoint are often called proximal control elements to distinguish them from enhancer elements, which tend to be farther away and can even be located downstream of the gene. The sequences important in promoter activity are often identified by deleting specific sequences from a cloned DNA molecule, which is then tested for its ability to serve as a template for gene transcription, either in a test tube or after introduction of the DNA into cultured cells. For example, when transcription of the gene for ?globin (the ? chain of haemoglobin) is investigated in this way, deletion of either the TATA box or an upstream CAAT box reduces the rate of transcription at least tenfold. In contrast to RNA polymerases I and II, the RNA polymerase III mole-



with boiling water. The water drips into the lower container, as the aromatic decoction. The device came to India with the British and was

The independent

More from disgust



Trypophobia — or the fear of holes may not be a real phobia after all, a new study has suggested.

The term, which was first coined in 2005 and made its rounds on social media, has quickly become a buzzword online for the adverse reactions some people experience when looking at an image of closely packed holes, such as honeycomb, lotus pods, or sponges. Some people have reported anxiety upon viewing such images, but the condition is not yet recognised as a medical diagnosis.

And new research by Emory University in Atlanta, Georgia, shows that it may not be a phobia at all. While phobias are triggered by the emotion of fear, the study published in the open-access journal PeerJ concludes that trypophobia is more likely driven by disgust instead. When participants in the study were shown images of both threatening images and photos of holes, researchers found that the size of their pupils changed in different ways. The participants' pupils dilated when looking at images of snakes and spiders, but in contrast, their pupils constricted when they saw images of the holes. According to the researchers, the smaller pupil sizes suggest feelings of disgust, rather than fear, which is characterised by larger pupils. That is because a fearful response involves an increase in overall cardiovascular functions, such as heart rate acceleration, prompting pupil dilation as a result of the perceived danger. On the other hand, disgust is associated with the opposite — the slowing of heart rate and as a result, smaller pupil size — in response to perceived contamination.

two parts. The part called the core promoter — defined as the minimal set of DNA sequences sufficient to direct the accurate initiation of transcription by RNA polymerase — actually extends into the nucleotide sequence to be transcribed. It is sufficient for proper initiation of transcription but transcription is made more efficient by the presence of an upstream control element, which for RNA polymerase I is a fairly long sequence similar (though not identical) to the core promoter. Attachment of transcription factors to both parts of the promoter facilitates the binding of RNA polymerase I to the core promoter and enables it to initiate transcription at the startpoint.

can be grouped into three main cate-

gories, one for each type of polymerase.

The promoter used by RNA polymerase

I-that is, the promoter of the tran-

scription unit that produces the pre-

cursor for the three largest rRNAs, has

In the case of RNA polymerase II, at least four types of DNA sequences are involved in core promoter function. These four elements are first, a short initiator sequence surrounding the transcription startpoint (which is often an A, as in prokaryotes); second, the TATA box, which consists of a consensus sequence of TATA followed by two or three more As, usually located about 25 nucleotides upstream from the startpoint; third the TFIIB recognition element located immediately upstream of the TATA box; and last, the downstream promoter element

cule uses promoters that are entirely downstream of the transcription unit's startpoint when transcribing genes for tRNAs and 5S RNA. The promoters used by tRNA and 5S rRNA genes are different, but in both cases, the consensus sequences fall into two blocks of about 10 bp each. The tRNA pro-

moter has consensus sequences called box A and box B. The promoters for 5S rRNA genes have box A (positioned farther from the startpoint than in tRNA-gene promoters) and another critical sequence, called box C.

The promoters used by all the eukaryotic RNA polymerases must be

recognised and bound by transcription factors before the RNA polymerase molecule can bind to DNA.

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