EYE ON SCIENCE

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Bibliotheca Alexandrina
Planetarium Science Center
SUMMER 2017 | Year 10, Issue 3

THE WONDERS OF SCIENCE

LIFE SCIENCES

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Cultural Outreach Sector

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IN THIS ISSUE...

INSIDE OUT 1

By: Maissa Azab

In the third instalment of our series “The Wonders of Science”, after tackling Space and Earth Sciences, we focus our attention on our inner body. In reality, every single science branch is related to our life in one way or another, but nothing is more relevant to us than Life Sciences. What we care about most is our own selves; our bodies, our health, our existence.

It is no wonder then how interested humans have always been in understanding the workings of the human body. Although we have struggled for centuries, if not millennia, to reach this knowledge—not that we know absolutely everything about it yet, nor can we know if we will ever know that much—we have taken great strides in recent centuries inside the realm of the human body. This is thanks to numerous avid scientist—and artists—only a few of whom, albeit maybe the most famous—or notorious—we tackle in this rich issue full of juicy, if not meaty, information—pun certainly intended.

Leaping from historical quests of knowledge, we fast-forward to modern-day mind-boggling discoveries, inventions, and technologies that in some cases, seem like science fiction. The abundance of research and advancements in life sciences are truly amazing; it was extremely difficult to select which to scratch the surface of in our limited space. That is why we highly recommend you keep an eye on our newly-revamped SCIplanet website (www.bibalex.org/SCIplanet), featuring not only copies of all our printed issues, but also numerous additional online articles that continually offer new information in a myriad of scientific fields.

It is our honor in this issue to pay tribute to two Egyptian pillars of knowledge as we bid them farewell. The first is none other than the one who was behind the revival of the Bibliotheca Alexandrina, Dr. Mostafa el-Abbadi. It is true that Dr. el-Abbadi left a mark in so many ways, but this single initiative will forever be a hallmark in Egyptian history. The second unfortunate loss we mourn is that of Dr. Mona Bakr, whom I have had the great pleasure and honor of meeting and working with several times in the past. Despite her short life, Dr. Bakr set an exceptional example and paved the way to new generations of Egyptian scientists, both women and men, towards a future of scientific discovery and innovation.

El-Abbadi and the Bibliotheca Alexandrina

By: Dr. Mohamed Soliman
Head of the BA Cultural Outreach Sector

We will never cease to write keenly about Alexandria and its renowned Library, for the history-changing contributions the city and its Ancient Library bestowed upon humanity are fathomless. This Library of Alexandria witnessed the marriage of the Pharaonic and Greek civilizations, as well as other civilizations such as the Persian, and gave birth to the Hellenistic civilization three centuries BCE. It created knowledge and made it accessible to the whole world, until, in the early first century, its beacon faded.

Two millennia later, the Library of Alexandria was resurrected to reclaim the mission of its predecessor. The revival of the Library of Alexandria was a pioneering idea by Alexandrian Professor of Greco–Roman Civilization, Mostafa el-Abbadi. Professor el-Abbadi obtained his PhD from Cambridge University in 1961; then obtained professorship from Alexandria University in 1972; in the same year, he was appointed Head of the Greco–Roman Civilization Department. During 1976−1979, he was the Vice Dean of the Faculty of Arts for Student Affairs.

El-Abbadi held several posts in national and international institutions. For example, he was a member of the Institut d'Égypte, the Head of the Archaeological Society of Alexandria, a member of the International Association of Papyrologists in Brussels (Belgium), a member of the American Society of Papyrologists in New York, and an observing member of the International Council for Philosophy and Human Sciences. He was also a member of the preparatory committees for the revival of the Library of Alexandria project, a member of the High Committee of History and Antiquities at the Supreme Council of Culture, and a member of the Permanent Committee for Monuments.

How did the revival idea start? In an interview with an eminent Egyptian magazine, Prof. el-Abbadi said "It all started in November 1972, during a public lecture to which I was invited by Dr. Lotfy Dowidar at the Teaching Staff Members of Alexandria University Club. I said that, if Alexandria University wanted enlightenment and enrichment of academic and intellectual knowledge, it had to establish a library, which was not possible when the University was inaugurated due to the War. Alexandria University Vice-President and Professor of Engineering and Architecture, Dr. Fouad Helmy, was enthused by what I had said. As a result, this lecture was the very first building block of the project; Lotfy Dowidar, Fouad Helmy, and I started to search for possible sites for implementation. We eventually chose the current location of the Bibliotheca Alexandrina because it was larger than the Quta Exhibition Area and was owned by the University".

"Years passed and no action had been taken due to the circumstances of the country at the time; in the early 1980s, however, we raised the issue once again. In 1984, Alexandria University President, Dr. Farid Mostafa, assigned a three-member committee to study the project feasibility. The committee included Dr. Lotfy Dowidar, Dr. Mohsen Zahran—as Dr. Fouad Hemly had passed away and the committee had to include a professor of engineering—and myself. UNESCO required an official letter from the Egyptian Government to consider the project proposal. Here came the role of an unknown soldier, Dr. Mostafa Kamal Helmy, former Minister of Education, who informed me that some ministers thought the Government should not seek UNESCO's help to establish a library. Yet, he asked me to draft the letter and said he would convince the Ministers Council to address UNESCO.

To our surprise, UNESCO took the project seriously and sent two experts in the field of libraries from France and Switzerland to meet the committee. The experts asked us about the status of libraries in Egypt; hence, I issued an evaluation of the most significant Egyptian libraries: the Cairo University Library, the Egyptian National Library and Archives (Cairo), and Al-Baladia Library (Alexandria)."

Since then, international efforts have interwoven to revive the Library of Alexandria. In October 1987, there was an international call in five languages to support the project; and in 1990, the Aswan Declaration announced the launch of the project's implementation. While the BA is celebrating its 15th Anniversary, the eminent Professor who incepted the notion of reviving it bids us farewell. Professor el-Abaddi's memory is as eternal as that of the BA; he will remain a shining star in its history and his name will always be attached to this great project. Our utter gratitude and appreciation go to our venerated Professor el-Abbadi.

MONA BAKR: THE VOICE OF NANOTECHNOLOGY IN EGYPT

By: Jailane Salem

This year, the world lost a shining beacon of science, Dr. Mona Bakr. Always enthusiastic to share what she knew in her field with others, she worked tirelessly to achieve her dream of improving society through her scientific research and benefiting humanity as best she could. Her field of interest was nanotechnology; to have lost her is to lose who many have called "the queen of nanotechnology". While she may no longer be with us, her legacy will surely remain as testimony to her great contribution throughout her exemplary scientific career.

From a schoolgirl's dream to a scientist's dream

In one of her previous interviews with us back in 2010, she told us she became interested in science through her father who was an ardent lover of all things science. She was exposed to the scientific field and the endless possibilities it provides from a tender age, since he would often bring her scientific books and magazines. While she had been aware of the importance of science since a young age, it was an article by the famed Dr. Zewail that truly sparked her passion for science, encouraging her to pursue a career in the field.

Looking at Dr. Mona Bakr's career trajectory, one can observe that she was a motivated individual, who pursued her career with gusto. She once said in a concluding statement of one of her talks "We do not create science; we discover it" and we can truly see that she lived by that motto. She earned her Bachelor degree in 1991, and her Master degree in Chemistry in 1994 from Assiut University. She then went on to receive her PhD in 2002 from Georgia Institute of Technology, USA, completing her thesis under the supervision of Professor Mostafa El-Sayed. She pursued her post-doctoral at the University of Lausanne, Switzerland, and became staff member at the National Institute for Laser Enhanced Sciences (NILES), Cairo University, Egypt; and also the Director of Egypt Nanotechnology Center (EGNC) in the same university.

Dr. Bakr's research focused on the synthesis and characterization of metallic, magnetic, and semiconductor nanocrystals. She also worked on their optical properties and ultrafast dynamics with the use of different laser techniques. She worked with a team on making nanomaterials that could be used for various purposes; such as in solar cell applications, biomedical imaging, and water treatment. One can see at a glance that she was interested in the diversity that nanotechnology has to offer; she was an avid researcher and has 56 publications in different international journals, such as *Nano Letters* and *Advanced Functional Materials*.

All the while, she supervised graduate students and was the Director of Nanotech Egypt; the first company in Egypt and the Arab world that manufactures different nanomaterials, and aims to create a hub for nanotechnology that can strengthen and improve Egypt's economy. This issue was near and dear to Dr. Mona's heart and she delved into it in an interview with the Nile Culture TV.

She said that nanotechnology has endless possibilities in its application when it comes to creating new materials and new uses for materials. She believed that they could be of great use in many industrial sectors, and realized that the future lied in implementing nanotechnology in the main industries of Egypt. She wanted nanotechnology to move out of experimental labs into practical use; however, the main impediment for that is the lack of communication between the different sectors.

She wanted to open communication channels between government bodies, scientists, and businessmen in order to create an environment where everyone could benefit and help develop the country. While Dr. Mona wished to see Egypt become one of the important hubs of nanotechnology, she knew that the journey was still long and arduous. Nevertheless, if we look at the recent developments in the field, it will become nanocrystal clear why her vision is one that should be carried out by her fellow colleagues.

Nonstop Nanotechnology

We have covered nanotechnology various times here, thanks to its evolving nature, there is always something new and exciting to report on. Nanotechnology is the manipulation of matter at an atomic scale; when changes are made to materials at the nano-level, their properties change and scientists can try and create materials that have better characteristics in accordance with their purpose. This technology is so versatile that it virtually leaves no aspect of life untouched, and therefore, offers a great potential for investment as Dr. Mona Bakr advocated.

Leading countries that invest in nanotechnology are the USA, followed by Japan, and South Korea in third place. In fact, South Korea Ministry of Science has announced that it plans on investing around USD 447 million on developing this technology in 2017.

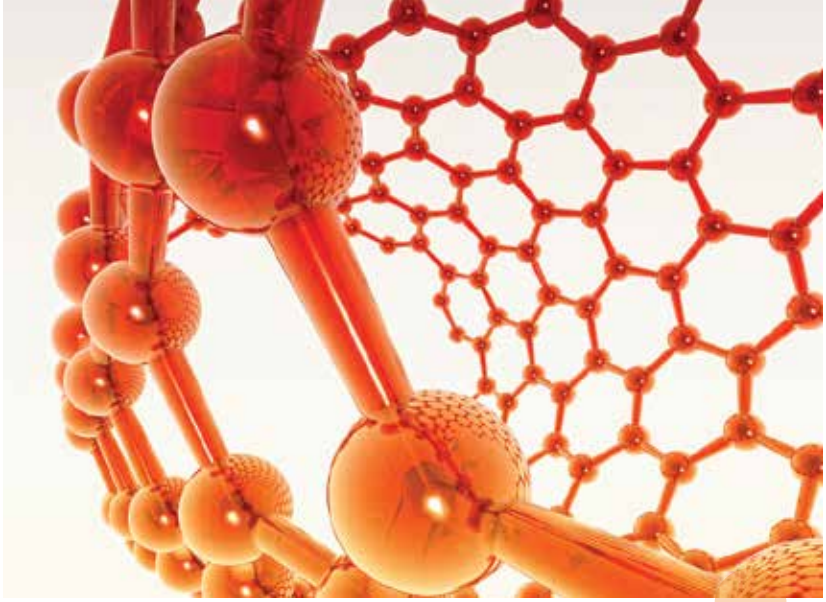
The plan is to develop "core nanotechnology know-how to improve the competitiveness of the country's industrial sector. Under a joint development plan with the Ministry of Trade, Industry, and Energy, and other related government agencies, Seoul will invest KRW 49.3 billion in 2017 alone to nurture skilled workers. The Government will spend an additional KRW 35 billion this year on developing infrastructure that will include a new evaluation system to check the performance of any nanotechnology product," according to the Ministry.

"We do not create science; we discover it"
Mona Bakr

This, in essence, is what Dr. Mona Bakr wanted to see happen in Egypt. This vision should be considered seriously since "the global market for nanotechnology products breached the one trillion dollar mark in 2013, and is growing at an average rate of nearly 40 percent annually." These numbers are nothing to scoff at; the rewards of investing in developing nanotechnology are quite evident. If we have a look at two recent developments in the field, the novelty of nanotechnology will become apparent to anyone.

