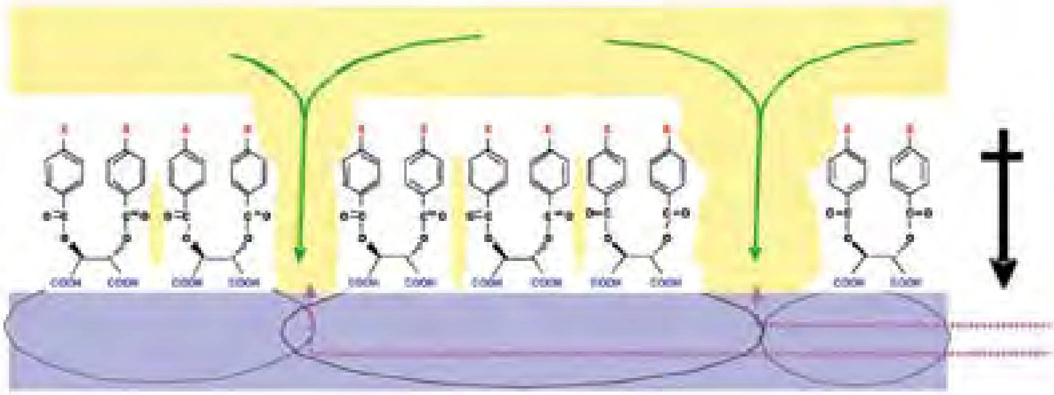
2000

After four decades of various attempts to crack the structure of the ribosome – the protein factory of the cell – a Weizmann Institute scientist, together with researchers from Germany, succeeded in solving the 3-D structure of one of its two subunits, followed by the second subunit the next year. The discovery was the result of a long and determined effort to coax the ribosome, a complex, dynamic and unstable structure made of proteins and RNA, into crystalline form that could be revealed through X-ray crystallography. *Science* magazine heralded the finding as a breakthrough for the year 2000.

2000

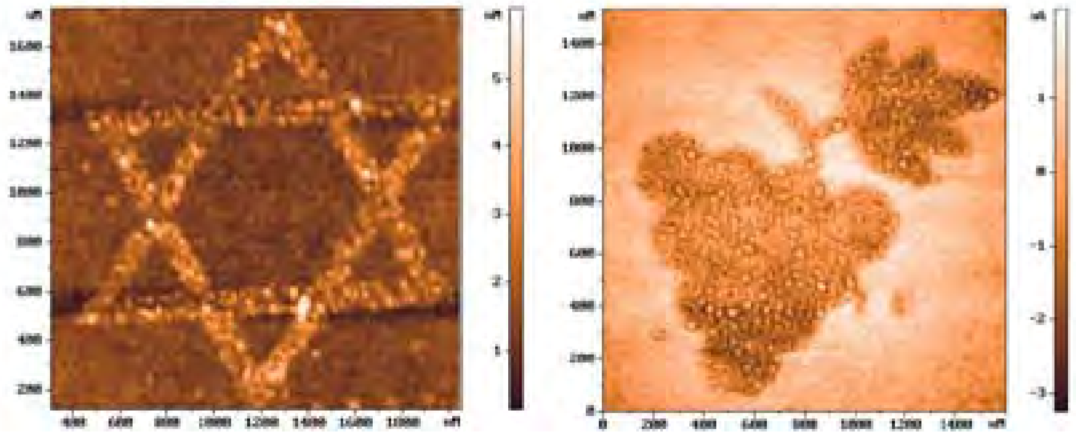
Organic molecules could be used to make inexpensive, versatile, miniaturized electronic components, but some problems remain to be solved. One of these is the small holes between molecules that affect the flow of electricity. A team of Weizmann Institute scientists created a one-molecule-thick layer of organic molecules that allows current to pass between the molecules without affecting them, circumventing one of the major problems for molecular devices – that of the molecules' stability.



