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## In this edition...



# The Four Elements: Roots of Life

By: Maissa Azab

Here we start a new year for the PSC Newsletter; the fourth for the Newsletter as a popular science publication. In what has become a tradition, in the first issue of every new cycle, we go back to the roots. Last year, we started by discussing Planet Earth; this year, we focus in this issue on the classical Four Elements of Nature, which were the core of all humanities and sciences for centuries, if not millennia of human history.

Earth, Water, Air, and Fire are indeed the four corners of life; life could not possibly flourish or sustain itself without each and every single one of these elements, which we can thus rightfully call the Roots of Life.

In this issue, we will discuss at length why the Four Elements are in fact the roots and foundations of life. We will delve into their origins, track them all the way to the Moon, explore their powers, find out how they make up our bodies, discover how they shape and impact our daily life, and how they can devastate life just as much as they sustain it.

In this new cycle, we re-introduce sections such as "ZoomTech", where we discuss how nanotechnology can change the four elements as we know them. In this issue, we also introduce new sections and columns. In the newly-introduced "Science in Sci-Fi" section, we have a column on the fantastical action motion picture "The Fifth Element", and a fascinating film review on the surprisingly insightful animation movie "The Lorax".

On the other hand, in our new section "Top Ten", we count down the top ten marvels of the elements of the periodic table from our perspective. In "In-Depth Science", we dive into the mystery that is antimatter; and finally, in "Fact or Fiction", we investigate the possibility of fire breathing dragons ever existing.

As always, we hope you will enjoy the selections we offer you; we also look forward to receiving your feedback at PSCeditors@bibalex.org.

# The Four Elements of Nature; For How Long?

By: Prof. Boshra Salem
Chair, International Coordinating Council of Man and Biosphere Program (MAB-ICC), UNESCO

The ancient Greeks believed that there were four elements that made up everything: Earth, Water, Air, and Fire. This theory was suggested around 450 BCE, and it was later supported and elaborated by Aristotle.

Let us add one more element; the 'Systems' element. We all depend on Earth's ecosystems and the services they provide, such as food, water, fiber, and wood, in addition to disease management, climate regulation, spiritual fulfillment, and aesthetic enjoyment. The Five Elements function as a principal structure for information, and as a guiding overview for aspects that should be considered when engaging individuals to act strategically towards sustainability of the four elements.

A system can be described as "anything which takes its integrity and form from the ongoing interaction of its parts". Companies, nations, families, biological niches, bodies, television sets, personalities, and atoms are all systems. What all of these systems have in common is that change in one part of the system will affect another part or parts of the system.

Systems thinking is based on the idea that the forces in a system are complex, and their interaction cannot be predicted in any mechanistic way. Systems thinking helps you think, and act more effectively towards desired goals, no matter what problems and opportunities you may face in the future. Systems thinking is needed because over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any other time before, largely to meet the rapidly growing demands for food, fresh water, timber, fiber, and fuel.

The four elements of nature are in danger; environmental problems such as climate change, energy crisis, water shortage, and pollution are jeopardizing the consistency of such elements in supporting our livelihoods and wellbeing. Every measure used by scientists to assess the health of ecosystems indicates that we are degrading them at an accelerating pace. For too long we have focused on how much we can take from our ecosystems, with little attention to the services they provide, such as climate control and nutrient recycling, which we cannot replace at any reasonable price.

This transformation of the planet has contributed to substantial net gains in human well-being and economic development. But not all people benefited from this process; in fact, many were harmed. Governments and people must view the sustainability of ecosystems as essential to human life. There must be a call for an approach to manage the world's critical resources, which means evaluating decisions on land and resource use in light of how they affect the capacity of ecosystems to produce goods and services.

In order to reach sustainability, all parts of the system have to change. In this quest, individuals are major leverage points. Being more efficient in engaging them to act strategically towards sustainability is and will be of critical importance for those who wish to accelerate societal change. Human well-being can be enhanced through sustainable human interaction with ecosystems, with the support of appropriate instruments, institutions, and technology.

There are many examples from businesses, NGOs, and other institutions showing possible paths forward and the benefits of being proactive. But then, why is not everyone engaged in taking action towards sustainability? Why is change so slow?

For change to take place, the commitment and actions of individuals are critical. One way to accelerate the needed change towards sustainability is to find answers to the following question: How can individuals be engaged to take actions leading strategically towards sustainability of the earth's four elements?

# The Origins of the Four Elements

By: Maissa Azab
in cooperation with
Sara Khattab & Reham Elbannan

The idea that the four elements—Earth, Water, Air, and Fire—made up all matter was the cornerstone of philosophy, science, and medicine for 2000 years.

Historians believe that Greek philosophers began formulating theories of the four elements as early as the 8th century BCE. Although they believed the four elements were unchanging, everything was made up of these elements, held together or pushed apart by forces of attraction and repulsion, causing substances to appear to change. This is similar to what really happens with molecules at an atomic level.

To the Greeks, the four elements described not only physical manifestations of the material world but essential qualities of human nature as well: Earth, solid and substantial, was associated with the physical and sensual aspects of life. Water, flowing and ever-changing, denoted emotion and empathy. Air was not only the air we breathe and the atmosphere, but signified the mind, intelligence, and inspiration. Fire meant the Sun and flame; it also indicated creative passion and destructive zeal.

Before digging into the myriad of aspects of how the Four Elements shape and affect our life, this is the story of how they originated.

## The Birth of Mother Earth

Ten billion years before the Earth was born, the universe started out with only two elements: hydrogen and helium, which formed stars that burned these elements in nuclear fusion reactions. Generations of stars were born in gas clouds and died in explosive novas that produced the heavier elements we have today.

Some 5 billion years ago, a supernova exploded, pushing a lot of its heavy-element wreckage into a cloud of hydrogen gas and interstellar dust. The mixture grew hot and compressed under its own gravity; at its center, a new star began to form, around which swirled a disk of the same material that grew white-hot from the great compressive forces. The new star became our Sun, and the glowing disk gave rise to Earth and its sister planets.

While the Sun grew in size and energy, the hot disk slowly cooled. This took millions of years, during which the components of the disk began to freeze out into small dust-size grains. Iron metal and compounds of silicon, magnesium, aluminum, and oxygen came out first in that fiery setting; bits of these are preserved in chondrite meteorites. Slowly, these grains settled together into clusters, then lumps, then boulders, and finally bodies large enough to exert their own gravity.

As time went by, these bodies grew by collision with other bodies, producing a lot of melting and vaporization. Materials, which we can call rocks and iron metal, began to sort themselves out; the dense iron settled in the center, while lighter rock separated into a mantle around it, in a miniature of Earth and the other inner planets today.

At some point, the Sun ignited; the process of ignition was energetic enough to blow away most of the gaseous part of the protoplanetary disk. The chunks, boulders, and mini-planets left behind continued to collect into large, stable bodies in well-spaced orbits.

The oldest rocks, dated by the uranium-lead method at about 3.96 billion years old, show that there were volcanoes, continents, oceans, crustal plates, and life on Earth in those days. While the eons that followed were full of strange stories and far-reaching changes, the Earth had taken on its basic structure long before.

## Where Water Came From

The exact origin of our planet's water, which covers about 70% of Earth's surface, is still a mystery to scientists. Many researchers think that, instead of water forming at the same time as Earth, objects in the outer solar system delivered water to Earth in violent collisions shortly after its formation.

Researchers speculate that any water conglomerating on the surface of the planet as it formed would have most likely been evaporated away by the young, blazing Sun, which means that water probably came here from somewhere else. The inner planets were probably too hot to house water during the Solar System's formation; outer planetary bodies however were far enough away from the Sun to retain ice.

During a period around 4 billion years ago called the "Late Heavy Bombardment", massive objects, probably from the outer solar system, hit Earth and the inner planets. It is possible that these objects were filled with water, and that these collisions could have delivered gigantic reservoirs of water that filled the Earth.

For a long time, astronomers thought that comets were the likely culprit. However, remote measurements of the water evaporating off of several major existing comets—Halley, Hyakutake, and Hale-Bopp—revealed that their water ice was made of a different type of $H_2O$, containing a heavier isotope of hydrogen than Earth's, suggesting that these comets could not be the source of our water.

With major comets crossed off the list, astronomers began to wonder if clues to our water's past may lie in the asteroid belt. This region of hundreds of thousands of asteroids orbiting between the inner and outer planets was believed by astronomers, to be too close to the Sun to house water, but astronomers found the first evidence of ice on the asteroid 24 Themis.

This discovery and others of ice on asteroids suggest that there might be far more ice in the asteroid belt than originally thought and provide another possibility for the origin of ocean water. Probes sent to explore asteroids, such as the DAWN spacecraft, in the coming years will reveal more about their mysterious water ice, potentially help us understand the beginnings of Earth's water.

On the other hand, evidence that water came to Earth during its formation from cosmic dust, rather than following later in asteroids, has been shown by a group of scientists. Nora de Leeuw at University College London and colleagues used molecular-level calculations to prove that when mineral dust particles came together during Earth formation, gas-solid interactions could have resulted in water being adsorbed onto the surface of the dust particles, meaning water could have been part of the Earth from the very beginning.

## The Atmosphere, History of

In the first 500 million years of Earth's history, a dense atmosphere emerged from the vapor and gases that were expelled during degassing of the planet's interior. These gases may have consisted of hydrogen ($H_2$), water vapor, methane ($CH_4$), and carbon oxides. Prior to 3.5 billion years ago, the atmosphere probably consisted of carbon dioxide ($CO_2$), carbon monoxide (CO), water ($H_2O$), nitrogen ($N_2$), and hydrogen (H).

The hydrosphere was formed 4 billion years ago from water vapor condensation, resulting in oceans of water in which sedimentation occurred. The most important feature of the ancient environment was the absence of free oxygen. Evidence of such an anaerobic reducing atmosphere is hidden in early rock formations that contain many elements, such as iron and uranium, in their reduced states. Elements in this state are not found in the rocks of mid-Precambrian and younger ages, less than 3 billion years old.

One billion years ago, early aquatic organisms called blue-green algae began using energy from the Sun to split molecules of $H_2O$ and $CO_2$, and recombine them into organic compounds and molecular oxygen ($O_2$). This solar energy conversion process is known as photosynthesis. Some of the created oxygen combined with organic carbon to recreate $CO_2$ molecules; the remaining oxygen accumulated in the atmosphere. As oxygen in the atmosphere increased, $CO_2$ decreased.

High in the atmosphere, some oxygen ($O_2$) molecules absorbed energy from the Sun's ultraviolet (UV) rays and split to form single oxygen atoms, which combined with remaining oxygen ($O_2$) to form ozone ($O_3$) molecules that are very effective at absorbing UV rays.

The amount of ozone required to shield Earth from biologically lethal UV radiation, wavelengths from 200 to 300 nanometers (nm), is believed to have been in existence 600 million years ago. At that time, the oxygen level was approximately 10% of its present atmospheric concentration.

Prior to this period, life was restricted to the ocean; the presence of ozone enabled organisms to develop and live on the land. Ozone played a significant role in the evolution of life on Earth, and allows life as we presently know it to exist.

## And then there was Fire

Logically, we may assume there was once a time when man had no fire; however, very early he must have become acquainted with fire derived from natural sources, and made use of it, for no remains of man's art show him without fire as his companion. Much later in the scheme of things he invented processes for making fire artificially.

The discovery of fire, or more precisely the controlled use of fire, was a necessity. The control of fire by early humans was a turning point in the cultural aspect of human evolution, allowing humans to cook food, as well as obtain warmth and protection. Making fire allowed the expansion of human activity into the colder hours of the night, and provided protection from predators and insects.

With the acquisition of fire came the problem of preserving it; interesting examples of the ingenuity of man were presented. First, the fire was buried; preserved in the ashes of the fire itself. Next, a type of slow-match or fire-stick was developed, and later, when man worked with metals, the curfew, or "fire-cover" was invented.

Symbolic and superstitious uses of fire have been common. At an early period, altar fires were kept sacred; as time went by, the significance gradually lessened. When possible the communal fire was placed in front of a rock shelter or cave; in a place safe and convenient for the use of everyone. The necessity for a screen to protect the early bonfires from the wind may have been the reason for the round form of house thought to be the earliest.

Later, individual fires were built in the center of the family shelters, where the hearth became known as the chimney. The term was then used to include the hole or flue that carried off the smoke of the fire burning in a pit in the center of the floor.

History has failed to record the inventor, or to state the place where chimneys as we might recognize them were first used, but they seem to have been common in Venice before the middle of the 14th century, for a number of them were destroyed by an earthquake in 1347.

The four elements are indeed the essence of life. All animals, plants, non-living objects, and energies are combinations of these elements as, of course, are we. Everything has its own unique blend of the four elements in it: everything that has substance has Earth in it; everything that flows and/or has feelings has Water in it; everything that involves sound, thinking, or communication has Air in it; and everything that has energy has Fire in it.

Let us then leaf through this issue to discover how the Four Elements shape and affect our life.

## References


www.lifeslittlemysteries.com
www.rsc.org
geology.about.com
teachertech.rice.edu
csep10.phys.utk.edu
hearth.com


### History of Science Museum

## Visitors INFO

**Opening Hours**
Saturday to Thursday
[from 10:00 to 15:00]

**Guided Tours Schedule**
Saturday to Thursday
[10:30 + 11:30 + 12:30 + 13:30 + 14:30]

- Museum entry fees are included in all Planetarium show tickets.
- For non-audience of the Planetarium, Museum entry fees are 0.50 EGP.
- Museum Tours are free for ticket holders.

### ALEXploratotrium

## Visitors INFO

### Discovery Zone

**Opening Hours**
Saturday, Sunday, Monday, Wednesday and Thursday: [From 09:30 to 15:30]
Tuesday: [From 09:30 to 12:30]

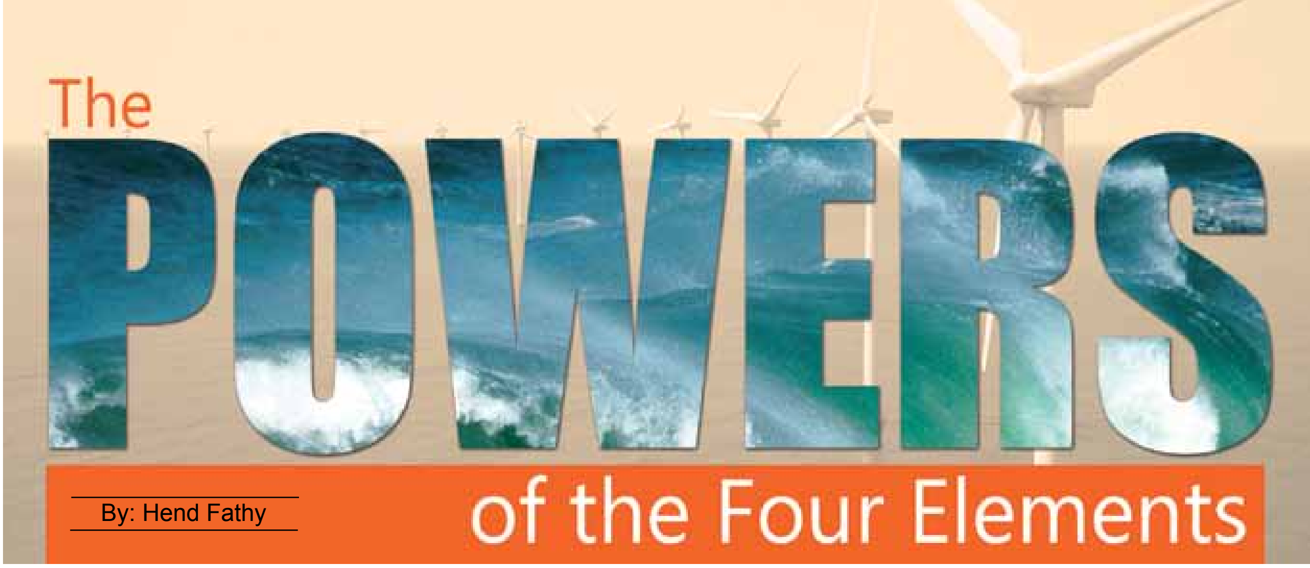
**Guided Tours Schedule**
Saturday, Sunday, Monday, Wednesday and Thursday: [09:30 - 11:00 - 12:30 - 14:30]
Tuesday: [09:30 - 11:00]

**Entry Fees**
Students EGP 2 Non-students EGP 4

### Listen and Discover

- For the list of shows available at the "Listen and Discover" and the schedule, please consult the Center›s official website: www.bibalex.org/psc.
- For reservation, please contact the PSC Administrator at least one week before the desired date.