Bringing Back the Light

Recently, engineers from the University of California with the collaboration of a start-up called Nanovision Biosciences Inc. made a breakthrough in the development of a technology that aims to help restore loss of sight caused by neurodegenerative diseases. While those affected by retinal degeneration can seek medical help, there is no way of helping these patients regain their eyesight, and in most cases, they end up being legally blind.



What the engineers working on solving this problem did was use both nanotechnology and wireless electronics to form a type of retinal implant that will have the ability to respond to light in the retina and has the potential to restore functional vision. The implant is made from an array of silicon nanowires that sense light, as well as electrically stimulates the retina.

The engineers said that "their development does not require a vision sensor outside of the eye to capture a visual scene and transform it into alternating signals to stimulate retinal neurons. Instead, the silicon nanowires mimic the retina's light-sensing cones and rods to stimulate retinal cells. This makes for a simpler yet scalable architecture for the retinal prosthesis". While the implants are still being tested on rats, the findings are encouraging and the goal for these engineers is to eventually have a clinically functioning device that can help patients with severe retinal degeneration.

Bringing In the Light

The versatility of nanotechnology is such that, while in one university researchers are working on restoring eyesight, at another they are working on creating windows that can store solar energy. A joint project between the University of Minnesota and the University of Milano-Bicocca has been working on the technology that will eventually make this project a reality.

It was at the University of Minnesota where they invented the process of creating silicon nanoparticles; they hold a number of patents in this technology. On the other side, at the University of Milano-Bicocca, Italy, they are experts in the field of making Luminescent Solar Concentrators (LSCs). Researchers worked together to develop the technology whereby they embed silicon nanoparticles into LSCs, making them a part of windows, so that when sunlight shines through the windows "the useful frequencies of light are trapped inside and concentrated to the edges where small solar cells can be put in place to capture the energy".

Such windows are called photovoltaic; the idea has been around for some time, but it is only recently that the technology has developed enough to be able to sustain prototypes. The innovation that is helping move this idea forward was the use of silicon, which is readily available, but in its conventional form, it does not emit light.

"In our lab, we 'trick' nature by shrinking the dimension of silicon crystals to a few nanometers. At this size, silicon's properties change and it becomes an efficient light emitter, with the important property not to re-absorb its own luminescence. This is the key feature that makes silicon nanoparticles ideally suited for LSC applications" explained Professor Uwe Kortshagen, from the University of Minnesota, who invented the process of creating the silicon nanoparticles. Having found a successful way to implement an idea, it is only a matter of time before we start hearing about windows that capture solar energy being available on the market.

Nanotechnology has the potential to truly change our lives, and although she left this world, Dr. Mona Bakr's legacy will endure. Her work and words should remain in our minds, guiding our scientists and policy makers, who have the potential of moving our country in the right direction.

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CLIMATE CHANGE AND HUMAN HEALTH

By: Sara Khattab

Nowadays, the dangers of climate change are one of the most visible environmental concerns; temperatures are rising, polar glaciers are melting, and sea levels are rising. Over the past few years, the frequency and strength of natural weather-related disasters more than doubled, killing thousands of people. Nevertheless, climate change does not only threaten human safety, but it also directly and indirectly affects human health.

In some areas, especially in Northern Latitudes, people are less prepared to cope with excessive temperatures. Young children, pregnant women, elders, and people with certain medical conditions are less able to regulate their body temperature, and can therefore be more vulnerable. As the planet warms up, heat wave attacks increase, leading to increase in deaths in certain areas due to excessive heat. In 2003, more than 70,000 excess deaths were recorded after the heat wave that attacked Europe. Exposure to extreme heat can lead to heat stroke and dehydration, as well as respiratory, cardiovascular, and cerebrovascular diseases.

Higher temperatures also affect air quality as the levels of ground-level ozone and other pollutants rise in the air. A new study found that breathing ground-level ozone can trigger coughing, throat irritation, and congestion. Excessive exposure to ozone can worsen bronchitis and asthma, and can also inflame the linings of the lungs, leading to lung tissue damage.

Particulate matters—extremely small particles and liquid droplets suspended in air—may be created by human activities, such as burning fossil fuels, and can be formed in the atmosphere from chemical reactions of gases. Climate change can increase the severity of wildfires, where the wind can carry particulate matter from the wildfire smoke for a very long distance. Inhaling these particles can lead to lung cancer and chronic obstructive pulmonary disease.

Researchers found that plants are growing earlier and faster, producing more airborne allergens. They linked this to increasing levels of carbon dioxide in the air, in addition to warming temperatures. Higher concentrations and longer intense pollen seasons play a large role in the rise of allergy-related illnesses and asthma attacks.

Changes in the climate will also influence the spreading of vector-borne diseases that are transmitted by mosquitoes, ticks, and fleas—such as malaria and dengue fever—changing their geographic range. Increasing rainfall patterns and higher frequency of floods will create more standing water for insects to thrive and breed; insects also grow faster in warmer climates. Malaria kills around 600,000 people every year, mainly African children under 5 years old; in recent years, with the continuous rise in temperature, mosquitoes can spread into new areas, so communities of higher altitudes are at higher risk.

Warmer oceans and other surface waters could increase water contamination with harmful pathogens, chemicals, biotoxins, and toxicants, resulting in increased human exposure to water-borne illnesses and cholera outbreaks. Fresh water contamination can also occur through the release of chemical contaminants previously locked in melting polar ice sheets, in addition to floods. This threatens fisheries and directly affects agricultural productivity, crop failure, and lack of clean drinking water, leading to intensifying malnutrition and starvation.

Climate change and high temperatures affect food safety and nutrition, where they increase cases of salmonella and other bacteria-related food poisoning, because bacteria grow more rapidly in warm environments. These bacteria can cause gastrointestinal distress, and in severe cases, death.

People in developing countries may be the most vulnerable to health risk globally, but climate change also threatens health in wealthy nations. World Health Organization (WHO) researchers are expecting that, between 2030 and 2050, climate change will cause approximately 250,000 additional deaths per year. Researchers are, thus, developing strategies to raise the communities' awareness while cutting down carbon emissions.

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HERO

Thousands of years ago, during the golden era of scientific enquiry in the 3rd century BCE, our hometown Alexandria of Ptolemaic Egypt was the world's greatest center of learning and scholarship. Alexandria was a hub for knowledge and discovery, home to The Royal Library of Alexandria; one of the largest and most significant libraries of the Ancient World, and the Alexandrian Museum, which acted as the world's chief medical research center.

Two of the city's most influential medical investigators were Herophilus and Erasistratus, who together made incredible breakthroughs in the fields of anatomy and medicine. Despite their significant contributions, their legacy is shrouded with great controversy and grave accusations; they were accused of the unspeakable: performing vivisections on live humans.

Herophilus, also known as "The Father of Anatomy", was born in 335 BCE, in the town of Chalcedon, Asia Minor, and is believed to have lived until 255 BCE. He fled to Alexandria to begin practicing medicine and commence his research. He took deep interest in general anatomy, and soon realized that the only way he could truly study human anatomy was by becoming the first person to perform systematic dissection of the human body, presumably on cadavers.

In Alexandria, Herophilus lived in an environment in which the dissection of human corpses was not met with general disapproval and religious taboos. His method proved to be a potent research tool, affording him unparalleled advantages

PHILUS and ERASISTRATUS:

The Butchers of Alexandria

By: Lamia Ghoneim

over previous students of human anatomy who had formulated their insights mainly on indirect evidence and speculation.

Through his fervent interest in the subject, Herophilus' discoveries made him an acclaimed medical practitioner. Apart from plying his trade, he penned down at least eleven treaties, which were unfortunately lost during the great fire in the Ancient Library of Alexandria, where his works were believed to be stored in 391. However, his anatomical knowledge passed down to the generations, providing vital input towards understanding the brain, eye, liver, and reproductive organs.

Herophilus has been credited with giving the best description of the reproductive system up to the Middle Ages. It was his work on the nervous system, however, that was considered to have been the most important. He is believed to be one of the first to differentiate nerves from blood vessels and tendons, and to realize that nerves convey neural impulses.

Realizing that the network of nerves spread throughout the body could be traced back to the brain, Herophilus concluded that the brain was the controlling organ in Man, through which "all bodily actions are accomplished". This discovery went against Aristotle's assertion that the heart was the source of human intellect and reason, which would have been the commonly held belief at the time. Herophilus' remarkable work effectively superseded that of his predecessors; later medical writers such as Roman doctor Galen of Pergamon adopted his interpretation over Aristotle's.

Erasistratus, Herophilus' younger contemporary and student, was born in 304 BCE, on the island of Cos. Before travelling to Alexandria and joining Herophilus, he served as royal physician at the court of Seleucus I in Mesopotamia. He made remarkable progress in anatomy, complementing Herophilus' teachings and research, and describing the brain even more accurately, distinguishing the cerebrum from the cerebellum and sensory from motor nerves.

Erasistratus was also the first to dispel the notion that nerves are hollow and filled with pneuma (air); instead, he averred that they are solid, consisting of spinal marrow. In his account of the heart and its function, he distinguished between pulmonary and systemic circulation; he appears to have been very close to discovering the circulation of the blood, a feat eventually achieved by English physician William Harvey in 1628.

In the centuries that followed Herophilus and Erasistratus' work, questions arose over the ethicality of their methods, and stories began to circulate that the subjects they dissected were cut up whilst still alive. Later physicians, such as Cornelius Celsus and Galen charged both Herophilus and Erasistratus with performing vivisection on condemned criminals awarded to them by the rulers of Alexandria.

Celsus, who did not witness the vivisections, wrote 250 years after the death of Herophilus that the criminals were dissected alive "while they were yet breathing". Tertullian, writing in the next century, called Herophilus a "butcher", implying that he cut up living people. It has been theorized that accusations of vivisections is the main reason why Herophilus has not received as much recognition for his scientific investigations of the human body as Hippocrates, Galen, or Vesalius.

Whether or not Herophilus and Erasistratus ever actually vivisected human subjects, the gruesome charges made against them helped ensure the practice of dissection was prohibited in the West until the Renaissance, when social and scientific changes allowed anatomists to practice on human corpses once again.

Herophilus concluded that the brain was the controlling organ in Man, through which "all bodily actions are accomplished"

The remarkable research that took place in Alexandria during the 3rd century BCE was therefore a unique event in the history of medicine and the Ancient World. The discoveries made by Herophilus and Erasistratus, thus, remained the pinnacle of anatomical knowledge for 1500 years.

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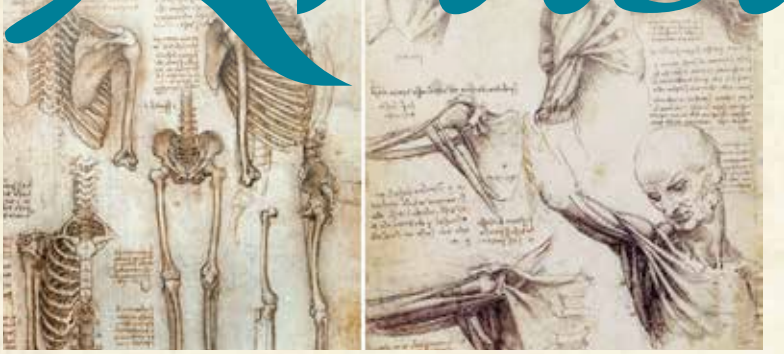
The Anatomist and the Artist

By: Maissa Azab

The intertwining of art and science cannot be eluded; the one cannot exist without the other. One of the most obvious examples of this unbreakable bond is the relationship between visual arts and anatomy, encompassing illustration of the body for anatomists and the study of anatomy by artists.



Anatomical illustration is fundamentally important to the teaching and study of anatomy, and at least since the Renaissance, artists have recognized the importance of anatomical knowledge for their own creative work. Naturally, the basis of anatomy, is and has always been, dissection of human corpses, which though practiced by the ancient Greeks, did not become part of accepted medical research until the 16th century.

During the Middle Ages—a time when the vast majority of ordinary people were uneducated and superstitious—anatomy was based on a sprinkling of facts derived from Greek sources and a large amount of guesswork. The internal workings of the body were not explained by scientific theories, but by the influence of supernatural forces, spirits, and demons. The picture of a "Zodiac Man", taken from a 14th century manuscript, demonstrates how doctors thought that the stars and the planets influenced the body.

The Renaissance may be best known for its artworks, which certainly shaped the course of art history; yet, during this formative period in art history, one primary source of inspiration for artists was actually anatomical sciences. The population was becoming wealthier; the rise in prosperity generated an interest in education, supported the flourishing of the arts, and promoted scientific discoveries and new inventions. Traditional theories were challenged and doctors looked for a better understanding of the workings of the body; by the early 1500s, dissections were, thus, increasingly being carried out in medical universities around Europe.

Andreas Vesalius, born in Brussels in 1514, studied medicine in Paris where he became skilled in dissection. In 1537, he joined Padua University where he became Professor of Surgery; and in 1543, he published *On the Fabric of the Human Body*, which would change the medical view of the human structure.

Vesalius' work was important because it challenged existing thinking. Before the Renaissance, medical knowledge was based on the writings of Galen, an ancient Greek physician who wrote over sixty works on medical practice that were the accepted textbooks on medicine during Roman times. Galen's ideas and methods, such as observing and recording medical conditions, were useful; however, he made many mistakes. Though he dissected human bodies, many of his ideas on human anatomy were based on the dissections of various animals, leading to many errors in his writings on the functions of the body.

Vesalius wanted to see for himself how the anatomy of a human body worked from the inside. In 1539, he was given access to the bodies of executed criminals by a local judge and began to regularly perform dissections, many of them as public demonstrations. Though Vesalius still included some inaccuracies in his anatomical work, he corrected many of Galen's mistakes; more importantly, he put anatomy at the forefront of medical study. His work typified Renaissance thinking; he looked back to classical modes of learning, as well as ahead to the developing scientific method, using experiment, observation, and physical confirmation to challenge and correct mistaken beliefs and ideas that were based on authority or tradition rather than evidence.

On the Fabric of the Human Body was aimed at a wide audience; it was used by medical students, but was also intended for people who attended the public dissections conducted by Vesalius. The pictures in the book provided the audience with a visual guide; in order to appeal to as many people as possible, the book was not only highly detailed, it was brilliantly illustrated, surpassing any anatomical work produced before. This would not have been possible to perform without the many advances that had been made during the Renaissance.

Geography played a part in Vesalius's success; Padua is near Venice, a wealthy coastal trading center. The wealthy merchants of Venice spent their money on education and luxuries; they created a ready market for Vesalius's fascinating work. The wealth and beauty of Venice also attracted a host of talented artists to the city; Vesalius was easily able to recruit the best artists—most notably Titian—from local studios to illustrate his book. Just as importantly, the recent invention of the printing press meant that Vesalius's book could be produced in large numbers, while the improvement in printing techniques made it possible to include the brilliant illustrations.

Anatomy was particularly important in Italy during the Renaissance, not only for educational purposes, but also because of the great number of leading artists who worked there. Employed by wealthy Italians to decorate their houses with paintings and sculpture, they desired to recreate the lifelike images produced a thousand years earlier by the Greeks and the Romans.

On the Fabric of the Human Body was aimed at a wide audience; it was used by medical students, but was also intended for people who attended the public dissections conducted by Vesalius.

The relationship between artists and physicians during the Renaissance was symbiotic. Not only did physicians contract artists to draw illustrations for their written works, artists, interested in exacting the human form in their art, observed physicians at work to learn the layers of muscle and bone structures that formed certain parts of the body. Some artists even forged partnerships with specific physicians, in which the physicians would allow the artists to assist in dissections in exchange for anatomical drawings and illustrations.

Some of the best artists even conducted their own anatomical studies, making new discoveries and expanding the field. While most artists limited their investigations to the surface of the body and observed live subjects, some went so far as to peel back successive layers of muscle, tendons, and bones, off corpses in order to gain a better idea of how to portray the human body in their art. Da Vinci, it is said, conducted the first correct anatomical study of a human fetus.

We tend to think of Leonardo da Vinci as a painter, even though he probably produced no more than twenty paintings before his death in 1519. Yet, for long periods of his career of nearly half a century, he was engrossed in all sorts of pursuits, from stargazing and designing ingenious weaponry, to overseeing a complex system of canals for Ludovico Maria Sforza, the ruling Duke of Milan. During the course of his life, Leonardo filled thousands of pages of manuscript with diagrams and text, probing almost every conceivable topic.

One area of scientific endeavor piqued Leonardo's curiosity arguably more than any other: human anatomy. Leonardo's early anatomical studies dealt mainly with the skeleton and muscles; from observing the static structure of the body, he proceeded to study the role of individual parts of the body in mechanical activity, which led him finally to study the internal organs.

His findings from these studies were recorded in the famous anatomical drawings, which are among the most significant achievements of the Renaissance. They are based on a connection between natural and abstract representation; representing parts of the body in transparent layers that afford an "insight" into the organ by using sections in perspective, reproducing muscles as "strings", indicating hidden parts by dotted lines, and devising a hatching system.

Leonardo's interest in anatomy began when he was working for Ludovico in Milan, when he began his book entitled *On the Human Body*. However, after completing a sequence of stunning drawings of a skull, his studies paused, probably because he lacked access to corpses that he could dissect. Around two decades later, he returned to his notebook, now known as the *Anatomical Manuscript B*, where he made a number of pen-and-ink drawings, recording his observations while dissecting an old man who had died in a hospital in Florence in Winter 1507/08.

In the years that followed, Leonardo concentrated on human anatomy more systematically than ever before. In Winter 1510/11, Leonardo compiled a series of 18, mostly double-sided sheets, exploding with more than 240 individual drawings and over 13,000 words of notes. Now known as the *Anatomical Manuscript A*, these sheets are full of lucid insights into the functioning anatomy of the human body.

Leonardo made many important discoveries; he produced the first accurate depiction of the human spine, while his notes documenting his dissection of the Florentine centenarian contain the earliest known description of cirrhosis of the liver. Yet, arguably Leonardo's most brilliant scientific insights occurred when the great polymath fled political turmoil in Milan and took shelter in the family villa of his assistant Francesco Melzi, where he became obsessed with understanding the structure of the heart.

Heart surgeon Francis Wells, who works at Papworth Hospital in Cambridge, and has published *The Heart of Leonardo*, recalls coming across Leonardo's studies for the first time as a medical student: "I remember thinking that they were far better than anything we had in modern textbooks of anatomy," he says. "They were beautiful, accurate, absorbing, and there was liveliness to them that you just do not find in modern anatomical drawings".

During his investigations, Leonardo discovered several extraordinary things about the heart: "The heart was believed to be a two-chambered structure," Wells explains; "but, Leonardo firmly stated that the heart has four chambers. Moreover, he discovered that the atria or filling chambers contract together while the pumping chambers or ventricles are relaxing, and vice versa".

Leonardo also observed the heart's rotational movement: "The heart empties itself with a twisting motion," says Wells; "it wrings itself out, a bit like the wringing out of a towel. In heart failure it loses this twist". According to Wells, Leonardo did not fully understand the function of cardiac twist; "but, everything starts somewhere," he says. "It was a correct start along the road to understanding cardiac twist, which is now one of the hottest topics in understanding heart failure."

Perhaps most impressive of all were Leonardo's observations about the aortic valve. Intrigued by the way opens and closes to ensure blood flows in one direction, he set about constructing a model by filling a bovine heart with wax, then recreating the structure in glass. By pumping a mixture of grass seeds suspended in water through it, he observed little vortices as the seeds swirled around in the widening at the root of the aorta; as a result, he correctly posited that these vortices helped close the aortic valve.

Continued on page 23

Vocal Learners and Evolution

In 2010, an orangutan called Tilda at Cologne Zoo in Germany was filmed making a series of deep-throated garbled sounds similar to human speech. The video roamed the Internet at the time; however, Tilda was not the first animal to mimic human speech. Other species make speech-like sounds, including whales, elephants, not to mention parrots; but, how do they make these human-like sounds?

By: Esraa Ali

For the orangutan, the answer lies in the complex musculature of its vocal tract and its thick and flexible tongue, which enable it to produce these speech-like sounds more easily. Other animals could mimic human speech; yet, using different methods. Whales, for example, could mimic human-like sounds by over-inflating their nasal cavities; elephants, on the other hand, put the tip of their trunks into their mouths to modulate their vocal tract.

You may think that, to talk, you need to have certain physiological abilities; but think of musical instruments. You will notice that some instruments you cannot do much with when their vocal tract is short, compared to longer ones, which are more versatile. Similarly, the human larynx is much longer than in other animals; so, why do some animals have talking abilities, while others do not?

What is common in these different mimicry species is that they are vocal learners; unlike other animals that produce only the calls they are born with and are unable to imitate new sounds. Vocal learners hear sounds, try to imitate them, and then produce them; yet, this minority of mimicry animals does not understand the meaning of these sounds, and as we say, are simply "parroting" them.

Accordingly, we may assume that humans are the best vocal learners. Humans have the ability to learn and form countless words, carrying different thoughts, but when did our speech and language evolve?

Our native languages, also known as natural languages, have evolved into their current form over centuries. Most scientists estimate that language first appeared among *Homo sapiens* 30,000–100,000 years ago. Unfortunately, where language began to rise and the secret of its evolution are still unknown; hence, many theories have popped up. One common theory assumes that language was the main reason behind the survival of human beings, where language was created to help humans communicate in order to hunt, farm, and defend themselves against their harsh environment.

Another competing theory posed by linguist Noam Chomsky and evolutionary biologist Stephen Jay Gould states that language was needed for social interaction; as part of the evolutionary processes, it has evolved. In their theory, they tackled Darwin's preadaptation process, also known as exaptation, which discusses how species use their features for a purpose other than that it was originally made for. A classic example for exaptation as argued by some evolutionary biologists is the original function of birds' feathers to shelter them from cold weather; they were later used for flying.

Chomsky and Gould hypothesize that, as the physical structure of the brain evolved, language may have evolved too; as humans started to construct different tools, there was a need to name each of them. This falls in line with the theory stating that our cognitive functions have increased as our brains were enlarging.

What is clear is that language is a human invention that developed as the need for more complexity increased. Our vocal mimicry was the ground of our language, which has allowed us to produce and reproduce a massive number of sounds. As a result, different forms of languages evolved; today we can, thus, find around 7,000 different languages spoken around the world.

We may conclude that, as stated by cognitive psychologist Steven Pinker: "This triad—language, social cooperation, and technological know-how—is what makes humans unusual. They probably evolved in tandem, each of them multiplying the value of the other two."

Given the above, we may notice that many of the mechanisms involved, including the ability to control produced sounds, are basic and owned by many animals. Yet, only a tiny minority of animals was able to mimic the sounds of human speech and talk as humans do. If we think about the other majority of less capable animals that cannot mimic human-like sounds—and are still as fascinating as their peers—we can get a picture of how our linguistic abilities have evolved over the centuries.

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By: Hend Fathy

Biodiversity at Stake

A Historical Account

What makes Earth unique among its peer planets is that it supports life. For ages, the planet has embraced diverse forms of life that flourished across its oceans and lands and has been home to innumerable species. However, there have been times when mass extinction strokes or biotic crises took place, killing 50−95% of the existing species and causing dramatic changes in the planet biotic characteristics.

Such events took place over thousands or even millions of years, and it also took millions of years before biodiversity flourished once again. Paleontologists have thus far spotted five major mass extinction episodes spanning geologic time. This was possible through studying, compiling, and modeling databases, and marking the fossils that went missing from the global record.

The Ordovician-Silurian extinction was the first in the Earth's history, occurring around 445 million years ago. It marked the end of the Ordovician Period and the beginning of the Silurian Period, and was mainly attributed to a drastic decrease in temperatures. This event eliminated an estimated 85% of all Ordovician species on three phases, the first of which was related to rapid cooling. The second wave was related to decreasing sea level associated with glaciation, which significantly reduced the available habitat for marine organisms. As the sea level rose again during early Silurian period, the third wave of extinction took place.