**Show fees**
DVD shows:
Students EGP 1 Non-students EGP 2
3D shows:
Students EGP 2 Non-students EGP 4



# The POWERS of the Four Elements

By: Hend Fathy

Dependant as we are on it, it is literally impossible to unplug electricity from human life. Electricity is responsible for operating almost all kinds of machinery and lighting systems you can think of; yet, it is a secondary energy source generated through the conversion of other energy sources; such as coal, natural gas, nuclear or solar energy.

The imminent depletion of non-renewable energy sources has pushed humans to invest more on research and implementation of projects that aim to generate electricity from renewable energy sources. Luckily enough, the sustainable powers of Earth, water, wind, and the Sun, representative of the four elements of nature, provide us with a wide set of renewable energies readily available for generating electricity.

## Geothermal Power

Geothermal power, as suggested by the name, is a sustainable energy generated from the heat produced in the Earth's core. The ongoing process of decaying radioactive particles that occurs in rocks produces extremely hot temperatures exceeding that of the Sun's surface.

Generally speaking, geothermal energy reservoirs are deep underground with no visible signs on the surface, but it could find its way up in the form of volcanoes, fumaroles or hot springs. Most of the Earth's geothermal activity occurs in the "Ring of Fire", an area encircling the Pacific Ocean representing the core of earthquakes and volcanic activities.

Generating electricity from geothermal power relies on steam or water geothermal resources at very high temperatures; 150°C to 370°C. Consequently, electricity generation power plants are generally built where geothermal reservoirs coming from either dry steam wells or hot water wells are located within a mile or two of the surface. The pouring steam spins a turbine that activates a generator to produce electricity.

There are three types of geothermal power plants: dry steam, flash steam, and binary cycle. Dry steam plants directly use the steam piped from geothermal reservoirs to turn the electricity generating turbines. The most common, flash steam plants, on the other hand, convert water from hydrothermal resources into steam to rotate the generator's turbines. Remaining water and condensed steam are injected back into the ground to be used again, making it a sustainable energy resource.

As for binary cycle plants, they use the heat of geothermal water to boil another organic liquid with a low boiling point; the resulting vapor is used to drive the generator turbine. The water is then injected back into the hydrothermal reservoir to be reheated, and eventually reused.

Geothermal power is a clean source for electricity generation as it does not burn fuel in the generation process; it has very low emission levels. Power plants incorporate scrubber systems to purify air from hydrogen sulfide existing in steam and hot water. Most importantly, used water and steam are injected back into the Earth to be reused over and over again.

## Hydropower

Hydropower is the energy of moving water, which basically relies on the water cycle on Earth. Solar energy heats surface water, leading to evaporation; water vapor condenses into water droplets that form clouds, then falls back in the form of rain or snow; the falling water flows through rivers into oceans for the cycle to repeat. As early as the last decades of the 19th century, Man has managed to use this energy to generate electricity, or hydroelectric power.

A common type of hydroelectric power stations is dams; they are built on river beds to store water behind. When water is released from the reservoir, it flows through a turbine causing it to spin; the spinning turbine, in turn, operates a generator to produce electricity.

Though dams generate a clean source of energy and do not produce any polluting emissions, their operation has serious environmental impacts. Dams can obstruct fish migration, change water temperatures and silt loads, which could upset the ecological system of the area.

Moreover, reservoirs behind dams may drown significant areas including agricultural lands and archeological sites, and may necessitate relocating communities; for example, Egyptian authorities had to relocate the Nubians and Abu-Simbel temples when building the High Dam in Aswan.

Wave power is another form of hydropower used in generating electricity. Waves result from the continuous interaction of wind with ocean surfaces, providing an unlimited source of renewable energy. Different types of wave power machines that can be deployed on the shoreline or offshore convert the power of moving waves into electricity.

A common type of wave power devices consists of a part floating on or below the water surface connected to another fixed to the ocean floor; electricity is generated from the vibrating action the floating part produces when resisting the motion of the waves. Wave power is said to have less environmental impacts than dams; however, scientists have raised problematic issues such as electromagnetic pollution, whale entanglements and altering bottom structures of the seabeds.

## Wind Power

Wind is the motion of air resulting from the uneven Sun heating of the Earth's surface; daily and seasonal changes in temperature consistently cause wind to blow, securing a-never-depleting energy source. Wind power is, thus, inexhaustible because wind will keep blowing as long as the Sun shines.

Nowadays, wind power is mainly used to generate electricity; actually, it is the world's fastest growing and least expensive renewable electricity generation technology. Moreover, its cost is expected to continue falling to become the cheapest of all electricity source options by 2020. But, how is electricity generated from wind power?

Like old-fashioned windmills, modern wind turbines have propeller blades that collect the wind's kinetic energy. Though they resemble fans, wind turbines work the opposite way; instead of using electricity to generate wind, they use wind to produce electricity. The blowing winds cause the turbine's blades to lift and eventually turn; the spinning blades are connected to a drive shaft that turns an electric generator to produce electricity.

Wind technologies are green; unlike conventional power stations, wind turbines do not release polluting emissions, neither do they require water for cooling. Moreover, compared to the small physical area they engage, they produce large amounts of electricity; thus, they have a small physical footprint compared to the amount of electricity they produce. They can even be located on lands also used for grazing or farming.

However, implanting a wind farm is not as simple as building a windmill in a windy place; it necessitates in-depth studies and smart decisions. Wind technology investors are advised to consider how fast and how much the wind blows at the chosen site. Recommended sites for wind power stations generally include tops of hills, open plains, coastal areas and mountain gaps representing wind funneling.

## Solar Power

Solar energy is the primary source of renewable energy on Earth; it is from within the inner core of the Sun through a process known as nuclear fusion. Though it is 150 million kilometers away, the Sun is amazingly powerful; scientists claim that the amount of solar energy arriving to Earth in one minute is sufficient to meet our demands for a whole year, if only we could harness it in a proper way.

Among the incalculable benefits and roles it plays in sustaining life on Earth, solar energy can also be used to produce electricity. There are two different approaches to generate electricity from the Sun: Photovoltaic (PV) or solar cells, and solar-thermal technologies.

Photovoltaic devices or solar cells directly convert sunlight into electricity. The term "photovoltaic" comes from the Greek word "*photos*", meaning light; and "*volt*", a measurement of electricity. Solar cells are made up of silicon, one of the most common substances on Earth; the one that makes up sand.

When sunrays strike a photovoltaic cell, they may be reflected or absorbed. Only absorbed rays provide the energy needed to generate electricity as they become capable of initiating a chemical reaction. When rays strike solar cells, they move the electrons around, starting an electric current. Unfortunately, photovoltaic systems are not economical compared to other electricity generation technologies, as a single cell only produces one or two watts.

Solar-thermal systems, also known as Concentrated Solar Power (CSP), use the Sun's heat, rather than light, to generate electricity. Most solar-thermal systems use a mirrored-surface collector to concentrate sunlight onto a receiver that heats a liquid to boiling degrees, and uses the resulting steam to power electric generators. However, solar-thermal plants require significant amounts of water for regular cleaning and cooling. Also, birds and insects can perish if they fly into the concentrated beam of sunlight.

Solar energy has great potential for the future; it is for free and presents unlimited clean energy supplies. However, the cost of building solar power plants nowadays is still relatively high compared to the amount of electricity they produce. They can also harm desert ecosystems due to the significant land they require. It is also important to remember that solar energy, evidently, will not work at night, and that its production is subjected to climate conditions, such as clouds or fog.

Once again, the four elements unite and cooperate to grant us a means of life; waves acquire their power from the wind, and wind from the Sun, so does water and Earth; that is how it always went, goes and will continue to go. These powers, compared to the dominating fossil fuels, neither pollute nor damage our environment; they cannot be controlled by any one nation or industry, and are readily available for free for each human being on the surface of the Earth.

## References


www.eia.gov
www.powerscorecard.org
www.renewableenergyworld.com
www.nrel.gov
renet-eu-india.com
windeis.anl.gov
www.darvill.clara.net
cell.html





Having always occupied the minds of philosophers, astrologers, scientists and inventors, the four elements of nature: earth, water, air, and fire; inevitably invaded the minds of movie makers. The mysterious powers and connotations of the elements inspired screen writers and directors to create a number of remarkable works, one of which is Luc Besson's 1997 production "*The Fifth Element*".

The plot of the American movie starring Bruce Willis, Gary Oldman and Milla Jovovich takes place in a comic Sci-Fi action setting, dated around 250 years in the future. The storyline of the movie revolves around "a mission to save humanity", involving conflicts between different parties including humans, aliens, monsters, among others, ending with a breathtaking triumph of good over evil.

In the movie, a secret fifth element that visits Earth every 5000 years to protect it from Evil through stones that represent the four elements of nature is unveiled in an archaeological excavation during the 1910s. The alien human-friend Mondoshawans take the stones away, promising to return with them before the coming Evil attack expected in the 23rd century. The secret, carved on the walls of an ancient Egyptian temple, is passed from one priest to a successor throughout time, ending up with Father Vito Cornelius and his student David.

The Mondoshawans keep their promise; however, during their journey back to Earth with the stones and the fifth element, Evil uses the greedy Dr. Zorg and the mercenary alien Mangalores to bomb their spacecraft. A team of scientists use the DNA of the remains of the Fifth Element to rebuild the perfect being Leeloo, who escapes and stumbles upon the taxi of Korben Dallas.

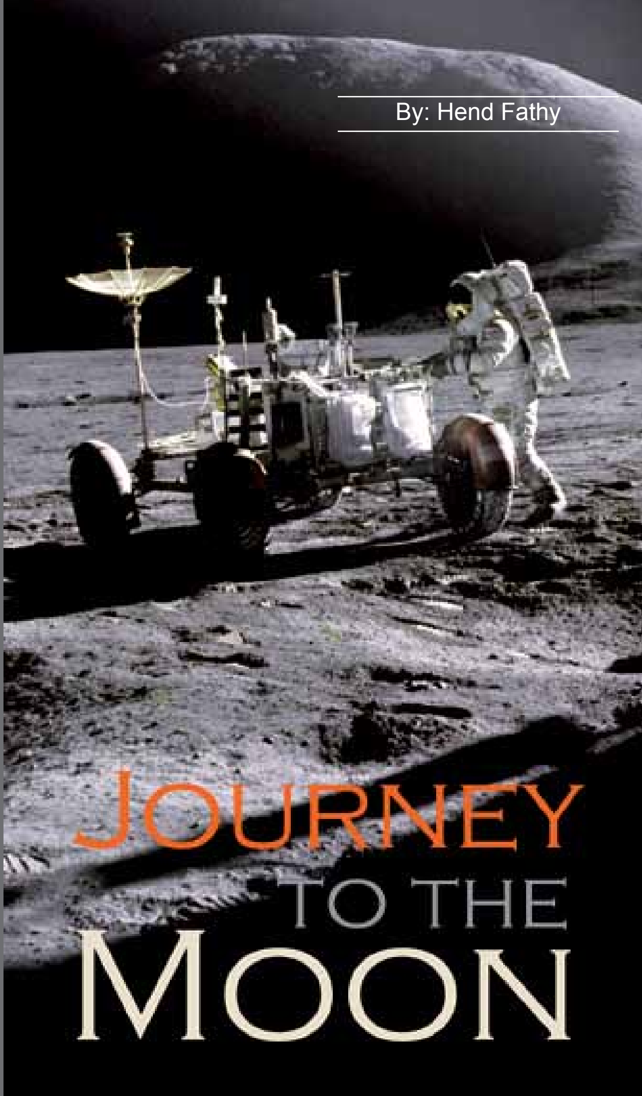
Dr. Zorg, who seeks to profit from the chaos that Evil brings, and his alien mercenaries fight to retrieve the stones and avoid the protection of Leeloo. Having become unwittingly involved in the battle, the skilled taxi driver and former elite Commando Major Korben Dallas falls in love with Leeloo and decides to help her find Father Cornelius and retrieve the stones to save the planet.

The movie highlights the importance of the four elements of nature representing matter in our life through their symbolic role in fulfilling the mission of saving humanity. However, it also stresses that they are worth nothing without goodness and love. Leeloo, the perfect being representing the Fifth Element, fails at the beginning to play her role in protecting Earth; during the short period she spends on Earth, she realizes that "everything [humans] create, [they] use to destroy". Only when empowered by the good deeds and feelings of Major Korben Dallas, she manages, alongside him, to fulfill the mission and save life on Earth.

Although the movie was not a major hit at the box office, ranking 26 in a sample of 100 movies shown in 1997, it was nominated for an Oscar.

## References


http://www.imdb.com/media/rm850107904/tt0119116
http://boxofficemojo.com/movies/?id=fifthelement.htm



By: Hend Fathy

# Journey to the Moon

Being our nearest neighbor, the Moon has always found its way into the realms of human curiosity; its desolate beauty has been the source of fascination, inspiring a rich cultural and symbolic tradition. It is no wonder then that it was the first new world on which humans set foot, and the target of dozens of astronomical missions, aiming to explore its mysterious body.

These explorations, as well as satellite images and remote-sensing observations highlighted radical differences between its nature and that of Earth. In this issue in which we discuss the four elements of nature, let us investigate how different, or similar, they are on the surface of the Moon.

## Earth

Looking at satellite images of the Moon's surface, all we can see are grayish rocks and dust beds; they are very different in nature from their counterparts on Earth though. Most lunar rocks are igneous[1] while most Earth rocks are sedimentary[2]; two common kinds of lunar rocks are basalts, rich in iron and titanium and found in lunar maria[3], and anorthosites, rich in aluminum, calcium and silicon, and found in highlands.

Similarly, lunar soils are different from "soil" as we know it, for there is no biological factor in their formation. They are basically derived from lunar rocks, yet, they contain some alien materials coming from celestial bodies crashing into the Moon's surface. Lunar soils also encompass solar-wind-driven particles that get implanted in the outer layers of soil grains.

Space scientists are indulged in extensive studies of lunar rocks and soils because they are believed to hold clues to the origin and history of Moon. More amazingly, helium-3 solar particles implanted in solar rocks represent a potential much cleaner and safer source of nuclear energy. Scientists claim that in high energy collisions, these particles would release more energy and less waste than traditional nuclear reactors; since there is no helium-3 on planet Earth, our closest supplier is the lunar soil.

## Water

Water, a major source of life on Earth, has long been suspected to exist on the Moon; however, scientists have struggled for many decades to prove that until they finally did. The suspicion was proven true in 2009 when NASA deliberately crashed the two-ton rocket Centaur accompanied with LCROSS (Lunar Crater Observation and Sensing Satellite) into the Cabeus crater near the Moon's south pole, discovering dozens of liters of water ice. Findings of later exploration of lunar water reservoirs reached about 600 million metric tons distributed among polar craters that remain in permanent shadow.

There are different scientific hypotheses regarding the source of lunar water. One theory suggests that hydrogen molecules carried to the Moon by solar wind reacted with compounds containing oxygen in the Moon rocks producing $H_2O$. Another proposes that it resulted from meteors crashing into the Moon's surface, because these bodies contain hydrated minerals and their cores are nearly pure ice. A third theory claims the Moon has a water cycle through which it migrates to the poles from lower latitudes; this hypothesis also suggests that water could have emerged from underground water-rich reservoirs to the surface through volcanic eruptions.