The second mass extinction event was the Late Devonian that accrued 359 million years ago and ranks least severe among the five extinction events. It marked the end of the Devonian period and the beginning of the Carboniferous period. The Late Devonian extinction eliminated 70−80% of all animal species and about 20% of animals families. Researchers agreed that it resulted from a combination of several stresses, rather than a single cause. Evidences refer to excessive sedimentation, rapid climatic changes, bolide impacts, or considerable nutrient shortage.

The greatest mass extinction in Earth's history, the Permian extinction, followed 248 million years ago; it marked the end of the Permian period and the start of the Triassic period. The Permian extinction was characterized by the elimination of over 95% of marine species and 70% of terrestrial species; moreover, over half of all taxonomic families present at the time disappeared. The Permian extinction is attributed to several factors, including disturbances in nutrient cycles, global warming due to the explosion of methane-producing organisms populations, changes in the carbon cycle, and basalt eruptions.

Fifty million years later, the End-Triassic extinction occurred, marking the end of the Triassic period and the start of the Jurassic period. It resulted in the demise of 76% of all species and 20% of taxonomic families. Researchers maintain that the End-Triassic extinction episode was the key event that allowed dinosaurs to become Earth's dominant land animals, having opened ecological niches for them. Most probably, the volcanic activities associated with the rifting of the supercontinent Pangea—where eastern North America met northwestern Africa—were responsible for this episode. Large amounts of carbon dioxide were emitted from the volcanoes, causing global warming and ocean acidification.

The fifth extinction event was the Cretaceous–Tertiary, which occurred 66 million years ago; it marked the end of the Cretaceous period and the start of the Paleogene period. The extinction event was responsible for eliminating approximately 80% of all species, including nearly all dinosaurs and many marine invertebrates. There have been several hypotheses on the extermination of dinosaurs, which has puzzled researchers for two centuries.

In the early 1980s, American scientists Walter Alvarez and Luis Alvarez formulated the "asteroid theory", which was supported by evidence in the rock record and received much attention. It states that a bolide impact caused the ejection of a huge quantity of debris into Earth's atmosphere. As a result, darkness enshrouded the planet and caused photosynthesis to cease, which killed green plants and disrupted the food chain.

In the past few years, scientists have been warning that Earth is experiencing its sixth mass extinction episode, the Holocene extinction, which they believe could be the most catastrophic of all. This time, however, the extinction episode is almost exclusively human driven. Human-induced climate change, destruction of habitats, pollution, ocean acidification, urbanization, soil erosion, among others, are causing the loss of dozens of species every day.

The human race has to revise its destructive practices against biodiversity. Humans are annually increasing in number by 100 million individuals, and hence, might seem far from the extinction danger. However, the survival of a species is not a matter of number, rather, it depends on the sustainability and well-being of all other organisms.

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THE DEADLIEST VIRUSES IN HISTORY

Which virus do we consider deadly? Is it the virus that spreads quickly? Or is it the virus that kills most of the infected persons? Viruses are tiny organisms that are not alive; they cannot grow or multiply on their own, but rather need a human or animal cell to take over the cell to be able to multiply. There are more than 5000 virus species known to Man; some have been eradicated by science, while others keep evolving into new strains that are harder to fight. Here are some of the deadliest viruses known to science.

By: Shahenda Ayman

Influenza

Influenza, or flu, is an airborne virus that spreads through coughing and sneezing; it can also spread through blood, bird dropping, saliva, and nasal secretions. Everybody gets infected with the flu and we think that it is not a big deal; however, every year, influenza racks up a massive number of deaths from among the old, the very young, and the sick. Despite the existence of a safe and effective vaccine for over sixty years, influenza still causes up to half-a-million deaths annually.

The outbreak of the Spanish flu in 1918 is considered among the worst pandemics in human history; it is believed to have infected almost a third of the global population and caused up to 100 million deaths. During the epidemic, the fatality rate was 20% of those infected compared to the usual 0.1% from seasonal flu. The Spanish flu was so deadly because it did not kill infected people only, but it killed healthy people as well. The particular strain caused the immune system to turn on itself, creating an overreaction known as a cytokine storm; as a result, those with the strongest immune systems were at the greatest risk.

Nowadays, the deadliest and most contagious strains are distinct. One fear is that the potentially lethal strains such as the H5N1 Avian influenza (bird flu), which is not able to spread person-to-person, would only require a small genetic event to cause an epidemic. Although there have only been just over 600 cases of bird flu, about 60% of them have been fatal, making it one of the most virulent human diseases.

Ebola

Ebola spreads through contact with blood or other body fluids, or tissue from infected people or animals. The deadly virus is named after the Ebola River where it was first reported. Ebola Hemorrhagic Fever (EHF) has a 50–90% mortality rate, with a rapid onset of symptoms that start with a headache and sore throat, then progress to major internal and external bleeding and multiple organ failures. There is no known cure.

Four of the five known Ebola viral strains cause Ebola Hemorrhagic Fever (EHF), which has killed thousands of people in sub-Saharan African nations since its discovery in 1976. One strain, Ebola Reston, does not even make people sick; but for the Bundibugyo strain, the fatality rate is up to 50%, and it is up to 71% for the Sudan strain, according to the World Health Organization (WHO). According to WHO, the outbreak in West Africa, which began in early 2014, is considered the largest and most complex outbreak of the disease to date.

Rabies

Rabies is transmitted from animals such as dogs, bats, monkeys, and foxes. It has a varying incubation period that depends on where the patient was bitten. Once the virus reaches the central nervous system, it travels to the brain. The initial symptoms are mild, such as fever and headache; but, once the virus kicks in, it leads to acute pain, violent movements, depression, uncontrollable excitement, and an inability to swallow water. It later causes mania, coma, and finally death.

While this virus itself is a beast, the sickness it causes is now wholly preventable if treated immediately with a series of vaccinations. However, if left untreated after exposure, the virus attacks the central nervous system and death usually results. If rabies ever became airborne, we might actually have to prepare for that zombie apocalypse after all.

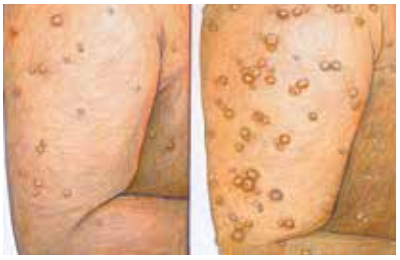
Dengue Fever

Dengue fever is a mosquito-borne infection that was first described nearly 2000 years ago in the Philippines and Thailand. Recently, globalization has its impact with dengue rates increasing by 30 times since the 1960s, making this a major emerging disease.

Dengue symptoms are high fever, severe headache, and in the worst cases, hemorrhaging. Sometimes dengue is referred to as “break-bone fever”, which reflects the intense pain that may be felt in the muscles and joints. For the unlucky few, the illness may develop into “severe dengue” with the risk of potentially fatal dengue hemorrhagic fever and dengue shock syndrome. Occurring in less than 5% of cases, the main issue here is the increased permeability of the blood vessels; this can result in vomiting blood, organ damage, and shock.

Now, dengue is endemic in 110 countries and infects up to 500 million people a year, causing approximately 20,000 deaths. There is no vaccine yet; however, there are a few potentials under development.

Smallpox

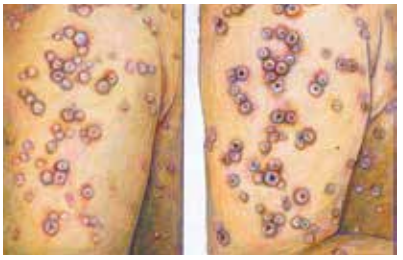


In 1980, the World Health Assembly declared the world free of smallpox. However, even if the smallpox virus was extinct, it has been suggested that it could be re-engineered from the digital viral genome and inserted into a related pox virus shell.

In terms of appearance, smallpox is particularly shocking with the body becoming covered in pox, with fluid-filled pustules. These can occur in the mouth and throat too, along with a number of complications including blindness. The mortality rate of the disease largely depends on the course it takes with malignant and hemorrhagic smallpox invariably being fatal.

Smallpox is both highly contagious and dangerous with high fatality rates. The disease killed about one in three of those infected; it left survivors with deep, permanent scars, and often blindness. It was estimated that around half of the native Aboriginal population of Australia died from smallpox during the early years of the British colonization. The disease was similarly disastrous to the native American people and in South America.

The list contains many other viruses that are considered deadly; it is scary to



think that this tiny organism can destroy our world. However, continuing scientific and technological advancements, as well as the open world that we live in nowadays, could help us defeat any new potential threats.

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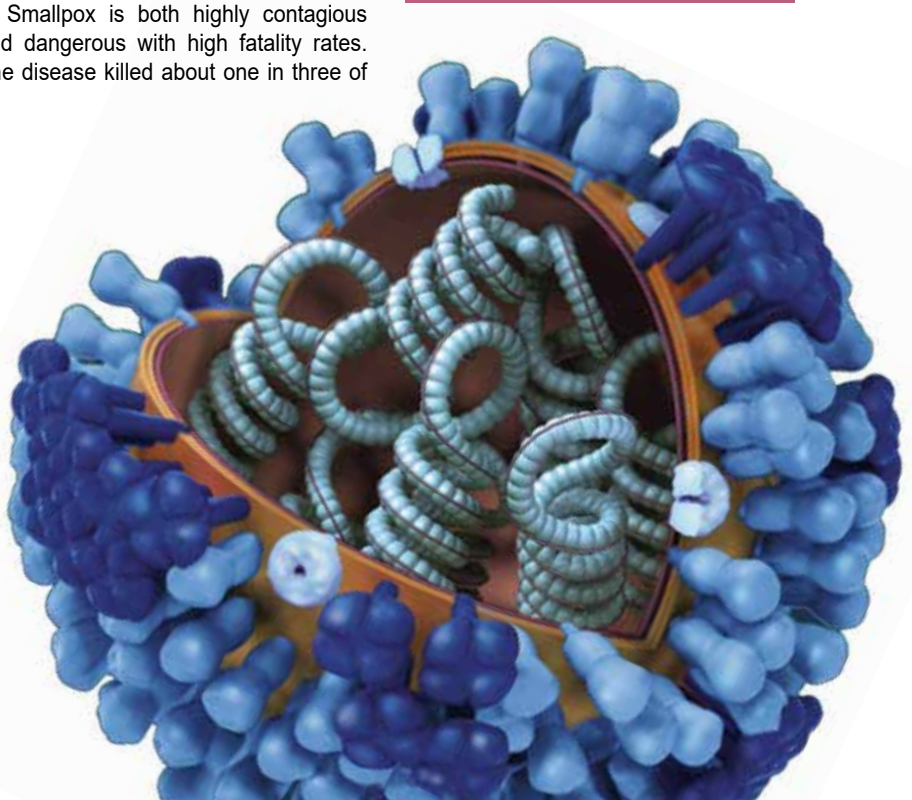
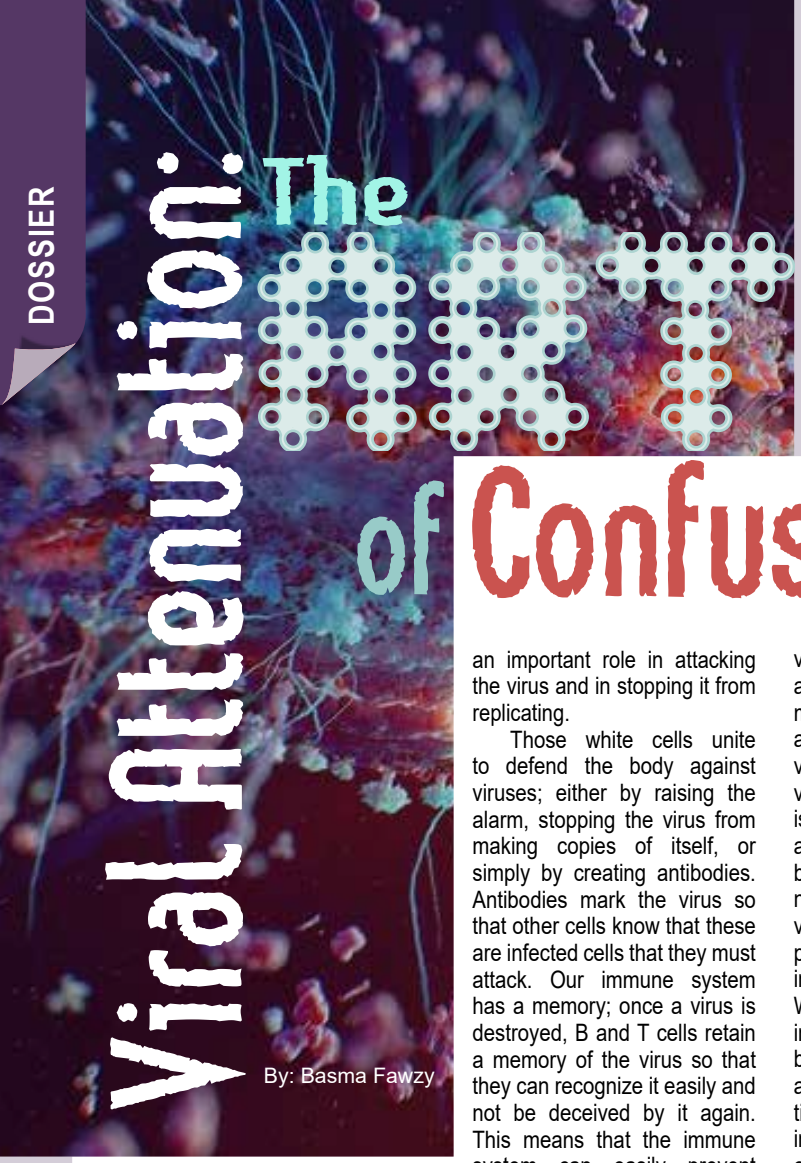