Scientists think of water discovery on the Moon's surface as a step towards a better understanding of the origin and evolution of the Solar System as a whole, in the same way samples from Earth surface reveal facts about ancient geological events. They believe that if water exists in sufficient quantities, it would turn the Moon into a permanent space station, a lunar base that supports manned explorations of farther celestial body; it could be drunk by astronauts and turned into oxygen to make the Moon habitable. Moreover, the presence of water besides hydrogen gas, ammonia and methane could be exploited to produce fuel.

## Air

Extremely tenuous as the lunar atmosphere is, astronauts need not worry about wind should they decide to play golf on the surface of the Moon! According to Anthony Colaprete, NASA Ames Research Center in Moffett Field, California, the lunar atmosphere is so fragile that "it is technically considered an exosphere, not an atmosphere; a cubic centimeter of Earth's atmosphere at sea level contains about 100 billion billion molecules, [while the] same volume of the Moon's exosphere contains only about 100 molecules".

Due to its fragile nature, lunar atmosphere is hard to study with humans and/or machines working on the Moon's surface, as they quickly disturb its fragile composition, swamping its natural composition. For example, analyzing data of atmospheric properties measured by Apollo[4] astronauts' machines was difficult because machine gases had a significant effect on the studied data. Nevertheless, lunar atmosphere remains of high scientific interest; as early as 2013, NASA will be launching the Lunar Atmosphere and Dust Environment Explorer (LADEE), aiming to study it better than ever before. However, what do we already know about the composition of lunar atmosphere?

The main gases composing the lunar atmosphere are neon, hydrogen and helium, in roughly equal amounts. Other gases detected in small amounts include methane, carbon dioxide, ammonia, argon and even water vapor. These gases come from different sources; mainly outgassing—gas emissions released from the Moon's interior as a result of seismic activities—and capture of particles from solar wind, which originates from the Sun's hot corona[5] and carries gas molecules along to the Moon.

Due to the Moon's low gravity, lunar atmosphere gases are easily lost to space; light gases escaping faster than gases of heavier molecules. Argon, for example, condenses due to the very low lunar night temperatures; while light gases, such as helium, which originate in the solar wind remain in the atmosphere and escape faster. Solar wind, thus, plays a very significant role in maintaining the lunar atmosphere as it carries constant supplies of gas molecules that makes for the escaping ones.

## Fire

It is technically impossible to light a fire on the Moon, for you cannot secure sources of fuel, heat and oxygen needed to sustain a fire flame. Yet, the associations of the fourth element such as light, heat and glow manifest in one way or another on the Moon's surface.

During daytime, sunlight is brighter and harsher on the Moon than it is on Earth because there is no atmosphere to scatter it and no clouds to shade it. At night, the Moon is lit up by sunlight reflected from Earth, and since Earth is much larger in size, lunar nights are brighter than Earth nights.

Lunar temperatures are also of a very unique nature; it can reach 107°C during the day, dipping down to -153°C during the night. This drastic drop is due to several reasons. First of all, as mentioned earlier, the Moon's atmosphere is very thin and thus heat easily escapes it. Also, the Moon takes 27 days to rotate once on its axis, which means that a single night on the Moon's surface is two weeks long.

As bright as a glowing fire, glowing spots on the Moon's surface were detected, yet, they were not fiery. Scientists observed the appearance of a series of glows on a large lunar crater that kept changing in shape until they finally faded. Such glows are believed to be caused by escaping gases that lift dust above the lunar surface into sunlight. At the same time, a series of fractures developed on the crater floor; they were believed to be the source of the escaping gases.

The four elements of Earth's nature are all present in different forms on the Moon; yet, they do not support any form of life over there. However, science is an endless race and "unquestionable facts" have no place in a world where new discoveries are made everyday. The Moon's four elements can qualify it as an expansion of the Earth's economic sphere or a testing place for new technologies. Scientists are already speaking of types of bacteria that can be implanted into lunar soil and can survive such gloomy conditions; who knows what is next?

## Glossary

(1) **Igneous rocks** are formed by the cooling and solidifying of molten materials.
(2) **Sedimentary rocks** are formed through the deposition and solidification of sediments transported by water, ice and wind. Sedimentary rocks are often deposited in layers, and frequently contain fossils.
(3) **Lunar Maria** are dark rocky spots on the Moon. The word "maria" means "seas" in Latin; these spots get their name due to their ocean-like appearance in contrast with surrounding lighter spots.
(4) **The Apollo Program** is a series of NASA space missions that have been launched to the Moon starting from 1969 until today; the missions land men on the Moon and return them to Earth.
(5) **The Corona** is a huge region around the Sun, the temperature of which is so high that the Sun's gravity cannot hold on to it, thus emitting solar wind.

## References


www.britannica.com
science.nasa.gov
discovermagazine.com
www.guardian.co.uk
www.telegraph.co.uk
www.nytimes.com
www.livescience.com
imagine.gsfc.nasa.gov
www.universetoday.com
news.bbc.co.uk
www.newscientist.com
www.wisegeek.com
dictionary.reference.com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- For the Planetarium daily schedule and fees, please consult the Center's official website: www.bibalex.org/psc.
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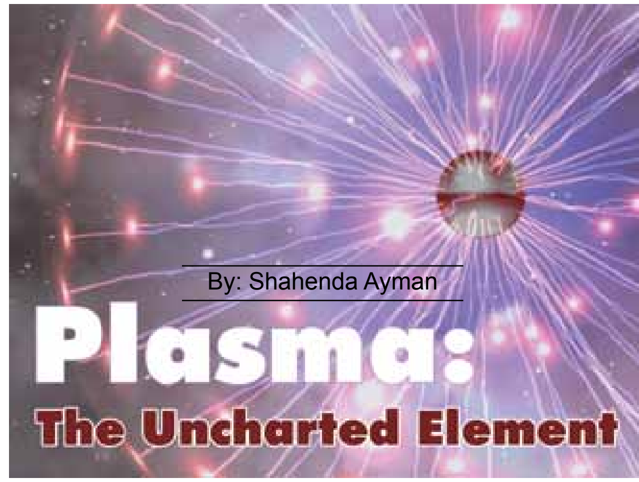


By: Shahenda Ayman

# Plasma: The Uncharted Element

Most schoolchildren learn that everything in the universe is a solid, a liquid or a gas. However, those lessons usually lack the fourth and by far the most common state of matter: plasma. Not only should plasma be added to the list, but the order should be reversed to put it in first place; as a matter of fact, beyond the Earth's atmosphere, the dominant form of matter is plasma, and "empty" space has been found to be quite "alive" with a constant flow of plasma, making up over 99% of the visible universem and perhaps most of that which is not visible.

Neither solid, nor liquid, nor gas, plasma most closely resembles the latter; however, unlike gases, whose components are electrically neutral, plasma is composed of approximately equal numbers of positively charged ions and negatively charged electrons. It is so energetic, or "hot", that in space it consists solely of ions and electrons; it is only when plasma is cooled that atoms or molecules that are so predominant in forming gases, liquids, and solids we are so accustomed to on Earth, are possible. Accordingly, in space, plasma remains electrically charged, carrying electric currents, and more influenced by electromagnetic forces than by gravitational forces.

The space surrounding the Sun, its corona and beyond, is a plasma. Indeed, much of all space is occupied by plasma, mostly in the dark current mode; planets and their moons each carry an electric charge as they travel through this plasma. The plasma sea in which the solar system floats extends out to what is known as the heliopause*, where there is probably a double layer separating our Sun's plasma from the lower voltage plasma that fills our arm of the Milky Way.

Plasma emits light because of "spontaneous emission", which basically means that the ion, atom or molecule, have a higher level of energy than stable ones, so it becomes unstable and the particles emit photons. Through this release, the particles return to stability, only to start again; each time a particle goes from the same higher state to lower, the same photon will be emitted.

The term "Plasma" was borrowed from blood plasma in order to describe its almost life-like and self-organizing properties. Although plasma is the dominant constituent of the universe as a whole, most people are ignorant of the plasma concept. In daily life on Earth, perhaps the plasma to which people are most commonly exposed is the one that produces the cool efficient glow from fluorescent lights. The most familiar examples of electrical plasmas here on Earth are neon signs and lighting, television screens, and electric arc welding machines. Fire and lightning are also forms of plasma.

## Glossary

***Heliopause** is a bubble of charged particles in the space surrounding the Solar System, "blown" into the interstellar medium (the hydrogen and helium gas that permeates the galaxy) by the solar wind.

## References


http://www.thunderbolts.info/forum/phpBB3/viewtopic.php?p=65974&sid=02c305aa448cd8a49013eae8b0c741e1
http://www.plasmas.org/what-are-plasmas.htm
http://www.egglescliffe.org.uk/physics/fun/plasma/plasma.html
http://www.plasmacosmology.net/
http://pluto.space.swri.edu/image/glossary/plasma.html

# The Four Elements
## The Epitome of Life

By: Shahenda Ayman

The Four Elements of antiquity—earth, water, air, and fire—dominated natural philosophy for 2000 years. The premise that everything was formed from these Four Elements was developed by the Greek philosopher Empepedocles[*] of Sicily, and continued to be believed until the rise of modern science. While we do know now that these previous theories are false, in a way, the Four Elements do align with the four states of matter that modern science has agreed on: solid (earth), liquid (water), gas (air), and plasma (fire).

Matter is anything that has mass and volume, and is made up of atoms, which are the smallest particles of matter; bonding occurs among atoms to make larger molecules. How atoms are arranged in an object determines whether it is a solid, liquid, gas, or plasma.

- In a solid, atoms are packed closely together in an ordered pattern and cannot move, forming a solid of definite volume and shape. Examples of solids include rocks, wood, metal, and ice.
- In a liquid, atoms are close together but can move around each other, allowing a liquid to take the shape of whatever container it is placed in. Examples of liquids include room temperature water, room temperature mercury, and hot lava (molten rock).
- In a gas, there is more space between atoms; they can move so freely that if the gas is not trapped in a container, the atoms will diffuse and spread throughout the atmosphere. Examples of gases are oxygen and nitrogen (in the air we breathe), helium, and steam (water vapor).
- In a plasma, atoms are spaced similarly to gas, except there is much energy in a plasma, the atoms actually split into smaller pieces. Plasmas are able to carry an electrical current and generate magnetic fields. Examples of plasmas include lightning, solar wind, fluorescent lights, and neon signs.

### Earth: The Root of Life

The two most common elements in the Earth's crust are oxygen (46%) and silicon (28%); that is why the most abundant mineral in the Earth's crust is silica (silicon dioxide). More commonly known as sand, silica is a major component of glass; when it is heated, it melts and becomes glass, hardening as it cools.

Moreover, rich deposits of metal ores exist throughout the Earth's crust. While these metals are used in the production of machinery, straight out of the Earth, these metals are useless. Fire is used to heat, refine, and shape metal so that machines, hammers, and support beams can be made from it.

Earth is full of a wide variety of rocks and minerals, which allow the soil to grow vegetation and support life. Our soil is obviously as important as our oceans and our water supply because we would not have anything to stand on. Without soil, we would not be able to plant trees or food crops; we would not be able to eat or have shelter. We are all connected in this planet and our soil is one of the most basic elements in our lives.

Aside from providing a place for seeds, plants and trees to grow, our soil is a very important data gathering element on our planet. Soil quality is measured to help scientist predict impending drought by measuring the soil's capability to hold water during the dry season; it can also show if the area can withstand flooding. The same is true when scientists are measuring the amount of chemicals and pH in the soil to show if the area can still sustain healthy plant life. In other words, our soil is like a measuring device that shows scientists the overall health of an area or a part of land.

Soil is also a very big link in the chain of life and death on our planet. Living things such as animals, leaves, seeds and other organic matter decompose in the soil, providing organic matter that enrich the soil. This process in turn makes plants grow healthier, which in turn are eaten by animals that are eaten by humans. The cycle resumes when the animal dies and decomposes with assistance from our soil.

### Water: The Nectar of Life

The chemical formula of water is $H_2O$, meaning it is made of two hydrogen atoms bonded to one oxygen atom. Each hydrogen atom attaches to one side of the oxygen atom, obtaining a positive charge; whereas the oxygen atom obtains a negative charge, which polarizes the water molecule, much like a magnet, giving a water molecule positive and negative ends. Since opposite charges attract, water molecules tend to stick together, giving water surface tension and allows objects, such as paperclips, to float on it.

While it cannot dissolve everything, water is known as the universal solvent because it can dissolve more substances than any other liquid; it can dissolve salt, sugar, acids, alkalis, some gases, and organic material. Water traveling through your body or through the ground takes chemicals, minerals, and nutrients with it. Water's ability to dissolve substances helps keep the planet healthy. To give one example, for more than a century, the burning of fossil fuels has pumped large amounts of carbon dioxide ($CO_2$) into the atmosphere; water in oceans has absorbed about half this $CO_2$ by dissolving the gas from the air and processing it through sea vegetation.

### Temperature Check

Water has a high specific heat index, meaning that it requires a lot of energy to change its temperature; this is essential for life to survive on a planet. The abundance of water on Earth keeps the planet in a very short but comfortable temperature range. The average surface temperature of Earth is 15ºC, with the highest recorded temperature 57.72ºC and the lowest temperature -89.22ºC.

To compare, it would seem logical that Mercury, the closest planet to the Sun, would stay really warm on all surfaces of the planet, regardless if it was facing the Sun or not. However, while the surface facing the Sun reaches very warm temperatures (up to 426.67ºC), the surface facing away from the Sun drops to a chilly -173.33ºC. Mercury's lack of water is responsible for this drastic temperature change because the dry material that makes up its surface cannot retain heat like water does.

To experience for yourself how well water keeps temperature from drastic fluctuations, pay attention to the change between daytime and nighttime temperatures the next time you visit a maritime or desert climate. You will probably notice that there is little to no temperature change near the ocean, whereas in the desert there is a significant change between daytime and nighttime temperatures.

This high specific heat index also helps water extinguish a fire by cooling the fuel surfaces that the fire is burning, removing the heat needed for the fire to burn. It also smothers a fire by preventing it from obtaining the oxygen it needs to burn.

### Drinking Water: Staying Fit

One of nature's most important gifts to mankind, pure water is an odorless, tasteless, clear liquid. Water is one of the most essential elements for good health as it is necessary for the digestion and absorption of food; it helps maintain proper muscle tone, supplies oxygen and nutrients to cells, rids the body of wastes, and serves as a natural air conditioning system. Health officials emphasize the importance of drinking at least eight glasses of clean water each and every day to maintain good health.

Since water contains no calories, serves as an appetite suppressant, and helps the body metabolize stored fat, it may possibly be one of the most significant factors in losing weight. In his book, "The Snowbird Diet", Dr. Donald Robertson states that the body will not function properly without enough water, and discusses the importance of drinking plenty of water for permanent weight loss.

### Clean Water: Clean Health

Water is a key component in determining the quality of our lives. Although water covers more than 70% of the Earth, only 1% of the Earth's water is available in rivers, lakes and groundwater reservoirs for drinking. Yet, our society continues to contaminate this precious resource.

Small traces of chemicals, microorganisms and bacteria may occasionally be present in water before treatment; any pesticides found will be at extremely low levels, which are not harmful to health. Moreover, iron occurs naturally in many water sources, but can also be added to water by the corrosion of water mains; it is unlikely though to be harmful to health.

On the other hand, lead could be found in drinking water, coming from lead pipes; it is suspected of affecting the mental behavior of children. Nitrates from fertilizers may also be found in pre-treated water, which could be harmful to babies.