Viral Attenuation: The Art of Confusing a Virus

Viruses are tricky; they sneak into the bodies of human beings unnoticed. While some viruses are merciful, lasting for only a couple of days and leaving the body without lasting damage, other viruses are deadly. Yet, no matter how tricky viruses are, human beings are trickier; they have come up with ingenious solutions to protect the human race from deadly viruses.

By: Basma Fawzy

Viruses are simple in their structure; however, their danger lies in their ability to trick the body. They can easily get into the cells, because they are disguised as nutrients that the cells desperately need; once it enters, it transfers its genome into the cell. This is the method through which an infected cell follows the instructions of a virus. A virus does not have the mechanism to duplicate itself; yet, through transferring its data to the cell, it reproduces itself.

Despite sneaking into human cells, the cells do not stand helpless in the face of viruses. The immune system is designed to recognize our own cells from other invaders; once an invader is detected, our white blood cells rise to defend the body. T-lymphocytes and B-lymphocytes (white cells) play an important role in attacking the virus and in stopping it from replicating.

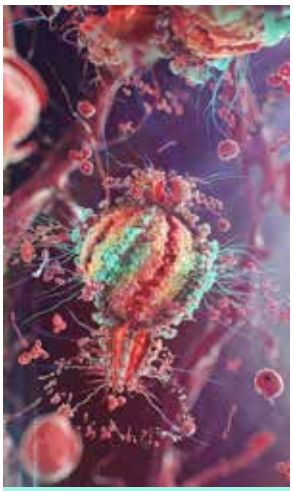
Those white cells unite to defend the body against viruses; either by raising the alarm, stopping the virus from making copies of itself, or simply by creating antibodies. Antibodies mark the virus so that other cells know that these are infected cells that they must attack. Our immune system has a memory; once a virus is destroyed, B and T cells retain a memory of the virus so that they can recognize it easily and not be deceived by it again. This means that the immune system can easily prevent another infection from the same virus.

However, with deadly viruses, human beings do not live to retain a memory of the virus; hence, the importance of vaccination. Vaccinations are intended to give our immune system a memory of a virus so that it can recognize and have a lifelong immunity against it without suffering its consequences. There are different methods in creating such vaccinations, but here, we will only focus on viral attenuation, which is the art of weakening a virus so that it can be safely given to human beings, incurring the same immune response expected from the immune system but without causing lasting damage.

Viral attenuation differs from the process of killing a virus completely. Vaccination against diseases such as measles, mumps, rubella, and chickenpox are based on viral attenuation. Weakening a virus happens when the virus is placed in a different host; a virus that attacks human beings is inserted into animals, normally animal embryos. The virus is not inserted once; it is passed from an animal embryo into another several times. With each time it is transferred into the animal embryo, it gets better at replicating itself in animals' cells, but at the same time, loses its ability to replicate in human cells. What comes out after inserting the virus into different hosts is a weakened version of it that the human cells can recognize. When human beings are vaccinated with an attenuated virus, their bodies receive lifelong immunity without suffering the devastating consequences of the disease itself.

Viruses in the past have claimed the lives of billions of people. Thankfully, with the help of "viral attenuation" vaccination, most of the deadly viruses have been successfully kept in check, if not fully eradicated. It is important to note we owe the disappearance of many deadly viruses to Edward Jenner, known as the "Father of Immunology". Jenner observed that milkmaids, who were infected by cowpox, were immune to smallpox; thus, he exposed people to cowpox and then to smallpox, and noticed that they were not affected. He repeated the same experience over and over again until he was positively sure that one of the two viruses actually makes people immune to the deadly other. His observations saved people from smallpox, and paved the way for many breakthroughs in vaccinations and immunology.

Since then, research has been ongoing and we have a better understanding now of the art of vaccinations than Jenner's basic observations. However, with his help, human lives have been preserved. Thanks to Jenner, and to many scientists who came after him, our world is safe. Stay vaccinated and stay safe.



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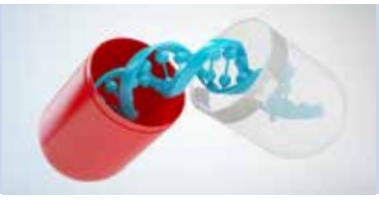
Gene therapy

By: Mona Shehata

Gene therapy is an exploratory treatment, which aims at curing genetic diseases and repairing defective genes through DNA. There are two types of gene therapy: germline gene therapy and somatic gene therapy.



Gene therapy mends defective genes or introduces a new gene to try to fight disease, or enhance the body's strength to battle it. Although gene therapy has great potential for curing a vast array of diseases, inherited disorders, and specific viral infections—such as AIDS, cancer, cystic fibrosis, diabetes, heart diseases and hemophilia—scientists are working on developing new ways of treatment, because nowadays, gene therapy is only used in clinical trials until it proves to be a safe method of treatment.

It works by injecting a gene into the subject's cells to make up for abnormal genes and produce a useful protein, rather than using medication or undergoing surgery. Introducing a gene directly in a cell mostly does not work; a vector is genetically modified and used to transport the gene into the cell. Specific viruses are usually used in the role of vectors, as they can carry the new gene through infecting the cell.

The viruses are altered so they only help in treatment and do not lead to diseases when injected in people. Some types of viruses, such as retroviruses, merge their genetic substance—containing the new gene—into a chromosome in the patient's cell. While others, such as adenoviruses, inject their DNA into the cell's nucleus, but the DNA is not merged to form a chromosome.

The vector is either injected or administered via an Intravenous (IV) directly into a particular tissue in the body, where it is consumed by individual cells. Alternatively, a specimen of the patient's cells can be extracted and subjected to the vector in a laboratory; the vector-carrying cells are afterwards returned to the subject. If the treatment succeeds, the new gene transported by the vector will produce a working protein.

A number of techniques are being studied for future application:

1) **Gene Augmentation Therapy** changes the mutated gene that leads to an ailment; with a healthy replica of that gene, its success depends on the extent of damage in the body.
2) **Gene Inhibition Therapy** subdues the mutated gene that does not work properly.
3) **Killing Specific Cells** works by inserting a new gene in the body to aid in battling the disease.

Federal laws, regulations, and guidelines to protect participating candidates govern gene therapy clinical trials; approval from regulatory agencies and institutions is thus needed to begin them. In the United States, the Food and Drug Administration (FDA) controls gene therapy treatment and research.

Furthermore, the National Institutes of Health (NIH) determines rules and regulations for institutions and researchers to adhere to when overseeing gene therapy clinical trials. The NIH Recombinant DNA Advisory Committee (RAC) reviews the policy of every clinical trial to figure out if it causes any ethical, medical, or safety problems, which then will require more deliberation at a RAC public meeting.

There are two types of gene therapy research, depending on the kind of cells being treated:

1) **Germline gene therapy**: Relocation of a part of the DNA to cells, which are responsible for reproduction. The individual's offspring and the following generations will inherit the gene therapy impact. This therapy is banned in numerous countries as a result of ethical and technical worries.
2) **Somatic gene therapy**: Relocation of a part of the DNA to any cell of the body that is not responsible for reproduction. The gene therapy impact will not be inherited by the individual's offspring.

Scientists have to solve an abundance of technical problems before gene therapy becomes a valid option for treating diseases due to health risks, such as discovering new better and safer techniques to transfer genes and aim them at specific cells.

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Genes and Epigenes

By: Prof. Mahmoud Rifaat
Professor of Genetics, Suez Canal University

Everyday scientists learn more about the regulation of gene expression (gene activity). Your genome is like a huge piano keyboard that contains more than 20,000 keys; each gene in your genome is like a key in this huge keyboard. Science is proving that what you experience throughout your life changes the way your genes operate. Your genes and your lifestyle form a feedback loop, and what you do to your genes makes a big difference.

Your lifestyle changes the expression of your genes through epigenetic marks or epigenes; these marks change gene expression without changing the DNA sequence itself. Several mechanisms are employed in epigenetic marking, including DNA methylation of CpG islands, post-translational modifications of histones, and non-coding RNA (ncRNA). In fact, the epigenetic programming is different in every cell type in the human body; different genes are expressed in different cell types.

The term epigenome indicates all those epigenetic marks that are added onto our genes to control the expression of our genes. The epigenome is nearly indistinguishable at birth in identical twins, but it diverges as they age. This explains why one twin may be more susceptible to a certain disease than the other although DNA sequences are the same in identical twins.

Like piano keys that produce inimitable sounds in response to external stimuli (fingering), genes produce inimitable expressions in response to their intricate genetic programming, and also in response to the different external stimuli that exist in life. Genes are switched on and off through some epigenetic marks that are largely dependent on life experiences; that is, on what happened to the genes throughout life. The epigenetic marks are allowing those lifestyle choices that we make to be traced to the genome, and are the equivalent of the fingering scheme for a piano keyboard.

Epigenetic modifiers are diverse, including diet, smoking, alcohol consumption, exercise, emotions, and even prayers. A recent study on rats showed that a diet rich in fructose disrupted the epigenetic control of more than 200 genes that are normally expressed in the hippocampus. The hippocampus regulates the processes of learning and memory, and therefore, fructose-rich diet impaired memory in rats. Fortunately, the harmful effect of fructose on brain genes could be reversed by a diet rich in Omega-3 fatty acid.

Emotions also act as epigenetic modifiers and can mark brain genes that are involved in stress responses. In experiments with rats, researchers found that rats raised by attentive mothers were able to deal with stressful situations better than rats raised by negligent mothers. The epigenetic marks of the genes normally expressed in the brain were different between the two rat groups. In humans, the stress-dampening genes are epigenetically turned-off in the brains of adults who suffered from unhappy childhood experiences. Emotional disturbances as panic, Post-Traumatic Stress Disorder (PTSD), and schizophrenia can alter gene expression in the brain through epigenetic marks that are grossly different from those marks found in normal happy individuals.

Inappropriate epigenetic marks could be responsible for a new class of diseases; epigenetic diseases. In human atherosclerosis, certain genes are turned off by hypermethylation—epigenetic marks—and gene expression is epigenetically shifted in endothelial cells from atheroprotective to pro-atherogenic status. Epigenetic diseases include also Type II Diabetes and obesity.

The gene encoding leptin—a hormone that inhibits hunger and regulates body weight—is also under epigenetic control. Many tumor suppressor genes are silenced by epigenetic marks that methylate the CpG islands in the promoters of these genes. Epigenetic therapy will be available in the near future to target those silenced tumor suppressor genes. This approach could weaken the cancer cell to the extent that it will be killed by lower doses of chemotherapeutic agents.