In order to make water safe to drink, it undergoes a treatment process tailored to suit the source; for example, groundwater requires much less treatment than river water. At treatment facilities, water goes through different stages of treatment:

**Clarification** is a process where a chemical is added to raw water and combines with material such as algae and silt to form larger particles, which are then removed either by settling them out (sedimentation) or by using air to float them to the surface (flotation).

**Filtration** is the removal of any particles remaining in the water following clarification. The water flows through a bed of sand or other media where the particles become trapped. It is necessary to ensure that as many particles as possible are removed in order for the final disinfection stage to be effective. It is at this stage that harmful microorganisms are removed.

**Disinfection**, most commonly using chlorine, is essential for the removal of bacteria from water to ensure it is kept safe during its journey to your tap.

The levels of organic substances such as pesticides and herbicides are controlled by a combination of ozonation and carbon adsorption; the ozone breaks down the chemicals, which are then adsorbed onto the carbon. Meanwhile, nitrate levels in water are controlled by a process known as ion exchange, which is similar to that used in domestic water softeners.

## Air: The Breath of Life

Air was considered a pure element; in fact, the air around us is made up of a variety of gases, primarily nitrogen and oxygen, with almost 1% argon and even smaller amounts of carbon dioxide and other elements, such as krypton and helium. The composition of air is just right for life on Earth though; we use oxygen we get from the air we inhale, then exhale carbon dioxide, which plants need to manufacture their food through photosynthesis, in turn giving off oxygen during photosynthesis.

### Pressure Check

Although air is invisible, and most of the time we forget it even exists, it takes up space; it has volume and exerts pressure. This can be seen when you take an empty glass, turn it upside down, and try to push it down to the bottom of a sink full of water. If the glass was truly empty, the water would easily fill the inside of the glass, but air is in there, and only a small amount of water can enter the glass. The air in the glass was compressed, giving the water some space that was previously occupied with air.

It is good that air fills empty space because air all around us actually presses down on us all the time; we would collapse under the weight of the air, except air is also inside us and exerts pressure that balances out the pressure exerted by the outside air.

### Fresh Air: Fresh Health

For many of us, the time we spend outdoors each day amounts to a bunch of minutes added up as we go from one closed space to another; some of us go out more when the weather gets warmer, but the body's need for fresh air is not seasonal. We need to get a good amount of fresh air each day.

There is no "right amount" of fresh air we should get each day; let your commonsense guide you and you will know what you need. Whether it is a half hour or a half day, there are so many ways to spend time outdoors and make it fun; perhaps a jog, a walk, flying a kite, throwing a Frisbee or even just sitting outdoors. Our lungs, skin and whole body benefit so much from fresh oxygen.

You may think that it cannot be that important to your health; after all, you spend most of your life indoors and seem to be doing fine. But, are you really fine? How often do you get respiratory tract infections such as the cold, flu or bronchitis, etc? How about allergies and asthma rates? Our respiratory health is informing us that we are not fine; getting sick is not supposed to be a normal part of life.

High oxygen levels increase the efficiency of almost all the reactions in your body; from losing weight to sleeping better at night, fresh air is a key component. High oxygen levels in the body have also been linked to decreasing cancer growth and preventing cancers all together.

Indoor air and outdoor air both contain oxygen naturally, but the quality is not the same. Some people say that they do not want to go outdoors or open their windows in fear of pollution; however, unless you live next to some combustion factory or it is a high alert smog day, I can assure you that the air outdoors is almost always better than that indoors.

The reason for that is the concentration and dilution effects. Outdoors, there is a better dilution effect as more fresh air is available; thus, the concentration of pollutants tends to be lower. Indoors, especially the air-tight way that most homes are built today, exists a higher ratio of pollutants to fresh air; thus, the air in your home is not high quality, unless it is regularly exchanged.

Open your windows and air out your house regularly; go outdoors to have some fun in the fresh air! No matter what season, what time of the day, these are relatively free, yet necessary actions for our health and wellbeing.

## Fire: The Engine of Life

Humans have been huddling around fires for thousands of years; from the very basic and primitive essentials to modern living amenities, fire plays one of the most important roles in our daily lives.

How fire works is closely linked to air; it needs three things in order to exist: oxygen, fuel, and heat. When all three of these things are in a controlled situation, such as in candles or a campfire, fires are considered helpful; however, when one or more of these things are not controlled, such as in a wildfire or a burning building, fires can easily become very dangerous.

To extinguish a fire, oxygen, fuel, or heat needs to be eliminated; smothering a fire by placing a blanket or dirt on it works because the fire goes out without oxygen. When the fuel is removed, the fire has nothing left to burn and is extinguished. Water often serves as an effective cooling source by removing the heat from a fire; this is seen when hot lava from an erupting volcano flows into the ocean or when a bucket of water is dumped on a campfire.

Fire creates light, heat, and smoke by a rapid chemical reaction known as combustion; smoke is the result of the incomplete combustion (burning) of a fuel as particles that were not burned become suspended in the air. Smoke is often dangerous because it contains harmful gases that can poison a person who inhales too much smoke.

You might be surprised to know that our bodies also use combustion to produce energy from oxygen and food through metabolic processes. We need a steady supply of oxygen to keep our bodies functioning normally; if there is insufficient oxygen in the air, we will suffocate; at the same time, we can be thankful there is not excessive oxygen in the air, or the chemical reactions in our bodies would speed up, causing us to soon crash and burn! Excessive oxygen in the air would also increase the risk of fires on Earth. Since nitrogen and argon are not very reactive, air is pretty safe for us.

### Multitasking Element

One of the most well known uses of fire is heating; dating back to the early years of mankind, humans used fire to keep warm. Even today people use open fires to stay warm outdoors during camping trips, or light fireplaces in homes to keep the house warm during the winter. Even gas burning central heating units ignite a flame and use its heat to warm air that is then blown into the home through ducts by a fan.

Perhaps one of the most important uses of fire throughout history has been its ability to provide light. Fire is a good light source although it pales in comparison to other sources, such as light bulbs and flashlights for some purposes. It does, however, provide a soft glow that can help light an area and make it possible to move around at night outdoors. In the days prior to electric lights in homes, fire was a main source of light in fireplaces and oil lanterns.

Fire can be used to prepare foods in many ways; open fires have long been used to roast meats and vegetables, while grills use flames to prepare favorite foods such as steaks, hamburgers, fish and much more. Many people prefer grilling to oven roasting or frying because of the distinct smoky flavor it produces. Fire is also the catalyst for smoking meats; this method of flavoring and preserving meats has been around for generations.

Every time you turn on a light in your home, flick on the air conditioner, watch television or use any other appliance, there is a good chance you have fire to thank for the luxury. While it does not seem apparent to many people, electricity does not magically occur without an energy source.

According to the Polymer Science Learning Center website, the vast majority of electricity in the USA comes from the burning of fossil fuels. Fuels such as coal, natural gas or oil is burned to heat water and produce steam that builds pressure and forces turbines to turn, creating energy that supplies electricity to the public. Fire is at the root of the process, and without it, much of the current electrical availability across the country and much of the world would not exist.

The in-commutable relationship between these four elements and our life is fascinating. These magical elements are the heart of everything and anything around us; if we take a closer look on our daily activities, we will discover their glory and glow. As far as I am concerned, they are the Epitome of my life!

### Glossary

***Empepedocles** was a Greek pre-Socratic philosopher; his philosophy is best known for being the originator of the cosmogenic theory of the four Classical elements.

### References


salemos.tripod.com
www.aomega.com
www.ehow.com
medical-dictionary.thefreedictionary.com
www.hometrainingtools.com
www.farmcommunities.com
rizwanisria.hubpages.com
www.rsc.org

# The Elements' Wrath

By: Jailane Salem

When I was a child, I used to watch a cartoon called "Captain Planet and the Planeteers"; it revolved around five teenagers from around the world who fought environmental pollution. Each had a magic ring that could summon the power of an element, be it earth, water, wind, fire or heart; by combining their powers together they could summon Captain Planet who would stop environmental disasters from occurring. The main message of the cartoon was that we should respect and protect our home planet; it also showed us how to be as green as possible.

Even though the powers of earth, water, wind, and fire were used in the cartoon to quell disasters, in reality, they themselves can lead to natural disasters. Especially now, with the increase of human interference in the ecosystem, we are upsetting the scales, triggering grave consequences; this can be clearly seen in the increasing number of natural disasters.

## On Shaky Grounds

In recent years, every now and then, Alexandria would experience a mild tremor; nothing to cause much alarm though, still people talk about it for a while since it is a rare occurrence. Others, however, are not as blessed; in some places, earthquakes are a habitual hazard, and drills are often carried out to make sure people are always prepared to flee to safety.

So, what exactly causes the ground to shake? Well, the Earth's crust and upper mantle is composed of several large, thin plates that move in different directions, causing friction depending on the direction the plates are moving. Sometimes the plates crash together, pull apart or slide along each other; this movement is what usually causes earthquakes.

There are about 20 plates along the surface of the Earth that continuously, and slowly, move past each other. As one person puts it: "Imagine holding a pencil horizontally; if you were to apply a force to both ends of the pencil by pushing down on them, you would see the pencil bend. After enough force is applied, the pencil would break in the middle, releasing the stress you have put on it; the Earth's crust acts in the same way. As the plates move they put forces on themselves and each other; when the force is large enough, the crust is forced to break. When the break occurs, the stress is released as energy that moves through the Earth in the form of waves, which we feel and call an earthquake".

One country that experiences many earthquakes is Japan; it can experience thousands of minor tremors each year. One of the worst earthquakes Japan experienced in its history was the Kobe earthquake in 1995; nearly 27,000 people were injured, more than 45,000 homes were destroyed, and 6,433 people lost their lives. The destruction was so devastating, Japanese scientists have since tried to improve prediction of earthquakes, but it is extremely difficult to predict when and where earthquakes will occur.

More recently, the 2011 Tohoku earthquake was of magnitude 9.0 on the Richter scale; a strength never recorded in modern times, making it one of the most powerful earthquakes. The epicenter was approximately 70 km east of the Oshika Peninsula of Tōhoku. As the Earth shifted during the earthquake, this movement triggered powerful tsunami waves that reached heights of up to 40.5 m in Miyako in Tōhoku's Iwate Prefecture; in the Sendai area, they travelled up to 10 km inland. Early estimates placed insured losses from the earthquake alone at USD 14.5 billion to USD 34.6 billion.

## Too Much Water … Too Little Water

We have all experienced days when it would rain non-stop for hours, even days, causing mayhem as draining systems become unable to cope with the sudden excess of water, causing roads to overflow and become blocked. Life can come to a standstill; but, why?

Not only is it due to poor infrastructure; but, when it rains, water would naturally soak into the soil, not concrete. The urbanization of large areas with buildings and concrete roads has left rainwater with no other option but to go down small drainage holes in the ground, assuming this would be enough. However, this is often hardly enough and water gets trapped, flooding the streets of many cities around the world.

Flooding also occurs when there is a large downpour of rainwater, like what happens during the rainy monsoon season, which leads to a lot of destruction, especially on farmlands, as crops end up drowning and the soil over-saturating with water, potentially leading to a food crisis. During most of the year, the winds blow from land to ocean, which makes the air dry; monsoons occur during the months of the year when the winds blow from ocean to land making the air moist, leading to monsoonal rains.

Among the countries that witness heavy monsoon rainfall and consequential flooding are India and Pakistan. The high elevation of the Tibetan Plateau in the north of India, which is one of the largest and highest plateaus on Earth, increases the probability of the development of a low pressure zone that leads to intense rainfall come monsoon season.

In 2010, Pakistan witnessed the worst flooding in its history as a result of heavy monsoon rains that affected the Indus River basin. Around one-fifth of Pakistan's total land area was engulfed in flood waters, which had a drastic impact, directly affecting about 20 million people, whether by destroying their homes and properties, or their livelihood and the infrastructure of the affected areas. An estimated 2000 people lost their lives in the natural disaster.

In December 2010, Australia's Queensland experienced its wettest season on record; record high rainfall occurred in a total of 107 locations during the month. Tropical Cyclone Tasha was the main cause for the high precipitation rate; when the rain continued, it caused the river to swell and eventually break its banks leading to a series of floods, which affected primarily the State of Queensland including its capital Brisbane.

The floods forced the evacuation of thousands of people from towns and cities; over 200,000 people felt the brunt of the floods in at least 70 towns. The damage was very costly and was initially estimated at around AUD one billion.

However, water disasters do not only occur when there is too much rain; they can also occur when there is not enough of it. In many areas around the world, countries suffer from severe extended periods of drought, forcing people to abandon their homes, especially in the countryside where farms are located. Instead of lush green pastures and crops, and lazily grazing cattle, there would be brown brittle bushes, sundried caked and cracked earth, and sad dried cattle carcasses.

One such drought-affected area is the Horn of Africa where severe drought affected millions of people in Djibouti, Ethiopia, Kenya and Somalia. Seasonal rains were disrupted due to weather conditions over the Pacific, for one year in Kenya and Ethiopia (2011), but it was disrupted for two years in Somalia. The main rainy season, from April to June, witnessed a decrease in precipitation rates; in many areas, the percentage of precipitation was significantly lower than past years, some areas receiving less than 30% of the average rainfall.

This lack of rainfall had an adverse effect on crops and livestock; food prices skyrocketed, and wages decreased leading to economic problems in the region. People's livelihood was threatened; many people were dislocated and tried to find refuge in other neighboring countries, pressuring refugee camps and stretching food supplies pretty thin. Due to political obstacles, aid did not easily reach those who needed it most, and an unfortunate famine claimed the lives of thousands.

In May 2012, the United Nations Humanitarian Chief warned that about 18 million people were facing hunger across eight countries in West Africa, including the Sahel region. The Sahel is the eco-climatic and bio-geographic zone of transition between the Sahara Desert in the north of Africa and the Sudanese Savannas in the south, covering an area of 3,053,200 $km^2$. It is a transitional eco-region of semi-arid grasslands, savannas, steppes, and thorn shrub lands.

The famine was due to a combination of failed crops, insect plague, high food prices, conflict and drought. The drought affecting this region is no newcomer, and has in past decades led to much suffering in the form of food insecurity. Some scientists blame the drought on humans' misuse of environmental resources, while others see it as consequences for global climate changes.

Rajiv Shah, Head of the United States Agency for International Development, believes that climate change increased the severity of the problem: "There is no question that hotter and drier growing conditions in sub-Saharan Africa have reduced the resiliency of these communities".

Others, on the other hand, do not believe that climate change is connected to the drought, or played a role in the crisis; two experts with the International Livestock Research Institute suggested that it was too early to blame climate change for the drought, and insisted that more research is needed to study the suggested connection between the two.

## Roaring Tempests

We have all seen the iconic image of a hurricane from space, a huge swirl of clouds around a small opening that is called "the eye of the storm"; we have also all heard of the devastating effect hurricanes can have on human lives.

Hurricanes are basically really big storms, reaching up to 900 km across, with strong winds spiraling inward and upward at speeds of 120 km/h to 320 km/h. A hurricane usually lasts for over a week, moving 16-32 km/h over the open ocean; as one person explains it: "A hurricane builds energy as it moves across the ocean, sucking up warm, moist tropical air from the surface and dispensing cooler air aloft.

Think of this as the storm breathing in and out. The hurricane escalates until this "breathing" is disrupted, like when the storm makes landfall. At this point, the storm quickly loses its momentum and power, but not without unleashing wind speeds as high as 300 km/h on coastal areas". Once a hurricane reaches land it unleashes heavy rain, strong winds and large waves which can damage buildings, trees and cars.

Hurricanes gain their energy from the warm water of the ocean; they can only form if the water's temperature is 27°C or higher. The warm, moist air from the ocean's surface begins to rise quickly; as it does, water vapor condenses to form storm clouds.

As the condensation releases heat, more cool air warms up, ending up rising and giving way for more cool air to be heated up; as this cycle continues, the size of the storm cloud increases, and more heat is being transferred from the ocean's surface into the atmosphere.

This exchange of heat creates a pattern of wind that circulates around the surface center called "converging winds", which collide and push more moist air upward. This rising air reinforces the air that is already aloft from the surface, causing the circulation and wind speeds of the storm to increase.

The rising hot air from the storm's center is removed by strong winds blowing at the same speed at higher altitudes (up to 9,000 m) helping in maintaining a continual movement of warm air from the surface and keeping the storm organized. As high-pressure air is sucked into the low-pressure center of the storm, wind speeds increase.

Most of the destruction caused by hurricanes is due to its storm surges; as a hurricane's winds spiral around and around the storm, water is pushed into a mound at the storm's center. Once the storm reaches land, this mound of water becomes extremely dangerous because it leads to flooding along the coast bringing in a large amount of water crashing into the land, sweeping anything that exists in its path.

A hurricane will cause more storm surge in areas where the ocean floor slopes gradually; this leads to major flooding, which was one of the biggest problems when Hurricane Katrina hit the USA in 2005.

In 2003, Hurricane Isabel was the costliest and deadliest hurricane in the Atlantic hurricane season. Isabel formed near Cape Verde Islands; it moved northwestward, reaching peak winds of 265 km/h on 11 September. In North Carolina, the storm surge from Isabel washed out a portion of Hatteras Island, damage was greatest along the Outer Banks, where thousands of homes were damaged or even destroyed.

The worst of the effects of Isabel occurred in Virginia, where most deaths and damage from the hurricane were reported; about 64% of the damage and 68% of the deaths occurred in North Carolina and Virginia. Some rural areas were without electricity for weeks, and local flooding resulted in thousands of dollars in damage. Throughout the path of Isabel, damage totaled about USD 3.6 billion.

More notoriously famous, Hurricane Katrina was one of the strongest storms to impact the coast of the United States during the last 100 years. With sustained winds during landfall of 125 mph—a strong category 3 hurricane on the Saffir-Simpson scale—and minimum central pressure the third lowest on record at landfall (920 mb), Katrina resulted in widespread devastation along the central Gulf Coast States of the US.

Cities such as New Orleans bore the brunt of Katrina's force, needing weeks and months of recovery efforts to restore normality. Katrina was the costliest storm in United States history with amounts over USD 81.2 billion; and more tragically, a death toll of over 1,836.

## Walking on Fire

One of the most famous volcanic eruptions in history is that of Mount Vesuvius in the year 79. Rivers of lava ran down the volcano after erupting through its vent, engulfing the nearby human settlements of Pompeii and Herculaneum, whose locations were lost until they were accidentally discovered in the 18th century.

The eruption, though unfortunate for the inhabitants of the time, became a fortunate event for archaeologists, who were later on offered an interesting glimpse into the past when the buried towns were unearthed.

Under the Earth's thin crust lie many layers reaching to the core of the planet; hot gases and magma lying underneath the plates, coming up to the surface from time to time through the vents of volcanoes. Volcanoes tend to exist along the edges between tectonic plates; around 90% of all volcanoes exist within the "Ring of Fire" along the edges of the Pacific Ocean.

When there is a large build up of pressure from molten rock, there is no way of releasing that energy except through erupting from volcanoes. With every eruption, a volcano gets bigger and bigger; when the magma flows out onto the surface it becomes lava, and as it slides down the sides of the volcano, it cools down and solidifies adding to the size of the volcano.

Basically, volcanoes are what remain after the material spewed during eruptions has collected and hardened around the vent, this can happen over a period of weeks or millions of years.

Scientists have categorized volcanoes into three main categories: active, dormant, and extinct. An active volcano is one that has recently erupted and there is a possibility that it may erupt soon. A dormant volcano is one that has not erupted in a long time but there is a possibility it can erupt in the future, while an extinct volcano is one that erupted thousands of years ago and there is almost no possibility of it erupting again.

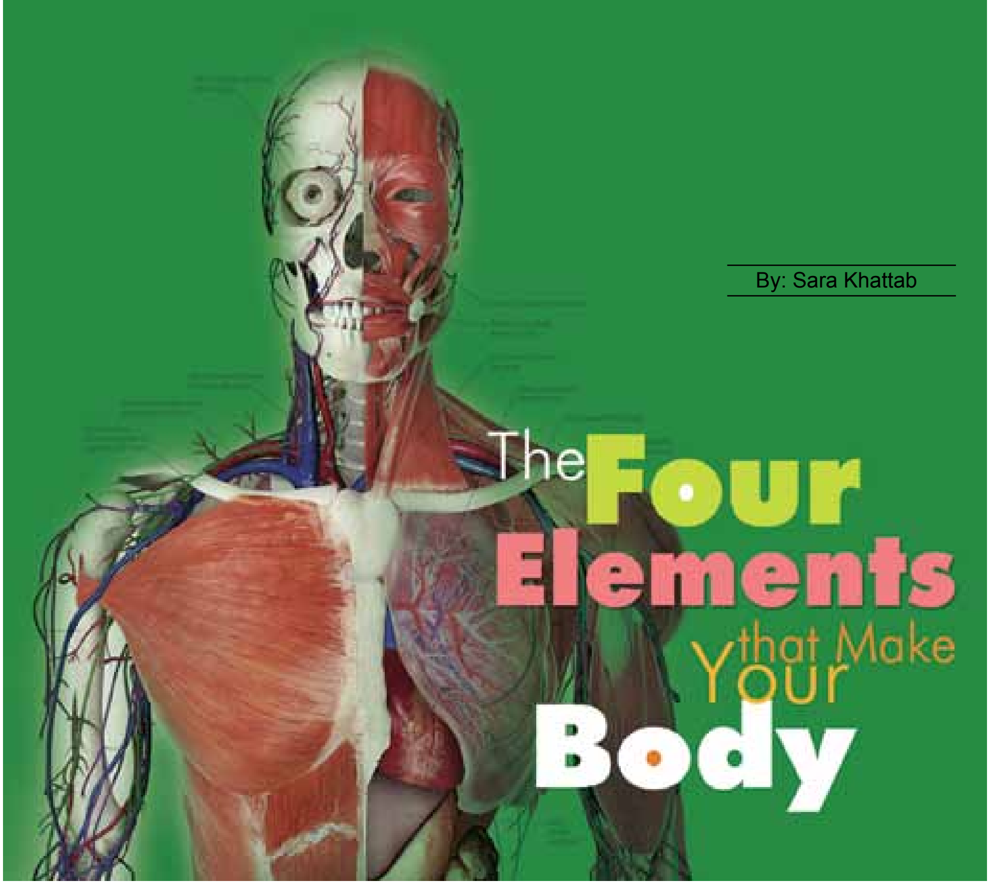
Even though the dangers of living near a volcano are apparent to all, many still do. A large eruption can be extremely dangerous; flows of searing lava, which can reach 1250°C or more, can be released, burning everything in its way. Large pieces of hardening lava can shower down on nearby villages and towns. Eruptions cause snow to melt quickly, which can result in mud flows that can strip mountains and valleys bare and bury towns in its wake. All the ash and toxic gases that are released into the atmosphere can lead to lung damage and other problems; still, people ignore all of that for the gain of farming the fertile soil of volcanoes.

Erupting in 2010, Icelandic Eyjafjallajökull maybe the most notorious volcano of recent years. Despite not being that big of an eruption, the disruption it caused impacted many people. There was enormous disruption to air travel across Europe over an initial period of six days, as ash clouds covered large areas of northern Europe; about 20 countries closed their airspace, hundreds of thousands of travelers were left stranded and disgruntled at airports. Still, this is nothing compared to volcanic eruptions of yore, such as that of Mount Vesuvius.

Whether it be a natural disaster due to earth. water, air, or fire, they can all have equally devastating effects on humanity. In many cases, we humans can do nothing but stand in awe watching Mighty Mother Nature; nevertheless, some disasters occur due to human negligence and disregard for environmental consequences. Like the five young Planeteers, we need to come together to defend our Earth from any unnecessary harm.


## Resources

eo.ucar.edu
www.bbc.co.uk
science.howstuffworks.com
environment.nationalgeographic.com



# The Four Elements that Make Your Body

By: Sara Khattab

In classical Greek science and medicine, the Four Elements are the basic constituents of all matter, including the Human Body. They were used to describe the Four Temperaments or Humors a person could have, which would affect personality traits and behaviors: *sanguine*, being pleasure seeking and sociable; *choleric*, being ambitious and leader-like; *melancholic*, being introverted and thoughtful; and *phlegmatic*, being relaxed and quiet.

Ancient theories stated that the temperaments and humors needed to be in balance with each other in order for a person to be normal both mentally and physically. These theories might have been void of actual science; our bodies, however, do in fact manifest the Four Elements of Nature: *Earth*, which manifests in bones, muscles, tissues, teeth, nails and hair; *Water*, which constitutes over two-thirds of the body; *Air*, which allows us to breathe, and therefore, live; and, *Fire*, which provides our bodies with the warmth and energy they need.

## Earth

Earth is what makes body mass such as bones, muscles, cells, tissues, teeth, hair and nails. Humans are born with about 300 to 350 bones, many of which fuse together between birth and maturity to produce an average adult total of 208 bones. The number of bones in the human body varies according to the counting method applied. While some methods consider a given structure to be a single bone with multiple parts, others consider the same structure to be multiple bones.

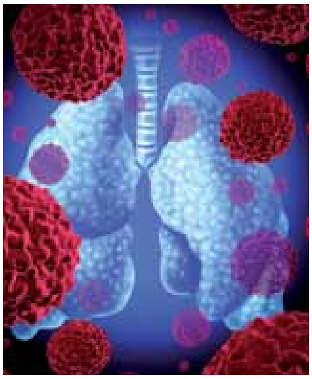
The number of muscles in the human body varies from about 656 to 850; there are three categories of muscle: skeletal, smooth, and cardiac. *Skeletal muscles* consist of striped or striated fibers; they move the various parts of the body. Skeletal muscles are considered "voluntary" muscles because the person controls their use.

*Smooth muscles* are found in the stomach and intestinal walls, veins, and in various internal organs. They are called "involuntary" because they cannot be made to work by conscious choice, but are controlled by the autonomic nervous system. Finally, *cardiac muscles*, which are only found in the heart, contain both striped and smooth tissue and they are involuntary.

Cells are the basic structural and functional unit of all known living organisms; a cell is the smallest unit of life that is classified as a living thing, and is often called the building block of life.

Tissues are composed of groups or layers of cells that collectively perform a specific function. There are major tissue types in the human body; one of which is *connective tissue*, which is made up of cells and protein fibers, and provides support for other body tissues.

Another type of tissue is *epithelial tissue*, which is comprised of tightly packed cells arranged in layers. It provides many functions, including absorption, excretion, protection, reproduction, secretion and sensory reception. The third type is *muscular tissue*, which provides stability to the skeleton and internal organs, and allows body movement. Muscle tissue makes up approximately 60% of the body's mass. Other types are the nervous system tissue, lymphatic tissue, and membranes.



Fingernails are important structures made of keratin, which is the same substance the body uses to create hair and the top layer of the skin. Fingernails act as a protective plate and enhance sensation of fingertips; they also serve to enhance precise delicate movements of the distal digits through counter-pressure exerted on the pulp of fingers. Nails then act as a counterforce when the end of the finger touches an object, thereby enhancing the sensitivity of fingertips, even though there are no nerve endings in the nail itself.

Teeth are necessary for chewing, tearing, biting and grinding food. The tooth has two parts: one part is visible in the mouth and is the crown; while the other, which is embedded in the bone, is the root. The outmost layer of the crown is called enamel, which is the hardest part of the body; then comes the dentin in which we can feel hot and cold sensations; afterwards comes the pulp, which contains the blood and nerve supply of the tooth.

Teeth are generally named based on the functions they perform. The incisors are the front teeth in both the upper and lower jaws found in the middle; they are useful for biting food. Then, there are the canines, one on each side of the incisor group; they are useful for tearing into the food. Following the canines are the pre-molars, which initiate the chewing process; after that there are the twelve molars that help grind the food. Adults usually have 32 teeth on their jaw.

Hair is basically a form of skin; it is made up of a protein known as keratin, and it grows everywhere on the body with the exception of the lips, eyelids, the palms of the hands, and soles of the feet. Hair serves as a protective layer for the skin; it traps dust and other particles so that they do not enter our bodies. It also helps maintain thermal balance by protecting the skin from heat and excessive coldness.

## Water

Humans can exist for several weeks without food; however, after several days without water, we would not survive. Water is one of the most essential elements in the body; in fact, it is the most abundant substance in the human body and is a major component of every cell.

Water is the basis of all bodily fluids; it is vital for the functioning of tissues, organs and bodily systems. Blood, lymph, and other fluids move between the cells and through the vessels, bringing energy, carrying away wastes, regulating temperature, bringing disease fighters, and carrying hormonal information from one area to another.

## Circulation

Blood is composed of blood cells suspended in a liquid known as blood plasma, which constitutes 55% of blood fluids, and is mostly water (92% by volume). The water portion of blood dissolves and carries necessary substances such as nutrients and oxygen to the cells, transporting metabolic waste products away from those same cells.

There are two types of blood vessels that carry blood throughout our bodies; one of which are arteries, which carry oxygenated blood from the heart to the rest of the body. Blood also travels through veins back to the heart and lungs, where it receives more oxygen. As the heart beats, you can feel blood traveling through the body at pulse points—such as the neck and the wrist—where large blood-filled arteries run close to the surface of the skin.

Water is a necessary ingredient for proper blood flow in the body. As you drink more water, oxygen levels in your bloodstream increase, leading to better circulation and improved overall health. Good blood flow can help increase your energy levels and burn more fat.

## Digestion

Gastric juices are liquids found in the stomach; in their normal state, these liquids are usually primarily clear in color. The juices in the stomach begin the process of breaking down food so that nutrients can be extracted by the intestines; they are produced by glands in the stomach as needed.

Acids and enzymes that are in the stomach need the balance of water to break down food into a homogenized fluid. Once the fluid is formed, it can be easily passed into the intestine for the next stage of digestion.

Water consumption plays an important role in the digestion of solid foods; an acidic stomach will respond to hydration, and therefore make it easier to digest food. Sometimes, an absence of water in the body may lead to common symptoms such as heartburn and constipation.

## Excretion

Excretion is the process by which waste products of metabolism and other non-useful materials are eliminated from an organism. This is primarily carried out by the kidneys through urine, and the skin through sweat.

Urine is a liquid waste product of the body secreted by the kidney by a process of filtration from blood known as urination and excreted by the urethra. Urine production serves a greater purpose than just dumping excess water from the body; it is actually composed of 95% water, which works as a vehicle to carry the waste of urea, uric acid, ammonia, hormones, dead blood cells, salts and minerals, and toxins out of the body.

Sweating, on the other hand, is the release of a fluid consisting primarily of water as well as minerals, lactate, and urea from the body's sweat glands in the skin; this process is also known as perspiration. Sweating is an essential function that helps the body stay cool.

The kidneys act as a filter, but for them to work properly they need to have plenty of water intake. Water lessens the burden on the kidneys and liver by flushing out waste products as it dilutes the calcium in our urine, which could crystallize to form kidney stones if the body did not receive enough fluids. Drinking water keeps the body hydrated by replenishing the bodily fluids lost through urination or sweating.

## Air

Within the body, air (oxygen) is the basis for all energy transfer reactions. As we breathe air, our bodies use oxygen from the air to create energy, build cells, and maintain healthy body functions.

## Respiration

In human physiology, respiration is the transport of oxygen from clean air to tissue cells, and the transport of carbon dioxide, in the opposite direction. Carbon dioxide can prevent hemoglobin from carrying oxygen around the body, leading to hypoxia, which can lead to organ failure, brain damage, and death.

We breathe with the help of our diaphragm and other muscles in our chest and abdomen; these muscles literally change the space and pressure inside our body cavity to accommodate breathing.