Not only does your lifestyle determine the activities of your genes, it also changes the activities of the genes of your descendants. For example, the age at which a boy begins smoking cigarettes is positively related to his future son's Body Mass Index (BMI). In another study, babies of mothers who were exposed to the World Trade Center (WTC) attacks during pregnancy, showed symptoms of PTSD early in life. These trans-generational effects are possible because some epigenetic marks can be transmitted across generations. Future fathers and mothers should, therefore, protect their epigenomes for the sake of their children and their grandchildren.

How Genes affect YOUR Eating Habits

By: Fatma Asiel

Food is the fuel for our body to move, feel warm, and practice different activities, and that our biological systems need to function. In brief, food keeps us alive. Healthy eating habits are no less important than food; they enable us to gain the utmost benefits from the food we consume. Hence, healthy feeding habits are vital for a healthy life and they prevent several diseases, such as obesity, diabetes, heart and artery diseases.

Scientists have lately been interested in studying the relationship between eating habits and inherited genes. Understanding the nature of this relationship would enable them to find methods to control them and protect many people around the world from diseases associated with unhealthy eating habits. There are two types of genes that affect people's eating habits: the first are carried by all human beings, such as taste genes; while the second is only carried by some individuals, such as those responsible for body fat percentage, anorexia, and bulimia.

Taste Genes

Taste directly influences one's choices of food; hence, influencing their eating habits. Normal people can identify four basic tastes: sweetness, saltiness, bitterness, and sourness. Although people are supposed to sense these tastes equally, this is not actually the case.

Studies have found that several factors affect taste; such as the number of tongue taste buds, the ingredients of saliva, genetic differences, etc. Sensing particular tastes, thus, differs from one person to another, affecting their choice of favorite foods, which might entail sugar- or fat-rich diets that negatively affect their well-being.

The Obesity Gene

The obesity gene is the gene responsible for increasing the body fat percentage; it is carried by numerous people around the world. This gene has two forms: a singular form—inherited from one parent—carried by over 40% of the world population; and a double form—inherited from both parents—carried by about 17% of the world population.

The obesity gene affects the part of the brain that controls appetite, causing a belated sense of fullness, thus, affecting eating habits. Carriers of this gene consume more food, especially fat-rich food that has a positive effect on the mood, which consequently increases their weight and exposes them to major health dangers.

The Anorexia Gene

You may have noticed that some children do not feel for food, or get hungry even after several hours since their last meal. This, of course, has a direct effect on their natural growth and might cause some serious malnutrition diseases. Medical analyses and scans for these children would be normal and would not show any physical diseases that can affect their appetite.

These cases have puzzled scientists until recently, when the gene responsible for appetite loss, or anorexia, was discovered. The anorexia gene is an inherited gene that profoundly affects a person's appetite. In the past, only some appetizers were prescribed to carriers of this gene; however, a medication has lately been developed to address this genetic disorder.

The Bulimia Gene

Unlike the anorexia gene, the bulimia gene makes one consume quantities of food much larger than what the body needs. The symptoms of this gene appear in early childhood, leading to overweight and idleness. Scientists are still investigating methods to control the gene carriers' eating habits; some medications have been developed, but are still being experimented.

To sum up, our eating habits are not necessarily a matter of choice, but are rather bound to compulsory factors, such as inherited genes. Some scientists confirm that studying a family's genetic history can help prevent its descendants from carrying such genes, consequently avoiding diseases associated with unhealthy eating habits.

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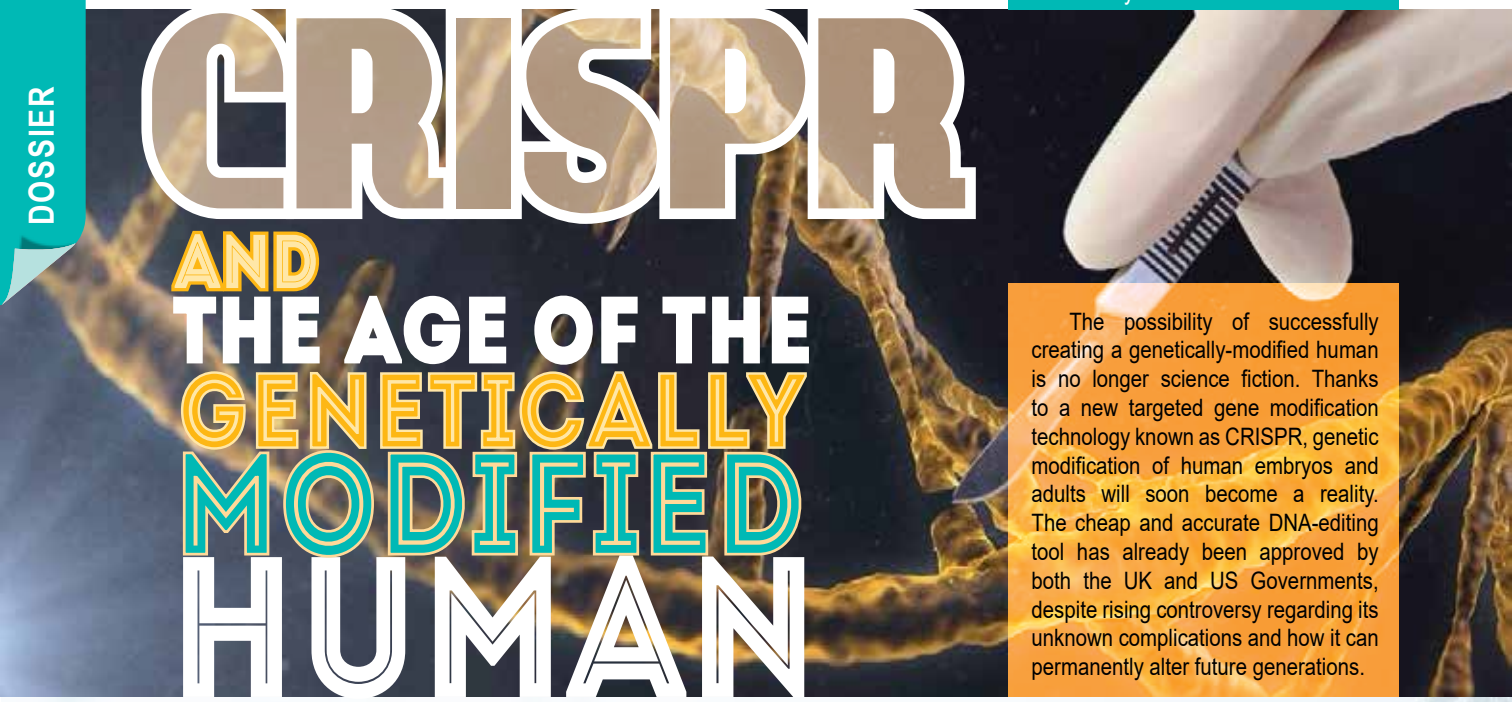
By: Lamia Ghoneim

CRISPR AND THE AGE OF THE GENETICALLY MODIFIED HUMAN



The possibility of successfully creating a genetically-modified human is no longer science fiction. Thanks to a new targeted gene modification technology known as CRISPR, genetic modification of human embryos and adults will soon become a reality. The cheap and accurate DNA-editing tool has already been approved by both the UK and US Governments, despite rising controversy regarding its unknown complications and how it can permanently alter future generations.

What is CRISPR?

CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeat. The name refers to the way short, repeated DNA sequences in the genomes microorganisms are organized. CRISPR was inspired by these organisms' naturally occurring defense mechanisms.

When bacteria become infected by a virus, they take pieces of the DNA virus and incorporate it into their own genome using an enzyme known as "Cas". These newly-formed sequences are known as CRISPR. The bacteria make RNA copies of these sequences, which help recognize the virus DNA and prevent future invasions.

In Fall 2012, a team of researchers led by UC Berkeley scientists Jennifer Doudna and Emmanuelle Charpentier announced that they had hijacked the bacteria's CRISPR/Cas immune system to create a new tool that enables the editing of genes, not only in bacteria but also in animals, plants and humans. Their CRISPR/Cas9 system involved CRISPR, a Cas protein called Cas9, and hybrid RNA that could be programmed to identify, cut, and even replace any gene sequence. The RNA acts as a "wanted poster"; it tells a bounty hunter enzyme called Cas9 where to look.

The enzyme scans the cell's genome to find a DNA match, then slices for the DNA in the cell's enzymes; to repair damage at that point, scientists can change or add DNA within the cell. By feeding Cas9 the right sequence or guide RNA, scientists can cut and paste parts of the DNA sequence, up to 20 bases long, into the genome at any point.

Why is CRISPR so significant?

The short answer is that CRISPR allows scientists to edit genomes with unprecedented precision, efficiency, and flexibility; more importantly, it is cheap. "The major impact of CRISPR has been in developing new model systems, cells, and animals, that are more rapid to develop and much more accurate than previous genetic models," Dr. Ed Wild, from UCL Institute of Neurology said.

Aside from having enormous implications for the study of human genetics and combating human diseases, CRISPR also has the potential to boost crop yields and create alternative fuel sources, as well as protect us from insect-borne scourges such as malaria and Zika. There is even a project to bring back the woolly mammoth from extinction using CRISPR technology. Further applications of CRISPR are appearing at a furious pace, and gathering momentum toward therapeutic use in human cells. Indeed, Chinese scientists recently began a human clinical trial using CRISPR-edited cells to fight lung cancer, and US clinical trials will begin this year.

CRISPR is already being used to edit pig DNA so that their organs can be transplanted into humans. Scientists at various institutions are also researching its use in human germ cells, including eggs, sperm, and embryos, which could confer major benefits. Namely, the technology could eradicate hereditary diseases, such as cystic fibrosis, sickle-cell anemia, and Huntington's disease from a family line altogether.

Why the Controversy?

Some experts are concerned about CRISPR in human genome editing for several reasons. Many feel that there are still too many unknowns about CRISPR, and that using it to edit human genomes is akin to humans attempting to play god. Beyond the effectiveness of the technique itself, there are ethical considerations, such as how to deal with altering the genetic material of future generations without their consent.

It is also necessary to consider another logical conclusion; that people might want to use gene-editing techniques to create humans with super strength, hyper-intelligence, or whatever other genetic traits people might desire. For good reason, such possibilities trigger fears of modified humans and designed babies. These weighty implications, as well as a charged, ongoing patent battle over who owns the technology, ensure that conversations around CRISPR will continue.

For now, answers to the big scientific and philosophical questions around CRISPR may remain unknown. What is clear, however, is that the five years since the first CRISPR studies, the technique has revolutionized biological sciences. With tremendous potential applications on the horizon, the next five years are sure to see even more CRISPR-enabled breakthroughs.

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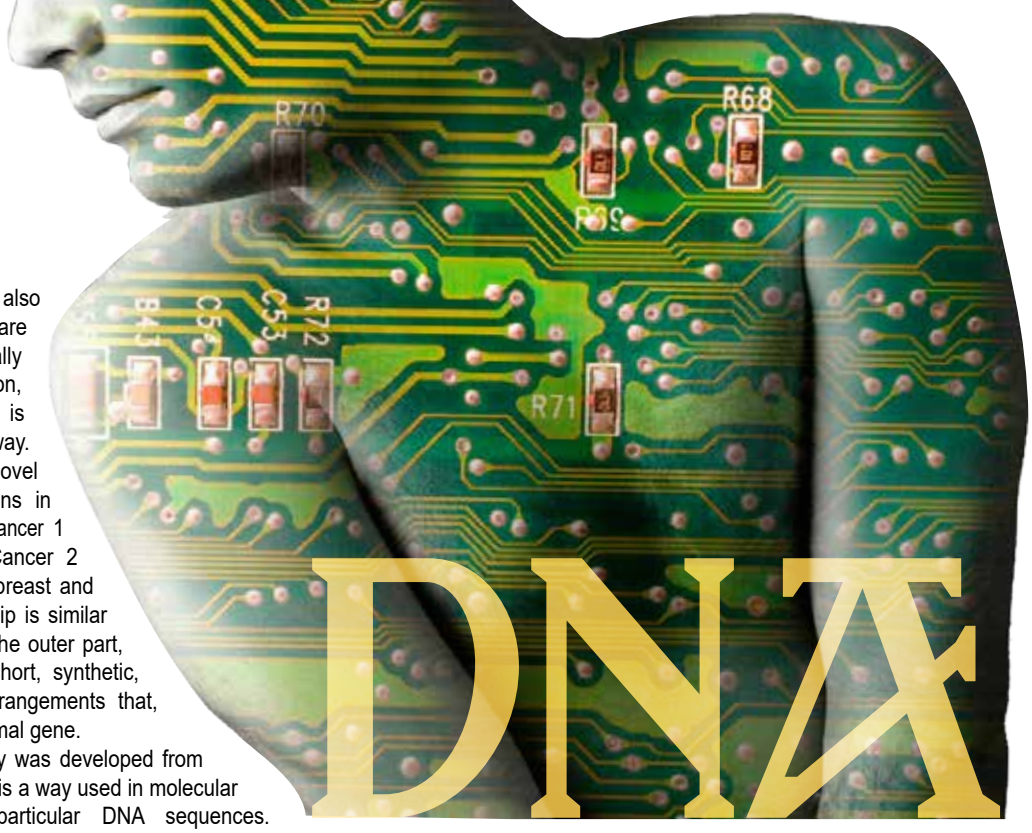

DNA MICROCHIPS

By: Mona Shehata

DNA microchips, also known as microarrays, are strong bases generally made of glass or silicon, upon which the DNA is added in an orderly way. The DNA microchip is a novel tool to analyze mutations in genes, such as Breast Cancer 1 (BRCA1) and Breast Cancer 2 (BRCA2), which cause breast and ovarian cancers. The chip is similar to a computer chip; on the outer part, every chip has many short, synthetic, single-stranded DNA arrangements that, as a group, form the normal gene.