When the diaphragm pulls down, it makes room for the lungs to expand; the lungs thus get bigger with air, pushing the diaphragm down, which lowers the internal air pressure. When the diaphragm relaxes, it moves up and the cavity inside the body gets smaller; muscles then squeeze the rib cage and the lungs begin to collapse as the air is pushed up and outside the body while exhaling.

## Fire

Within our bodies, fire (energy) is most manifested in the process of nourishment, in which foods are transformed into the energy needed by the body; in turn, this energy enables the body and mind to function properly.

Fire transforms food into energy through digestion, which allows the body to gain nutrients and energy it needs from the food you eat. Even before you eat, once you smell a tasty food or see it, digestion begins. Saliva begins to form, so when you eat, this enzyme starts the digestion of starch in the food into small particles, making the food soft and easy to swallow. The food then travels down the esophagus and into the stomach.

The stomach is your body's mechanical and chemical food processor; it is a pouch composed of sheets of muscles that encircle the stomach in different directions. When they contract, the stomach mixes the soft food. The lining of the stomach secretes gastric juices; including hydrochloric acid, which dissolves the food; a protein-splitting enzyme known as pepsin; and a fat-digesting enzyme known as lipase.

For comfortable digestion, the stomach lining should secrete just the right amount of acid at the right time; no more or less. If the lining pours out acid when the stomach is empty, the acid irritates the stomach lining leading to uncomfortable sensations, or indigestion.

Indeed, the Ancient Greek Four Temperaments or Humors Theory might have been void of actual science; our bodies, however, do in fact need a balance of the Four Elements to be in good health.

Too much air in the body will produce nervous conditions such as anxiety; lack of air will lead to lack of oxygen, leading to hypoxia. When there is too much water in the body we will usually see imbalances in the lower body such as edema, or swelling of the ankles, or bloating; not enough water may lead to dryness, which would cause joint problems and dry skin.

Likewise, excess fire (energy) can manifest as high blood pressure, heat rushes, bad temper, frustration, and more; too little fire in the body can manifest as paleness in the face and poor digestion. Last, but by no means least, when out of balance, the Earth element could lead to stagnation.

Once again, ancient cultures have proven to have had a piercing look into nature, creating mythical theories that surprisingly find reflection in modern scientific truths.

## References


salemos.tripod.com
cms.yourholisticdentist.com
yoga-connection.com
www.jiva.com
www.drstandley.com
www.healthhype.com
www.dhammacenter.org
www.helpwithcooking.com
www.fitness.com
www.dirjournal.com
www.wisegeek.com

# Nano-Elements of Nature

By: Hend Fathy

Have you ever heard of water-repelling sands, or ever imagined fire that does not burn? Did you obtain your portable water-desalination device to use at the beach next summer? If not, let me then welcome you into the nanotechnology world; the gateway to the next industrial revolution.

Taken from the Greek word for midget, “nano” is a metric prefix indicating a billionth part. Nanotechnology simply states that manipulating substance at the atomic/nano scale opens endless channels of assigning them new surprising properties. This technology is still in its infancy; once mature, it has the potential of changing everything around us, producing highly advanced, cleaner, safer, and smarter substances.

Let us zoom into the possibilities nanotechnology applications can offer to the four elements.

## Earth

As far as our imagination would stretch, we would have never thought that sand, as found on the beach embracing waters of breaking waves, would become hydro-phobic.

To understand how hydrophobic sand works, you need to know some basic information about water molecules. Due to the unequal distribution of electrons in the molecule’s bonds between atoms, water molecules have slightly positively- and slightly negatively-charged ends. Positively- and negatively-charged ends of different molecules strongly interact with each other in the same way poles of a magnet do. These interactions known as “hydrogen bonds” are so strong that substances made up of non-polar molecules, such as that of oils and tar, cannot mix with water.

Naturally, atoms on the surface of sand particles have charged ends that are attracted to the water molecules charged ends; that is why sand absorbs water. Applying nanotechnology, scientists have coated natural sand grains with a silicon-based compound that has a hydrophilic end, which is attracted to the sand particle, and a hydrophobic end that sticks out away from it. This process creates a hydrophobic water-repelling layer on the surface of the sand grain. However, other liquids will soak into the nano-modified sand, such as oils.

Hydrophobic sand is used in cleaning up petroleum oil spills due to its ability to absorb it. It has also been used to protect electric and telephone wires in extremely cold climates as it repels water and prevents it freezing around junction boxes.

## Water

Though it covers over 70% of the Earth’s surface, less than 3% is suitable for human use; not only that, but a large portion of this small fraction is hardly accessible to humans, being enclosed in ice reservoirs far in the Poles. With the steady growth of human population and the accelerated effect of climate change, the challenge of securing sufficient supplies of freshwater is to become more and more compelling in the coming decades.

A research team led by Jongyoon Han, Associate Professor of Biological Engineering at Massachusetts Institute of Technology (MIT), has innovated a nanotechnology water desalination system that works on the ion(1) levels. The core mechanism of this system relies on the polarization of ion concentrations. Salty water passes through a channel lined with nano-structured membrane that polarizes salt ions; salts are diverted into a branched brine channel leaving another for salt-free water. Han states this mechanism “moves not only salts, but also any charged colloids in the water source, such as cells or bacteria, thereby fundamentally eliminating the potential for membrane fouling and clogging. This can significantly reduce the complexity and cost of direct seawater desalination”.

It is claimed that in this single-step operation, 99% of the salt contained in seawater is removed; however, it cannot remove non-ionized organic compounds. Hence, to obtain drinkable water, we should further use conventional methods such as charcoal absorption for removing neutral compounds. This technology can be applied to produce small scale, portable desalination systems operated by batteries. However, the team currently aims to build a scaled-up version of the current unit device in order to reach a meaningful flow rate (100 mL/min).

## Air

Changing air properties has been our own making; Man has drastically disturbed the nature of Earth’s atmosphere through constant human-induced emissions of greenhouse gases and pollutants. Although political-economic communities have failed, or have chosen to fail, to put an end to this urgent problem since the last decades of the 19th century to this very day, the environment-friendly scientific communities have provided nanotechnology solutions.

There are two major approaches to remediate air pollutants applying nanotechnology: nano-catalysts and nano-structured membranes. A catalyst is an exhaust emission control device that converts toxic chemical engines exhaust into less toxic ones; catalysts are all that stands between a society depending on engines and the toxic pollutants they create.

Nano-catalysts have a greater surface area than normal catalysts made from larger particles, which allows more chemicals to interact with the catalyst, simultaneously making it more effective. Speeding up the chemical interactions responsible for transforming the harmful vapors from cars and factories into harmless gases, nano-catalysts do our Earth’s atmosphere, and us, a great favor.

Nano-structured membranes are designed for trapping the emissions of greenhouse gases caused by mining, power generation stations and industrial plants. These filtration membranes have nano-pores that are small enough to separate methane or carbon dioxide from the exhausted emissions. John Zhu, a Queensland-University-researcher, states that these membranes can trap gases up to hundred times faster than the conventional ones.

## Fire

WATCH OUT! That is what is usually heard when someone’s clothes is unintentionally close to a fire flame of a candle or a cooker for example. Believe it or not, scientists have managed, applying nanotechnology, to produce fire-resistant fabrics.

Dr. Jaime Grunlan, Associate Professor at the Department of Mechanical Engineering, Texas A&M University, developed a thin polymer(2) coating that could keep cotton clothing from going up in flames, eventfully managing to produce cotton fabric that does not burn at all.

The developed technology involves covering every fiber of a fabric with a nano-thin coating of two polymers, producing a protective carbon foam coating when exposed to high temperatures. This breakthrough can revolutionize cotton industry; it can be used for making children’s clothes, laboratory uniforms, firemen uniforms, and more.

These fabrics can also be used in making camping and military tents, where a fire in a single tent can wipe out an entire camp. Fire-resistant applications of nanotechnology do not stop here; a lot is mentioned about fire-resistant paints, fire-resistant foams, as used in making sofas and theater chairs, and even fire-resistant glass.

Like electricity before it, nanotechnology will definitely change the way we live; offering greatly improved efficiency in almost every facet of life. Most importantly, it would change our perception of each and every element around us, even if it were of the main four element of nature.

### Glossary

1. **An Ion** is an atom or molecule in which the total number of electrons is not equal to the total number of protons, giving it a net positive or negative electrical charge.
2. **A polymer** is a substance that has a molecular structure built up mainly or completely from a large number of similar units bonded together.

### References

www.nanotech-now.com
dujs.dartmouth.edu
www.understandingnano.com
mrsec.wisc.edu
www.sigmascan.org
www.nanowerk.com
www.nanoacademia.com


By: Lamia Ghoneim

## Warning: Spoiler Alert!

When I took my three-year-old daughter to watch the 3D animation movie "The Lorax", I was expecting to see a fun kid's movie with a light-hearted attempt at delivering an environmental awareness message to the youngsters; one that I was sure my daughter—between dancing enthusiastically through the musical numbers and munching eagerly on her popcorn—would probably fail to notice.

Personally, I was prepared for some serious snoozing time; I certainly was not expecting to find anything intriguing or thought-provoking in such a kid's tale. I was definitely in for a surprise.

Based on Dr. Seuss's 1971 picture book, which unfortunately most of us here in Egypt have not had the chance to read, the story seems so ahead of its time; one might even call it visionary. The tale focuses on the plight of the environment and the risks that industrialization and corporate greed can have, which at the time the book was written were only starting to become apparent. However, 40 years later, the messages of conservationism are more relevant than ever.

The famed Dr. Seuss tale takes place in and around Thneedville, a sparkling clean town where everything is synthetic, trees are inflatable and made in factories, animals are long gone, water is poisonous and the air is so polluted that everyone breathes bottled air sold to them by a creepy little villain.

A young girl named Audrey longs for a real tree, and 12-year-old Ted is determined to find her one. With the help of his grandma who still remembers the trees, he seeks out the Once-ler; the old hermit tells the tale of how he broke a promise to "The Lorax"—the mystical creature who is guardian of all the trees—and cut down all the trufulla trees so he could sell the populace his briefly trendy "Thneeds". Thneeds were a useless product, just a piece of fabric that everyone thought was cool for a while worn as a hat or worn in other ways, and then they went out of fashion and nobody cared for them anymore.

Bottled air, inflatable trees? Ridiculous as it may seem, I could not help feeling that this is not too far off from what we could soon face. In fact, the story contains many common components found in environmental issues we are facing today: deforestation, air and water pollution, lack of natural resources, animals critically endangered due to human activities, and the destruction of the ecosystem biodiversity; all those serious issues are represented in the story and are predicted to lead down this road.

However, the tale is not all gloomy; there is hope in the end and lessons to be learned to avoid such fate. As I became deeply engrossed in the tale, and even more so deeply touched and inspired by all the powerful messages portrayed within the plot, I found myself tracking the lessons we could all learn from the Lorax; the following are just a few:

### *"Unless Someone Like You Cares a Whole Awful Lot, Nothing is Going to Get Better. It's Not"*

Dr. Suess said so 40 years ago and it still applies today. Unless we start caring and changing things, we too will end up trying to survive in a dirty wasteland and a barren landscape.

The idea that protecting and preserving our environment cannot happen without personal ownership by all is delivered by the character of the young boy "Ted", the one who cared enough to try and change things, and managed to find hope in the end by planting the last Trufulla seed, and growing a real tree once again. Kids and adults can identify with Ted and learn that one person can make a difference; one just needs to care "A whole awful lot".

### *"The More Smog in the Sky, the More People Will Buy"*

Mr. O'Hare, the greedy businessman in the tale who managed to find a way to sell air, was aware that the more the air was polluted, the more people will buy his bottled air. While the obvious lesson here is a message of criticism towards greedy capitalism, the deeper message is to tackle environmental problems from their roots, something "Ted" was able to understand.

Instead of purifying the air and selling it in plastic bottles, which in turn pollutes the environment even more from the manufacture of plastics and the creation of non-biodegradable waste, Ted realized that he needs to solve the root of the problem; in that case, the lack of trees.

While deforestation is definitely an issue for us today—it has been estimated that every minute,

we lose 36 football fields-worth of forests—the underlying message could also be a parody of the bottled water industry; an industry surviving on the pollution of our natural resources and in turn pollutes the environment furthermore.

### *"A Tree Falls the Way it Leans. Be Careful Which Way You Lean"*

The Lorax said so as a warning to the Once-ler, who was still a young well-intentioned boy at the time, when he found him leaning towards his own personal profit without thinking of the effect on the environment and the animals that need the trees he was chopping off.

By cutting down the Trufulla trees, the Once-ler thought he was "only building the economy"; he was not aware of how much he endangered the planet and only realized his mistake very late. The sustainable development focus is to balance quality of life with quality of the environment, a concept the Once-ler did not understand, but one that the young boy was able to introduce with the last Truffula seed. Thus, young children and adults can identify with him and understand how essential it is to help preserve the environment before it is too late.

The Lorax knew that Thneeds made from the Truffula trees were useless and unwarranted, but the Once-ler, who was dazzled by the dollar, claimed that everybody needs Thneeds. The message here is also complex, we must not just lean towards sustainable development, we also have to adjust our aspirations to ensure a more secure future. We need to ask ourselves when and where we fall victim to irresponsible consumerism, realize what we really need and what is unnecessary, and work at becoming more Earth-savvy. In other words, We Do Not Need Thneeds!

The lesson that really stuck with me however, was the one presented by the mystical Lorax himself (voiced by none other than the legendary Danny Divito who delivered a star performance) with his distinctly deep voice as he declared:

### *"I am the Lorax, and I Speak For the Trees!"*

I found myself channeling my inner Lorax and speaking for the trees and what they represent; in the story, the Lorax spoke for the trees and although the Once-ler did not listen at first, he eventually redeemed himself and began to speak for the trees as well. There is hope in being green, and public awareness is essential, so we need to keep hope alive and keep on spreading the message.

As we left the theater, I asked my daughter what she thought the movie was about, she said that the bad man cut down all the trees, which was wrong; we should not cut down the trees or the air and the water will stink!

So, I guess she did sort of get the message after all.

# Antimatter Mirror of the Universe

By: Lamia Ghoneim

Every *Star Trek* fan knows that there is matter, and there is the equally opposite antimatter. In fact, the employment of matter-antimatter reactions is a major theme of *Star Trek* that resolves almost every single energy issue one would expect from a sci-fi show; from powering warp engines that send the enterprise starship faster than the speed of light, to phaser technology[1], antimatter is the ultimate solution.

The idea that there exists a mirror image of all matter is one of the most interesting and revolutionary ideas perceived way beyond the scientific world; it is no wonder that sci-fi writers exploited the concept as an attractive plot device. Some, such as *Star Trek* writers, foresaw matter-antimatter annihilation as the most powerful source of energy in the cosmos, using it for the propulsion starships; others produced visions of parallel universes and anti-worlds made up entirely of antimatter. Many even imagined the existence of an evil twin for every person in another parallel anti-world; an anti-you and an anti-me living somewhere out there in an anti-universe.

While science fiction is undoubtedly entertaining, in most cases, it is not science. Fortunately though, in the case of antimatter science fiction, a lot of what we see on the screen is at least based on scientific facts. While the existence of an anti-you may not be evidence based, a lot of the actual concepts of antimatter are scientifically proven, with some issues remaining a mystery to date.

For those few who are not familiar with the "physics" of *Star Trek*, or antimatter for that matter, here is how the story begins.

## Antiparticles Revealed

In 1928, Paul Dirac, British physicist, set out to solve a problem: How to reconcile the laws of quantum theory with Einstein's special theory of relativity, for apparently both would not agree.

Through complex mathematical calculations, Dirac finally managed to integrate these disparate theories. He explained how things, both very small and very fast—in this case, electrons near the speed of light—behave, and successfully managed to formulate a quantum theory for the motion of electrons in electric and magnetic fields; the first theory that correctly included Einstein's theory in its context.

His theory led to a surprising prediction; the equations he used to describe the electron also described, and in fact required, the existence of another type of particle with exactly the same mass as the electron but with positive instead of negative electric charge. This particle, which is now known as the positron, is the "antiparticle" of the electron; it was the first example of antimatter.

The positron's discovery in experiments soon confirmed the remarkable prediction of antimatter in Dirac's theory. A cloud chamber picture taken by Carl D. Anderson in 1931 showed a particle entering from below and passing through a lead plate, where the direction of the curvature of the path, due to a magnetic field, indicated that the particle was a positively charged one, but with the same mass and other characteristics as an electron. Experiments today routinely produce large numbers of positrons; scientists have also managed to trap antimatter atoms and hold them captive for brief periods.

Dirac's prediction applies not only to the electron, but to all the fundamental constituents of matter; meaning that each type of particle must have a corresponding antiparticle type. The mass of any antiparticle is identical to that of the particle and all the rest of its properties are also closely related, but with the signs of all charges reversed.

Just as protons, neutrons, and electrons combine to form atoms and matter; antiprotons, antineutrons, and anti-electrons (positrons) combine to form anti-atoms and, thus, antimatter. The existence of antimatter partners for all matter particles is now a well-verified phenomenon, with both partners for hundreds of such pairings observed. But, what happens when these opposing partners meet?

## Matter vs Antimatter

Physicists have learned a great deal about antimatter since Anderson's discovery; one of their most dramatic findings, custom-made for many a sci-fi adventure, is that antimatter and matter explode on contact. Thanks to their opposite charges, matter and antimatter initially attract and then annihilate each other with a burst of energy.

In fact, any antimatter produced in the laboratory soon disappears because it meets up with matching matter particles and annihilates. Outside the laboratory, antimatter is uncommon and appears to exist primarily in cosmic rays, which are extraterrestrial high-energy particles that form new particles as they penetrate the Earth's atmosphere.

Although modern theories of particle physics and of the evolution of the universe suggest, or even require, that antimatter and matter were equally common in the earliest stages, there is certainly a dramatic difference in the numbers of matter and antimatter objects we find in the world around us today.

The entire world is made of matter; why was it not all annihilated, and why is antimatter so uncommon today? In other words, why do we even exist? While most people probably take it for granted that the universe is made mostly of matter and not its opposite antimatter, particle physicists have been grappling with this question of asymmetry for decades.

Physical theories assert that, when the universe burst into existence some 15 billion years ago with the "Big Bang", enormous amounts of both matter and antimatter were created in the first few moments of existence; moments later, they combined and annihilated, generating the energy that drove the expansion of the universe. However, within a milli-fraction of a second of the Big Bang, matter somehow outnumbered its particulate opposite by a hair, so that, for every billion antiparticles, there were one-billion-and-one particles. Everything we see today was that tiny fraction of matter that remained.

Thus far, physicists are hard at work, trying to identify the exact mechanism that would produce this apparent asymmetry. They study the properties and behavior of manufactured antiparticles, and the antimatter they form when they combine, hoping to find clues to this asymmetry mechanism. While theory predicts that the antimatter world is a perfect reflection of our own; experiments have already found suspicious scratches in the mirror.

## Prevailing Matter

Most scientists believe that there is a subtle difference in the way matter and antimatter interact with the forces of nature, especially in the way they decay, which may account for a universe that prefers matter. This subtle difference—technically known as Charge-Parity (CP) violation—would have allowed normal matter to prevail over antimatter so that normal matter could go on to form everything we see in the universe today. Over the years, evidence has been mounting, supporting this theory; recent research may well be on its way to confirm it.

The first evidence of this difference was found in the 1960s, in the decay of particles called neutral kaons, which can transform into their antiparticles and vice versa, but such transformation does not occur with exactly the same probability in both directions, indicating a difference between the properties of matter and antimatter of this kind.

In 2001, accelerators in the United States and Japan found more evidence for a difference in particles called B mesons. Last year, at CERN's Large Hadron Collider (LHC)[2] near Geneva, Switzerland, evidence was found in a third system, D mesons; however, there was not enough data to rule out a statistical fluke.

More recent results from the Collider Detector at Fermilab (CDF) experiment near Chicago also show very similar results to the CERN's collider, confirming almost the same level of difference in the decay of D meson particles and their antiparticles. These combined results are still not conclusive evidence, but they bring the chances of a fluke down to about one in 10,000.

To witness this kind of CP violation, physicists study particles to see if there is any difference in the rate of decay between normal particles and their antiparticles. The accepted theory of elementary particles, the standard model, allows for a low level of CP violation, but not enough to explain the prevalence of normal matter. Researchers have thus been trying to find cases in which CP violation is higher, and the combined results from LHC and CDF are close to what they have been looking for.

Although these results cannot be claimed as a *bona fide* discovery, which requires a chance of it being a fluke at less than one in a million, particle physicists are still excited; "We cannot yet say for sure it is CP violation," says Angelo Carbone, a member of the LHC and CDF collaboration, "but it is close".

Thus far though, the observed imbalance between matter and antimatter remains a puzzle yet to be explained. Yet, without this imbalance, there would be essentially no matter left around; annihilations would have converted everything into massive energy.

## Antimatter Power

Smash a lump of matter into antimatter and it will release a thousand times more energy than the same mass of fuel in a nuclear fission reactor, and some two billion times more than burning the equivalent in hydrocarbons. It is not surprising then that *Star Trek* writers chose it to power the enterprise, and they are not alone in thinking antimatter fuel could be the dream fuel.

Scientists and futurists have put a lot of thought into the promise of an antimatter engine; even NASA put forth early designs for an antimatter spacecraft, complete with special magnetic storage rings to safely house the vital antimatter.

According to the NASA research team, the energy produced by a gram of antimatter meeting a gram of normal matter would equal that of the thrust behind 1,000 external space shuttle fuel tanks. Moreover, the concept of its power generation is quite simple and easy to achieve, not that fundamentally different from a rocket engine where a combination of fuel and an igniting agent produce the explosive trust.

So, if a pound of antimatter can roughly produce enough energy to satisfy the requirements of a group of countries for a number of years, what is stopping us from harnessing this ultimate source of energy that could solve all our energy problems, now and in the future?

The answer to this question lies in the difficulty of producing antimatter artificially. So far, antimatter happens to be one of the most expensive-to-produce materials in the universe.

The primary way antimatter is produced is through high energy collisions that occur naturally in the universe; high energy particles and particle jets from sources as varied as cosmic rays, the solar wind, solar flares and even supernova, collide with other matter such as the upper atmosphere of the Earth.

These collisions involve massive amounts of energy; hundreds of thousands of times more powerful than our most powerful particle accelerators here on Earth. When these incredibly high energy particles collide with other particles, the immense energy leads to radical changes in the way the components of the atoms are themselves made up, resulting in the creation of antimatter.

Although particle colliders are able to produce high energy particle collisions that can create positrons, antiprotons, anti-hydrogen, and even a few anti-helium atoms, the amount they produce is minute, not enough to power much of anything.

If we were to gather all the antimatter that has ever been artificially created, it would hardly be enough, when combined with normal matter, to light a standard light bulb for more than a few minutes. It is also a very expensive operation; it would cost an estimated USD 25 billion to produce one gram of positrons, while researchers at CERN point out that it would take USD 100 quadrillion and 100 billion years of running their accelerator to produce a single gram of antimatter. Yet, according to the *Journal of Propulsion and Power*, a mere millionth of a gram would be enough to power a one-year flight to Mars.

Still, with the technology currently available today, it costs more energy to create antimatter than the energy one could receive from an antimatter reaction, which does not make antimatter reactors viable. However, scientists are looking for ways to capture antimatter that is naturally created in the universe.

## The Antimatter Belt

A newly discovered belt of antimatter circling Earth, consisting of antiprotons trapped by Earth's magnetic field several hundred kilometers above the planet's surface, may ultimately become a main source of fuel for missions venturing beyond the Solar System.

The belt was discovered by the international PAMELA (Payload for Antimatter/Matter Exploration and Light-nuclei Astrophysics) satellite and was found to contain 28 antiprotons as counted by the team; now considered the most abundant source of antiprotons ever imagined close to Earth.

However, in order to use the antiprotons as an energy source, scientists still need to find a way to harvest this antimatter in space. If feasible, harvesting antimatter in space would completely bypass the obstacle of low energy efficiency when an accelerator is used to produce antimatter.

As far-fetched as all of this may sound, imagine trying to explain to Lord Kelvin or Thomas Edison the mastery we would have over matter and energy at the start of the 21st century. Even Albert Einstein was quoted in 1932 saying, "There is not the slightest indication that nuclear energy will be obtainable". Therefore, the seemingly impossible challenges of using antimatter as the ultimate power source may be comparatively routine a century from now.

## Glossary

(1) **Phaser Technology** is a common fictional technology employed in *Star Trek* that works as a direct energy weapon, emitting energy in an aimed direction without the means of a projectile. It creates a beam of a fictional type of subatomic antiparticles called "rapid nadions".

(2) **Large Hadron Collider (LHC)** is the world's largest and highest-energy particle accelerator; a device that uses electromagnetic fields to propel charged particles to high speeds and to contain them in well-defined beams. It was built by the European Organization for Nuclear Research (CERN), 1998-2008, with the aim of allowing physicists to test the predictions of different theories of particle physics and high-energy physics.

## References

Encyclopaedia Britannica Ultimate Reference Suite, Chicago: Encyclopædia Britannica, 2010.
http://www.nasa.gov
http://www.exploratorium.edu
http://www.scientificamerican.com/article.cfm?id=what-is-antimatter-2002-01-24&print=true
http://www.wikipedia.com
http://space.about.com/od/Space-and-Astronomy-Star-Trek/a/Matter-Antimatter-Power.htm
http://news.discovery.com/space/harvesting-antimatter-in-space-to-fuel-starships-120523.html

# The Marvels of the Elements

By: Shahenda Ayman

The word "element" is defined as the building block of everything that has come into common use in the world. From the air we breathe—oxygen, nitrogen, and other gases—to medications we take, all are found, or in a few cases, created, here on Earth. Many elements stand out for a myriad of different reasons; here is a countdown of the Top Ten Most Marvelous Elements, in our humble opinion.

## 10 Mercury (Hg)

Silvery-white in appearance, mercury can exist at room temperature in a liquid state; it is the only metal that is known to exist in liquid form naturally. The discovery of mercury was made thousands of years ago; traces of the element can be found in Egyptian tombs that date back to the year 1500 BCE. In ancient time, mercury was known as "quicksilver", roughly implying live silver. The origin of this name can be based on the fact that when liquid mercury is poured on a flat surface, it forms distinct small beads that move around as if they were alive.

Mercury has extremely strong reflective powers, and is regularly used in making mirrors. In fact, it is used for a myriad of purposes: in manometers, thermometers, barometers, vapor lamps, among others. Most street lamps contain mercury, and it is used in some electric batteries as well; moreover, it helps in the production of sodium hydroxide, chlorine and in dental silver amalgam fillings.

## 9 Magnesium (Mg)

Magnesium is classified as an alkaline-earth metal[1]; it widely exists in nature, ranking 9th among the most abundant elements on the surface of the Earth, but due to its high reactivity, it cannot be found in its elemental form.

In its purest form, magnesium can be identified as a soft, silvery-white solid material; however, when exposed to air, it tarnishes easily. The surface of freshly extracted magnesium is often coated with a thin layer of magnesium oxide in order to prevent tarnishing.

At room temperature, this element reacts with water; on reaction with acids, it releases a large amount of heat energy. Elemental magnesium is an inflammable substance; it readily catches fire when in powdered form, but it is not the case when it is in bulk amount. It is combustible in nitrogen as well as carbon dioxide present in the air; when it burns in air, it produces a magnificent white light, which is why it is used for preparing fireworks, marine flares, and photographic flashbulbs to produce bright lights.

Magnesium is the third most widely used structural metal after steel and aluminum; it has major applications in construction. It is widely used in manufacturing an aluminum-magnesium alloy called 'magnelium' or 'magnalium'; as it has a lesser density than aluminum, it gives the alloy lightness and strength required for manufacturing aircraft and automobile parts. It is used in various electronic devices mainly because it has good electrical and mechanical properties, and is light in weight.

## 8 Krypton (Kr)

A noble gas, krypton is colorless, odorless and tasteless; it is produced in the Earth's crust as a result of radioactive decay of thorium and uranium. As an inert gas, krypton is chemically inactive; however, compounds of krypton have been synthesized in the laboratory and used for research purposes.

Like other inert gases, krypton is used in making luminous, fluorescent lights used in different kinds of lamps, incandescent light bulbs, advertising signs, and more. One of the radioactive isotopes of krypton can be combined with phosphorus to produce materials that glow or shine in the dark.

Krypton is characterized by emission of sharp spectral lines, out of which green and yellow lines are the strongest and most prominent. When ionized, krypton gas emits bright white light; hence, krypton-based bulbs are widely used in high speed photography. It is also used in slide and movie projectors.

Moreover, krypton-85 is used to study the flow of blood in the human body. When the gas is inhaled, it is absorbed by the blood and travels through the bloodstream and the heart along with blood. The pathway can be determined by holding a detection device over the person's body.

## 7 Curium (Cm)

Curium, named in honor of Marie and Pierre Curie, is a radioactive transuranic-metallic element[2]; it is produced by bombarding plutonium with helium nuclei. Curium is classified in the actinide series as one of the rare Earth elements, most of which are synthetic or man-made.

Curium is a hard, dense radioactive silvery-white metal, which tarnishes slowly in dry air at room temperature. It is highly radioactive and it glows red in the dark; its radioactivity makes it harmful as it accumulates in bones and destroys marrow, stopping the formation of red blood cells.

Curium is mainly used in scientific research; curium-244 was used in the Alpha Proton X-ray Spectrometer (APXS), which measured the abundance of chemical elements in rocks and soils on Mars. Curium-244 is a strong alpha emitter and is being studied as a potential power source in Radioisotope Thermoelectric Generators (RTGs) for use in spacecraft and other remote applications.

## 6 Strontium (Sr)

Strontium is classified as an alkaline-earth metal that is found in the Earth's crust, though not in the elemental form due to its reactivity; instead, it is widely distributed in rock structures. This metal can be prepared by electrolysis of the fused chloride mixed with potassium chloride, or is made by reducing strontium oxide with aluminum in a vacuum at a temperature at which strontium distills off.

Strontium should be kept under kerosene to prevent oxidation; freshly cut strontium has a silvery appearance that rapidly turns a yellowish color with the formation of the oxide. The finely divided metal ignites spontaneously in air; volatile strontium salts impart a beautiful crimson color to flames, and are used in pyrotechnics[3] and in the production of flares.

The major use for strontium is in producing glass for color television picture tubes. Moreover, strontium titanate is an interesting optical material as it has an extremely high refractive index and an optical dispersion greater than that of diamond; it has thus been used as a gemstone, but it is very soft. Furthermore, strontium chloride is used in toothpaste for sensitive teeth, while strontium oxide is used to improve the quality of pottery glazes.

## 5 Lutetium (Lu)

A silvery-white rare-earth element, lutetium is used in nuclear technology; it was the last natural rare-earth element to be discovered. It does not exist free in nature, but is found in a number of minerals, mainly monazite.

Historically, isolation of rare-earth elements from each other has been difficult and expensive because their chemical properties are so similar. Ion exchange and solvent extraction techniques developed since the 1940s have lowered the cost of production. Pure lutetium metal is produced by the reduction of the anhydrous fluoride with calcium metal. Lutetium oxide is used to make catalysts for cracking hydrocarbons in the petrochemical industry.

## 4 Chlorine (Cl)

Chlorine is produced commercially by electrolysis of sodium chloride brine. It has a variety of uses, one of which is disinfecting water; it is part of the sanitation process for sewage and industrial waste. During the production of paper and cloth, chlorine is used as a bleaching agent; it is also used in cleaning products, including household bleach.