Microchip technology was developed from Southern blotting, which is a way used in molecular biology to discover particular DNA sequences. Miniaturized microchips were first used in 1995; this technology relies on the use of machines and robots in delivering the DNA samples.

The microchip functions by getting a sample from the subject's blood and a control sample, which does not have any mutated genes, then scientists denature the DNA in the specimens. This "denaturing" is a method in which scientists separate the two interdependent DNA strands into single-stranded molecules. After that, they reduce the size of the long DNA strands into smaller easier-to-manage parts, marking each part by adding a florescent dye.

The patient's DNA is marked with a green dye, while the control is marked with a red dye. Both groups are introduced to the chip and permitted to hybridize to the artificial BRCA1 or BRCA2 DNA on the chip. If the patient does not have these gene mutations, both the red and green specimens will attach to the arrangements on the chip. However, if the patient has these mutations, their DNA will not attach normally in this area. At that time, the researcher can check this area more thoroughly to confirm the presence of a mutation.
There are numerous uses of DNA microchips:

1. **Disease Diagnosis and Genetic Engineering**: This sort of technology allows scientists to know more about various diseases, such as heart diseases, mental illnesses, and infectious diseases and to focus on cancer research. Cancer nowadays is classified according to the organ where the tumor grows, but using DNA microchips will enable scientists to classify it based on gene mutations in tumor cells. This will help in the production of specifically designed medicine that will target this particular cancer. Moreover, knowing the gene mutations that cause these diseases can help in their prevention using gene therapy and genetic engineering.

2. **Drug Discovery**: DNA microchip technology has a wide-ranging function in Pharmacogenomics, which studies the connection between therapeutic responses to drugs and the patients' genetic profiles. Comparative investigation of diseased and normal cells will aid in identifying the biochemical composition of the proteins created by the diseased genes. This enables researchers to formulate drugs that can fight these proteins and decrease their impact.

3. **Gene Discovery**: DNA microarrays aid in discovering new genes, and learning about the functional and expressional levels according to various conditions.

4. **Toxicology Research**: Toxicogenomics is the science that deals with the relationship between response to toxins and genetic profile mutations of the exposed cells. Microchip science provides a healthy research environment on the effect of toxins on the cells and the possibility of inheritance by the offspring.

Other advantages of these chips are that they provide information on many genes while only doing one test, as there is no more need to perform numerous tests. This test provides quicker and more accurate results. Microchips also help discover which genes are working in the various mitosis (cell reproduction) levels and which genes are working during growth (as fruit growth). This may be implemented in determining vital genes that maybe used as the foundation for a screen for expected cultivation decisions and choices.

Some disadvantages of DNA microchips are that they are costly to create, demanding many results need a lot of time for analysis, which is already a complicated process, and the chips are perishable and do not survive for a long time, which proves to be a huge disadvantage of this technology.

With the availability of new information and developments, researchers will be able to use microchips to pose more complicated questions and to carry out more difficult experiments, which in turn may lead to breakthroughs in the fields of disease diagnosis and drug discovery, amongst others, while working on decreasing the disadvantages.

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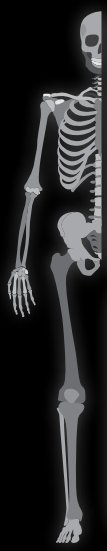
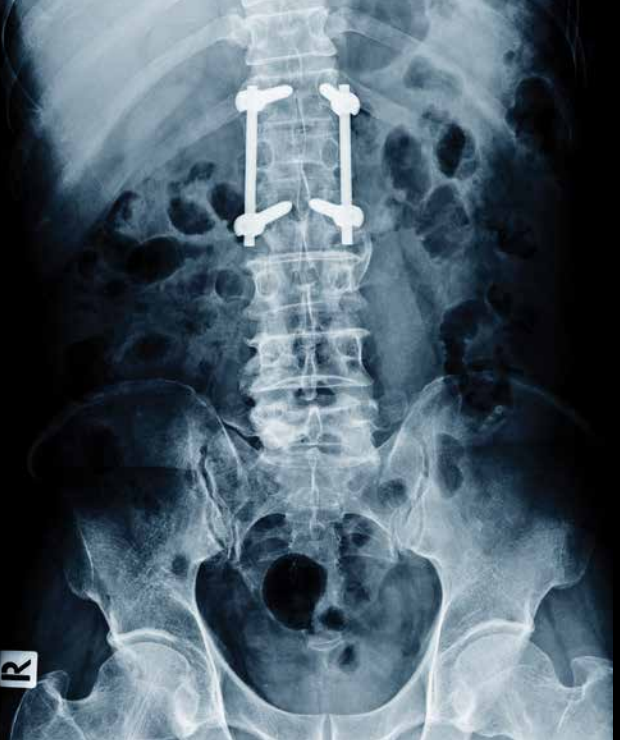


Bone Grafting

By: Jailane Salem



Technology has come such a long way that it has definitely entered all aspects of our lives; one of the fields that have developed by leaps and bounds is the medical field. Surgical procedures are nothing like what they used to be in the past, which is great news for us, since we do not have to rely on someone forcefully, holding us down while we get a medical procedure done. Nowadays, it all comes down to precision, whether it has to do with testing to find out what is wrong with you, or how to target that specific health issue in order to fix it.

One of the issues that used to stump physicians were bone injuries; in order to fix them, bone grafting emerged, greatly revolutionizing bone treatment. Grafting is a horticultural method that joins two different plants through their tissues, so that they continue to grow as one. This is the same idea behind bone grafting; it aims at transplanting bone tissue into an affected area. This method has allowed many people who would have otherwise spent the rest of their life suffering to have a chance at fully healing.

There are various problems that bone grafting can address, such as bone fractures, damaged joints, bones suffering from trauma that did not heal properly, lost bones due to infection or disease, and giving better support around an implanted device by growing bones. If the treatment is successful, patients are left with completely regenerated bones that are well and fully integrated in its surrounding region.

Not all transplanted grafts are the same; there are three different kinds of bone grafts that can be transplanted: an autologous bone graft is one that is taken from a person's own body; an allograft is one that comes from a donor; and an artificial bone graft is one that is made in the lab. After bone grafts are transplanted, they are eventually reabsorbed into the body; thus, bone and graft become one. Sometimes, the body rejects the transplant, causing complications; as with any other kind of transplant, you are never fully sure that the body will accept it. However, this procedure does have a high success rate and numbers show that bone graft procedures are on the rise, meaning that they are an effective treatment option.

There is a collaboration to create new bone grafting material between researchers from American and Chinese universities. What is innovative about their research is the source material they are using to create artificial bone grafts. They are researching the possibility of using a sea urchin's spine as material for bone grafts, because they have a structure that is very similar to human bones. Researchers started looking into sea urchins to try and find an alternative to the synthetic material known as hydroxyapatite, which has caused issues in bone transplants, because it is brittle and weak, and when dislodged from the bone graft could cause inflammation.

The research is led by Lei Cao from the Chinese Academy of Sciences in Beijing. He wanted to create a stronger scaffold from the sea urchin spine, and used a hydrothermal reaction to convert the spines into biodegradable scaffolds. This allowed the spine to retain its shape, while becoming a more appropriate scaffold for bone grafting. After creating this hybrid scaffold, the research team tested it out on rabbits, which had damaged femurs. The rabbits had transplants using the newly-created urchin spine as a bone graft; the results were impressive as studies stated: "New bone grew after one month. By three months, the rabbits' own bone and the scaffold had fused together nicely. By seven months, the scaffold was almost entirely degraded and replaced by the rabbit's own bone".

The success of this research bodes well for the future of bone grafting. As researchers continue looking for suitable lightweight material well suited for bone repairing, the possibilities are endless.

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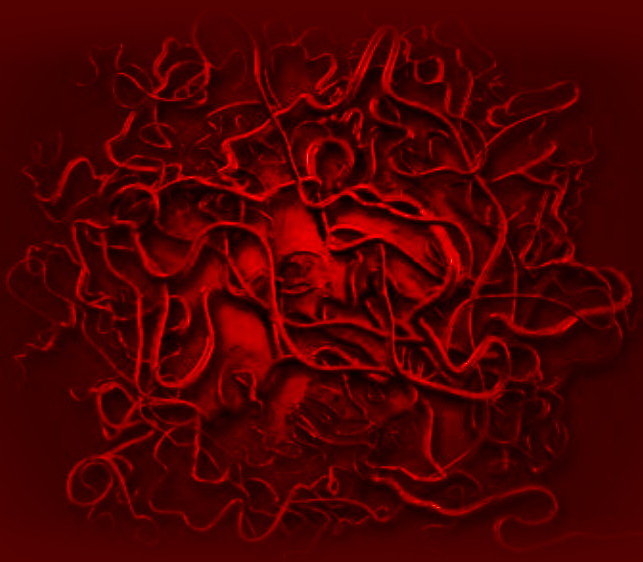
By: Soha Elborgy

3D Printed Vasculature Networks Created



Technology is deeply entrenched in every aspect of our lives. Researchers in the field of 3D printing technology have been actively attempting to come up with new methods to artificially create lifelike blood vessels that can fully function in the human body.

Up until recently, 3D printing technologies have been slow, costly, and are only capable of producing single blood vessels; a tube that still does not integrate with the body's own vascular system. However, that has changed; thanks to technology.

Nanoengineers at the University of California, San Diago, led by Dr. Shaochen Chen, a nanoengineering Professor, have dived into a major challenge in tissue engineering. They have managed to 3D-print lifelike tissues and organs with functional vasculature, which are networks of blood vessels that can transport blood, nutrients, waste, and other biological materials, and perform those functions safely when integrated in the human body.

Human tissues and organs require blood vessels to survive and function properly, and this is where organ transplants, which are high in demand and short in supply, become problematic. The technology boost in the science of tissue engineering can be the reason for great change. Chen's lab has artificially created a vasculature network that can safely implant with the body's own vessel network to circulate blood. These blood vessels then branch out into much smaller vessels, similar to the blood vessel structure in the body.

The team of scientists developed an innovative bioprinting technology, using their own homemade 3D printers, to rapidly produce 3D microstructures that act like the sophisticated designs and functions of biological tissues. Chen's lab has made use of this technology in the past to create live tissue and microscopic fish able to swim in the body and remove toxins.

A lot of effort goes into the creation of this tissue. First, a 3D model of the biological structure is designed on a computer. The computer then transfers 2D snapshots to millions of microscopic-sized mirrors, which are each digitally controlled to project patterns of UV light in the form of these snapshots. The UV pattern is then exposed to a solution containing live cells and light-sensitive polymers that solidify upon exposure to UV light. The structure is then printed layer by layer, creating a 3D solid polymer structure encapsulating live cells that will grow into biological tissue.

Unlike other 3D printing technologies, which produce pixelated structures and require sacrificial materials and additional steps to create the vessels, Chen's lab 3D printing technology print detailed microvasculature structures in extremely high resolution. The team used medical imaging to create a digital pattern of a blood vessel network found in the body. With their technology, they printed a structure containing endothelial cells—the cells that form the inner lining of blood vessels. The entire structure fits onto a small 4×5 millimeters and 600 micrometers thick.

This lengthy process actually takes a few seconds. This made the new technology an enormous improvement over competing bioprinting methods, which normally take hours to print simple structures. Besides, the new method uses materials that are inexpensive and biocompatible.

The researches grafted the resulting tissue into skin wounds of mice. Two weeks later, the researchers examined the implants and noticed that they have successfully merged with the host blood vessel network, allowing for normal blood circulation. The presence of red blood cells throughout these fused vessels provided strong evidence that blood was able to circulate through them.

However, Chen noted that the implanted blood vessels are not yet capable of some functions; such as transporting nutrients and waste. Although this new technology is a breakthrough in the future of tissue regeneration and repair, improving these materials still needs a lot of work.

Chen and his team are working on building patient-customized tissues using human induced stem cells, which would prevent transplants from being attacked by the human immune system. Since these cells will be taken from the patient's skin cells, researchers will not have to extract any cells from inside the body to build a new tissue.

Submitting their work for clinical trial is the team's ultimate goal and it will take several years to reach that goal. That is why we will eagerly await the day organ transplants become high in supply as it is in demand. We are hoping this will end the long patient waitlists for organ transplants. The breakthrough is a major turning point in the history of science.

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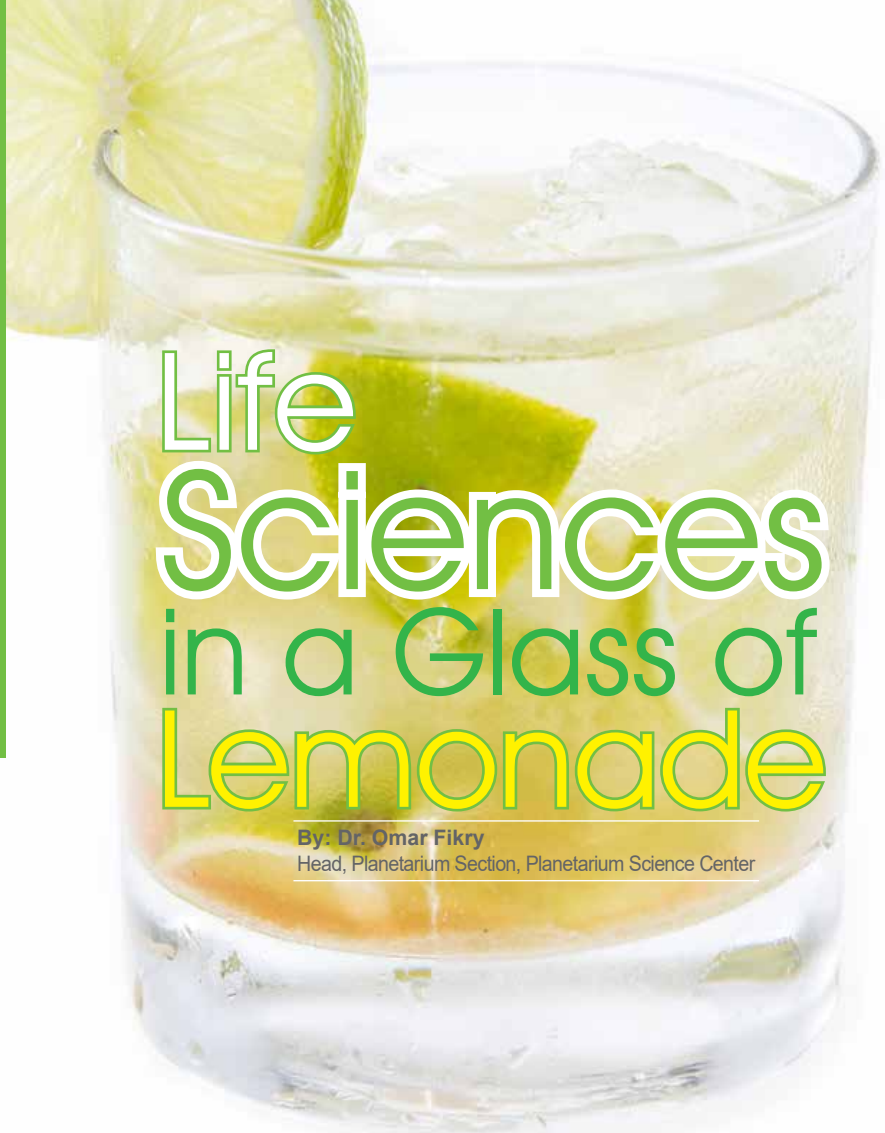


Life Sciences in a Glass of Lemonade

By: Dr. Omar Fikry
Head, Planetarium Section, Planetarium Science Center

As summer approaches with its suffocating weather, the need to drink water and cold juices increases to counter dehydration. One day when the weather was unbearably hot, upon my return from work, my daughter offered me a glass of lemonade with ice cubes in it. I hastily and delightedly drank to quench my thirst; I thanked God, then my daughter, for this lemonade that was just in time. However, before I put down the glass, I looked at the remains of lemon lying at the bottom in contemplation and a question came to my mind, so I asked my daughter: "Do you know how many branches of science are in this lemonade?"

My daughter smiled and eagerly replied: "An interesting question, father. I think I know the answer: there are chemistry and physics". However, I added: "In addition to astronomy and biology" which surprised my daughter. She wondered: "How could astronomy and biology be in a glass of lemonade?" My reply was: "If you tell me how chemistry and physics are, then I will answer your question".

She agreed and proceeded: "Lemonade is composed of water, sugar, and lemon; these are three elements different in nature and chemical properties. On one hand, water is a transparent liquid that has no taste, color, or smell; while sugar, or sucrose, is derived from fructose in sugarcane. Both are organic substances formed of carbon and hydrogen; on the other hand, lemon juice is citric acid, so the chemistry lies in understanding the dilution process of sugar in water, while lemon granules remain undiluted. As for physics, it lies in the dilution process and the shape of the juice's surface."

I was delighted with her understanding of these seemingly complicated and unpleasant issues; I added: "You forgot to mention the condensation of water vapor on the glass". She said: "You are right, father; now, let me continue. Sugar dissolves in water because both are polar hydrogen bonds. Water molecules attract hydrogen atoms in sucrose, because its atomic volume is very small; water, thus, turns into positive ions and sucrose into negative ones. An electrical attraction, thus, occurs, where sugar particles dissolve in water and the solution remains colorless. Sugar can be detected in water by taste; however, when sugar exceeds a certain density, the solution will become saturated and excess sugar will precipitate at the bottom.

Citric acid, on the other hand, is weak and anhydrous, yet highly soluble in water. Its molecules take the form of white, transparent crystals, but they remain suspended in water, giving it the familiar color of lemonade. Physics also interprets the reasons the atomic volume of citric acid molecules is too large, so they do not dissolve in water, because water molecules cannot take the hydrogen atoms from it".

My daughter carried on: "Physics is also found in the concave surface of the glass, which illustrates surface tension or the difference in the attraction forces of the particles in the middle of the glass as opposed to those by the sides. Moreover, physics is in the condensation of water vapor in the air, which is a result of the difference in the temperatures of the lemonade inside the glass and the air. Father, it is your turn now to explain how astronomy and biology are in the lemonade".

I immediately asked her: "Where do we get sugar and lemon?" She replied: "From sugarcane and lemon trees". I then explained: "If it were not for the distance between Earth and the Sun, and Earth's rotation around the Sun, plants could not have survived. The shortest distance between Earth and the Sun is 147 million kilometers, while the farthest is 152 million km. This variation is known as the Astronomical Unit (AU), which plays a major role in the process of germination.

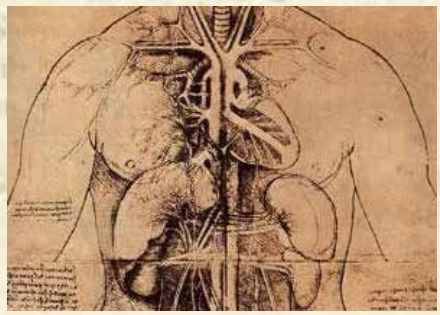
Furthermore, biology can be observed in the process between plants and the Sun: photosynthesis. When you read about the method or the interpretation of this wonderful phenomenon, by which plants convert energy from the Sun to form food from water and protein found in the soil, you will be totally impressed".

My daughter got up, saying: "Well father, since you mentioned food, it is time for lunch!" I could not help commenting: "Then let us see how many branches of science are there on the dining table today". She quickly replied with a smile: "Father, do you always think about everything that way?" I said: "I wish we all do, as science is life!"

"Physics is also found in the concave surface of the glass, which illustrates surface tension or the difference in the attraction forces of the particles in the middle of the glass as opposed to those by the sides."

Continued from page 9

The ANATOMIST and the Artist



Yet, because he never published his far-sighted research, this remained unknown for centuries. “This was not understood until the 20th century” says Wells, “when it was shown most beautifully in Nature in 1968 by two engineers in Oxford; there was only reference to Leonardo da Vinci”.

“There were lots of investigative anatomists around at the time, and there were lots of artists who were interested in anatomy,” says Martin Clayton, head of prints and drawings in the Royal Collection, and the curator of the Edinburgh exhibition, “but Leonardo pushed these two things further than anybody else. He was the supreme example of an anatomist who could also draw, or of an artist who was also a very skilled dissector. It was the union of these two skills in a single figure that made Leonardo unique”.

In the centuries after Leonardo’s death in 1519, the approximately 6,500 surviving sheets from his voluminous notebooks were dispersed. By 1690, nearly all of his anatomical studies were held in the Royal Collection, where they languished, unappreciated and unpublished, until end-19th century. As a result, Leonardo’s stupendous anatomical discoveries had no impact whatsoever on the history of science.

Throughout his life, Leonardo da Vinci remained a researcher of visual observation. It is precisely through this observation—and his own genius—that he developed a unique “theory of knowledge” in which art and science form a synthesis. His intellectual force, inherent in every one of his creations, is a force that continues to spark scholarly interest today. Whether the subject is his life, his ideas, or his artistic legacy, Leonardo’s influence shows little sign of fading.

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VISITORS INFO

Planetarium

Available Shows

Enlightened Mind
19 min.

The Mission
24 min.

Stars Show
45 min.

Oasis in Space
25 min.

Stars of the Pharaohs
35 min.

Seven Wonders
30 min.

The Life of Trees
33 min.

Kaluoka’hina:
The Enchanted Reef
35 min.

To Space and Back
25 min.

Alexandria, The Cradle of Astronomy
22 min.

- For the Planetarium daily schedule and fees, please consult the Center’s official website: www.bibalex.org/psc
- Kindly note that, for technical reasons, the Planetarium maintains the right to cancel or change shows at any time without prior notification.

History of Science Museum

Opening Hours
Sunday–Thursday: 9:30-16:00
Saturday: 12:00-16:00

Guided Tours Schedule
Sunday–Thursday:
10:30, 11:30, 12:30, 13:30, 14:30, 15:30

- Museum entry fees are included in all Planetarium shows tickets.
- For non-audience of the Planetarium, Museum entry fees are EGP 2.-
- Museum Tours are free for ticket holders.

ALEXploratorium

Discovery Zone

Opening Hours
Sunday, Monday, Wednesday, Thursday: 9:30-16:00
Tuesday: 9:30- 12:30
Saturday: 12:00-16:00

Guided Tours Schedule
Sunday, Monday, Wednesday, Thursday:
10:00, 11:00, 12:00, 13:00,14:00, 15:00
Tuesday: 10:00, 11:00
Saturday: 12:00, 13:00, 14:00

Entry Fees
Students: EGP 5.-
Non-students: EGP 10.-

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 2.-
Non-students: EGP 4.-
3D shows:
Students: EGP 5.-
Non-students: EGP 10.-
12D shows:
EGP 20.-

LOOK WHO'S TALKING!

Check out the articles on pages 10 and 11.

Illustrated by: Mohamed Khamis