Chlorine is a yellow-green gas at room temperature; it is not flammable, but may react explosively or form explosive compounds with many common substances. It is also used in the preparation of chlorides, chlorinated solvents, pesticides, polymers, synthetic rubbers, and refrigerants. Chlorine was also the first poison gas to be used as a weapon during World War I.

Most chlorine exposures occur via inhalation; low level exposures to chlorine in air will lead to eye/skin/airway irritation, sore throat and cough. Since chlorine is a gas at room temperature, it is unlikely that a severe exposure will result from ingestion. However, ingestion of chlorine dissolved in water (such as sodium hypochlorite or household bleach) will lead to corrosive tissue damage of the gastrointestinal tract.

Earth's oceans contain a large amount of chlorine; if this chlorine were released as a gas, its weight would be 5 times greater than Earth's total current atmosphere. Chlorine is not only abundant in our oceans; it is the sixth most abundant element in Earth's crust.

## 3 Aluminum (Al)

Aluminium is classified as one of the other metals(4), all of which are solid, have a relatively high density and are opaque. Aluminium never occurs in a free state in nature, owing to its great affinity for oxygen; in combined form, as oxides, silicates, and a few other salts, it is both abundant and widely distributed, being an essential constituent of all soils and of most rocks, excluding limestone and sandstone.

Today, aluminum and aluminum alloys are used in a wide variety of products; cans, foils and kitchen utensils, as well as parts of airplanes, rockets and other items that require a strong, light material. Although it does not conduct electricity as efficiently as copper, it is used in electrical transmission lines because of its light weight. It can be deposited on the surface of glass to make mirrors, where a thin layer of aluminum oxide quickly forms that acts as a protective coating.

There is more aluminum in the Earth's crust than any other metal; at about 8%, aluminum is the third most abundant element in our planet's crust, following oxygen and silicon. Pure aluminum is quite soft and lacking in strength; aluminum used in commercial applications has small amounts of silicon and iron (less than 1%) added, resulting in greatly improved strength and hardness.

## 2 Zirconium (Zr)

Zirconium is a lustrous, gray-white, strong transition metal. Given the metal's low absorption of neutrons, and significant resistant towards heat and chemical corrosion, it is widely used in nuclear reactors; it is used to provide an outer covering to components such as the fuel rods that run the reactor. As a matter of fact, the nuclear power industry exploits 90% of the metal produced each year.

The main sources of zirconium are the minerals known as zircon ($ZrSiO_4$) and baddeleyite ($ZrO_2$); a process known as the Kroll process is applied to obtain the metal from these minerals. It also finds its application in steel as an alloying agent; vacuum tubes, different surgical appliances, lamp filaments, piping, artificial joints and limbs require this metal. Apart from these, the metal is employed in photoflash bulbs, explosive primers, rayon spinnerets, and more.

Moreover, zirconium oxide or zirconia, is mainly used in the manufacture of ceramic materials; it is an inorganic metal oxide also used as a gemstone as it has a high refractive index. On the other hand, lithium zirconate can be used to absorb carbon dioxide; the reaction is reversible so the carbon dioxide can be released in a location of choice. This application may be useful in addressing environmental concerns about the release of carbon dioxide into the atmosphere.

## 1 Elements 112-118

(Ununbium, Ununtrium, Ununquadium, Ununpentium, Ununhexium, Ununseptium, Ununoxium)

Relatively new to the Periodic Table, elements 112-118 are completely man-made by bombarding specific atoms of one element with specific atoms of another, thereby separating each into an entirely new element only stable, though not necessarily visible, for a fraction of a fraction of a second.

Ununbium was first created on 9 February 1996 in a lab in Germany. This element was created by fusing a zinc-70 nucleus with a lead-208 nucleus by accelerating zinc nuclei into a lead target in a heavy ion accelerator. The two ununbium nuclei so produced had a mass number of 27.

On 1 February 2004, the discovery of ununtrium and ununpentium were reported by a team composed of Russian scientists and an American scientist at the Lawrence Livermore National Academy. Most of the others were created or discovered much in the same fashion in different parts of the world since then. As of yet, since none of these have been witnessed for more than a second, their inclusion remains suspect and under investigation.

Our universe is full of wonderful treasures; this is just a humble list of a small selection of amazing elements found in it. It would take days and days to talk in depth about all the elements that surround us and form everything. Without elements, there would be no universe; thus, there would be no life and there would be no Us!

## Glossary

1. **Alkaline-Earth Metal**: The term "Alkaline" refers to its slight solubility in water, and "Earth" is derived from its inability to decompose when exposed to heat; the name refers to their oxides that produce basic alkaline solutions. They are reactive and widely distributed in rock structures; they are characterized by having two electrons in their outer shell, and they conduct heat and electricity.
2. **Transuranic-Metallic Element:** Any element with an atomic number greater than 92; they are all radioactive.
3. **Pyrotechnics:** Fireworks, especially rockets, flares, smoke bombs.
4. **Other Metals:** Metallic elements within Groups 13, 14, and 15 in the Periodic Table; they are ductile and malleable, good conductors of both electricity and heat, and form ionic bonds with non-metals.

## References


listverse.com
education.jlab.org
chemistry.about.com
www.ptable.com
www.eco-usa.net
www.buzzle.com
www.health.ny.gov
www.chemicool.com
www.facts-about.org.uk
www.radiochemistry.org
www.radiochemistry.org
www.yourdictionary.com
www.periodic-table.org.uk
www.thefreedictionary.com
www.about-the-element.com

# Fire Breathing Dragons

By: Lamia Ghoneim

## The Legend

Since the beginning of time, Man has been fascinated with dragons. No mighty creature, in fantasy or in perceptible reality, can compare to the giant flying serpent with rows of sharp teeth, breathing fire through its jaws; it is the beast of all beasts, the mightiest of all legendary creatures and the single most universal fantasy ever known to mankind.

From the Chinese wise and benevolent lake dragon, to the evil maiden eating European dragon, these awe-inspiring creatures are part of the mythology of most cultures in the world. Perceived in many different yet similar ways, throughout the ages and almost everywhere in the world, dragons are what one may consider a universal culture phenomenon.

In Europe, dragons are evil nightmarish fire-spewing reptiles, large and lizard-like, with the forked tongue of a snake and wings like a bat. In the ancient cultures of Mexico and South America, a divine feathered serpent known by various names was believed to renew the world after each cycle of destruction.

In the East, dragons are amphibious creatures that dwell in oceans, lakes, rivers and even raindrops. They are revered as life-giving symbols of fortune and fertility, capable of unleashing rain and spewing fire to punish evil-doers. In Ancient Egypt, sky serpents and winged dragons were well represented in the Egyptian pantheon of gods and goddesses. *Meretseger* (a serpent with wings) and *Apep* (a giant serpentine dragon and an evil god) are both representations of dragons in Egyptian mythology.

Although the depiction of dragons from different cultures conjures dissimilar images in our minds, those images are undoubtedly related; for however different qualities the dragons may possess, they are all enormous and powerful creatures who share a resemblance and a most thrilling quality; the ability to breathe fire.

Yet, however widespread the stories of dragons maybe, to this day, there exists no shred of scientific evidence that these magnificent creatures ever existed. No dragon fossils or skeletal remains were ever discovered; all that remains are numerous works of art and literature, and the legends and stories we heard as children.

While most scientists believe that dragons are the product of the rich imagination, inspired and influenced by other living creatures the likes of giant lizards, serpents and crocodiles, other scientists, undeniably outnumbered, question this notion, and some even truly believe that dragons one day roamed the Earth and might have been the last surviving dinosaurs.

Although I always tend to ally with the side that holds the most scientific evidence and living proof, this time I would like to question the science; perhaps because I am prejudiced by my own dragon fascination, but more so because realistic scientists failed to answer a most important question: If dragons were just a fantasy, why are they depicted in so many cultures, at a time in history when cultures were not inter-mixed? These are cultures that never connected, or even corresponded with each other; is it reasonable to believe that they were all coincidentally and simultaneously making it up?

For a moment, I would like to explore the notion that dragons are not a mere fantasy, and to ask the science if it is theoretically possible for a dragon, or any creature for that matter, to be able to breathe fire?

## The Science

To answer the question of whether any creature can evolve to possess the ability to inhale or exhale fire, one must first understand how a fire starts, and what breathing fire would require.

Fire starts when a flammable and/or a combustible material, in combination with a sufficient quantity of an oxidizer, such as oxygen gas or another oxygen-rich compound, is exposed to a source of heat or ambient temperature above the flash point of the fuel/oxidizer mix (the lowest temperature at which the mixture can vaporize), and is able to sustain a rate of rapid oxidation that produces a chain reaction. Fire cannot exist without all of these elements in place, and in the right proportions. Some fuel-oxygen mixtures may require a catalyst, a substance that is not directly involved in any chemical reaction during combustion, but which enables the reactants to combust more readily.

So, the first thing a fire-breathing dragon would need is a flammable material; in other words, a fuel. Assuming dragons could utilize coal or gasoline in their gut would be ludicrous; their fuel would have to be the result of a natural biological process that can safely take place in their gut. One plausible theory suggested by dragon proposing creationists is that dragons produced hydrogen with the help of bacteria in their guts.

The gut of all animals, and even humans, contains numerous bacteria. In many species, gut bacteria play a key role; for example, most plant-eating animals, such as hippos, are unable to digest one of the main constituents of plants, cellulose; gut bacteria in a compartmentalized stomach do it for them.

One of the products of the activity of some bacteria is flammable gas, such as methane and hydrogen, both of which can be produced by bacterial fermentation in the human colon. It has even been estimated that this process could lead to the use of bacteria on an industrial scale, to generate hydrogen for use as a fuel.

It is biologically conceivable then to assume that dragons had the ability to produce hydrogen and store it in a fuel storage unit similar to a bladder that trapped the hydrogen released, which would solve the fuel issue since hydrogen is a highly reactive fuel.

Oxygen is the easiest to supply, as it is in the air all around us. Assuming that these dragon-type animals inhaled roughly the same manner as other mammals—the debate about whether dragons would be a mammal or a reptile is a whole different matter, but the few dragon believing scientists lean towards dragons being mammals—the air that was drawn into the lungs was not totally depleted of oxygen when they exhaled.

In a normal healthy human, for instance, we inhale air with approximately 20.9% oxygen content, and then exhale air with about 15.3% oxygen content. Obviously the lung capacity of a dragon would affect how much oxygen this actually was, but it seems to me that this would be sufficient to coax a flame out of the body until it reaches the outside world, where external oxygen can then fulfill the need for further rapid oxidation.

The only thing left is the spark, the heat energy needed to start the reaction, chemically dubbed as the "Activation Energy". We know hydrogen molecules violently react with oxygen when the existing molecular bonds break, and new bonds are formed between oxygen and hydrogen atoms. As the products of the reaction are at a lower energy level than the reactants, the result is an explosive release of energy and the production of water. However, hydrogen does not react with oxygen at room temperature; a source of energy is needed to ignite the mixture, a spark.

Introduction of a spark to the mixture results in raised temperatures amongst some of the hydrogen and oxygen molecules; molecules at higher temperatures travel faster and collide with more energy. If collision energies reach minimum activation energy sufficient to "break" the bonds between the reactants, then a reaction between hydrogen and oxygen follows. As hydrogen has low activation energy, only a small spark is needed to trigger a reaction with oxygen.

One could assume the dragon had an extraordinarily high internal body temperature, sufficient enough for a spark, but it would seem that such a feat would put


these creatures at risk of constant spontaneous combustion; not the best survival strategy for a species.

Another option could be that they were able to strike a spark against their teeth. There is also the possibility of electricity; there are animals that create amounts of electricity—electric eels and electric rays—but none we know can generate a spark.

The most plausible solution, employed by the creators of Animal Planet's documentary on dragons, is that dragons ingested platinum from rocks, and platinum acted as a catalyst that sparked the hydrogen oxygen reaction.

The scientific inspiration for the theory that dragons can ingest and grind platinum originates from many biological examples. For instance, birds do not have teeth, and many species rely on swallowing grit and even small stones to help grind up food in their gizzards. Dinosaur stomachs sometimes contained large stones, or gastroliths, worn smooth by grinding or exposure to digestive fluids; the stones probably also played a part in breaking down hard food. Modern crocodiles do much the same, the stones also serving as ballast for swimming.

Rather more special than these examples are the elephants of Mount Elgon in Kenya. Many animals congregate around salt licks; for the Mount Elgon elephants, though, the only natural source of salt is in deep caves in the sides of the mountain. Herds of elephants enter the caves, walk as far as 500 feet in pitch-darkness, then chip off chunks of salt-rich rock with their tusks and crunch them up.

The fact of the matter is that quite a number of animals take in minerals to use for their own purposes, why not dragons?

Combining all these theoretically feasible assumptions, we now have a dragon that produces hydrogen in its gut, combines it with oxygen in the presence of powdered platinum, previously ingested and grinded now serving as a catalyst; then poof, fire spews out of its jaws.

The final problem is how dragons avoided getting completely scorched by the fire it exhaled; one could assume that the inside of dragon's mouth was armor-plated and that it had a false palate in its throat, similar to a crocodile, to stop back draft.

So, there you go; the possibility that fire-breathing dragons once existed is not so outrageous after all.

## The Reality

One real living creature that comes close to possessing the ability of fire breathing is a little insect known as the Bombardier Beetle (*Brachinus*). This insect has evolved a little combustion chamber that combines several chemicals and can blast out hot gas, about 100ºC, from their rear end.

It is a remarkable defensive system; when threatened, it emits a rapid burst of scalding, irritating chemicals in the face of its attacker. The process is complex though; cells in the tip of the beetle's abdomen produce hydrogen peroxide ($H_2O_2$) and substances called hydroquinones, which are stored in a reservoir. This reservoir is connected to a thick-walled reaction chamber by a valve, controlled by a sphincter muscle.

The reaction chamber is lined with cells that secrete enzymes; when the reactive mixture of hydrogen peroxide and hydroquinones is passed into the reaction chamber, the enzymes break down the $H_2O_2$, releasing copious free oxygen, and catalyzing the oxidation of the hydroquinones.

The reaction generates enough heat to bring the volatile mixture to boiling point and vaporizes much of it, which greatly increases the pressure within the reaction vessel, forcing the valve shut, preventing backfires, and expelling the mixture explosively through openings in the tip of the abdomen.

Although the scalding chemicals produced by the beetle are in no way as hot as fire—the coldest visible fire is at least 525°C—but it is pretty hot, and the closest living example to fire breathing. After all, it is just a tiny beetle; one would not expect it to produce a firestorm!

So, what do you think? Could dragons have been real? Maybe if you believe in them, that is real enough.

## References

http://www.livescience.com
http://animal.discovery.com
http://www.ehow.com

# Light it Up!


Illustrations: Maha Sherin

**Phenomenon**

Egypt has high potential for generating electricity; from clean and sustainable energy recourses well abundant in its lands, waters, air and Sun. Vast deserts that stretch under the powerful sunrays all year round can host enormous solar power stations. Moreover, the extended coastlines on both the Mediterranean and the Red Sea can host power plants; to generate electricity from both wind and wave powers. Researchers also point out the possibility of geothermal power stations in the Gulf of Suez and the Red Sea coastal zone. We have no excuse; it is high time we started such national projects, no matter how much they cost, or we must get accustomed to spending long days and nights in darkness, deprived from the luxuries on which we rely.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**Editorial Team:**

Maissa Azab
Head, Educational Publications Unit

Shahenda Ayman
Sara Khattab
Hend Fathy
Educational Publications Specialists

Lamia Ghoneim
Jailane Salem

**Write to us at:**
PSCeditors@bibalex.org

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PSC Administrator
psc@bibalex.org
TEL:+203 4839999
EXT: 2350, 2351
FAX: +203 4820464