Silver Nanograins Grown on a Patterned Molecular Layer

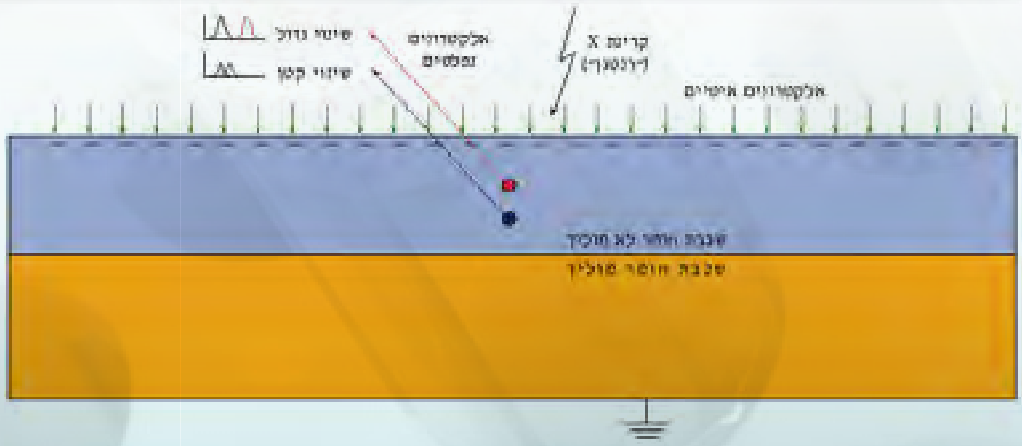
2000

Today's microchips are etched onto existing materials, but tomorrow's nanoelectronics, if they are to be smaller, will be assembled from the bottom up, from atoms and molecules. Institute scientists used an atomic force microscope to "write" on a single layer of molecules deposited on silicon surface. The molecules activated by the microscopic tip encoded information that could be read back in the same microscope. The initial layer was able to bind to other atoms and molecules, adding further layers of densely-packed information.



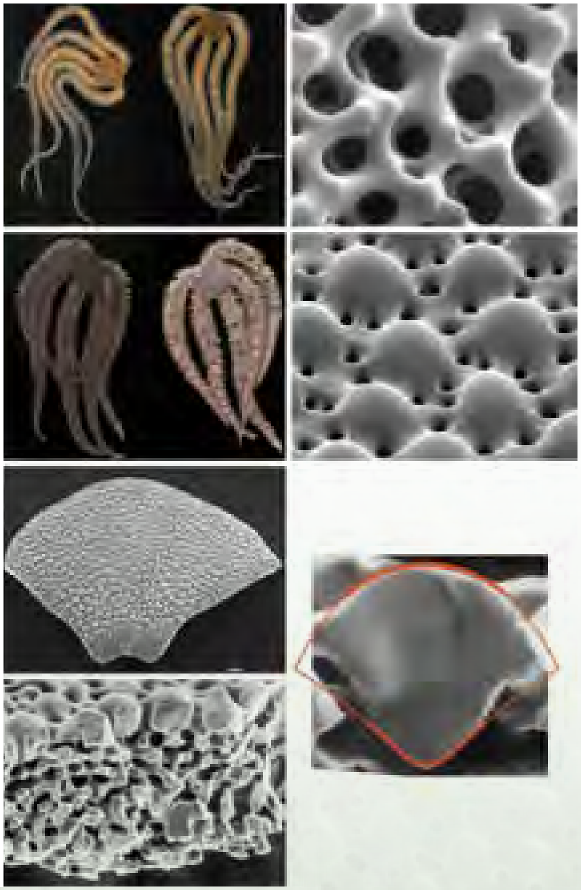
2000

Films only a few nanometers thick are used in a number of applications, including optoelectronics and biosensors. These uses rely on near absolute precision, yet techniques for determining their composition often distort the sample. Institute chemists turned a method for determining which atoms are on a sample surface on its head: The researchers had flooded the sample's surface with electrons to overcompensate for the change in charge when photoelectrons are ejected by X-rays. They realized that these low energy electrons could cause changes in the energies of the freed photoelectrons that would give them information about the atoms' depth in the film with nanometer resolution.



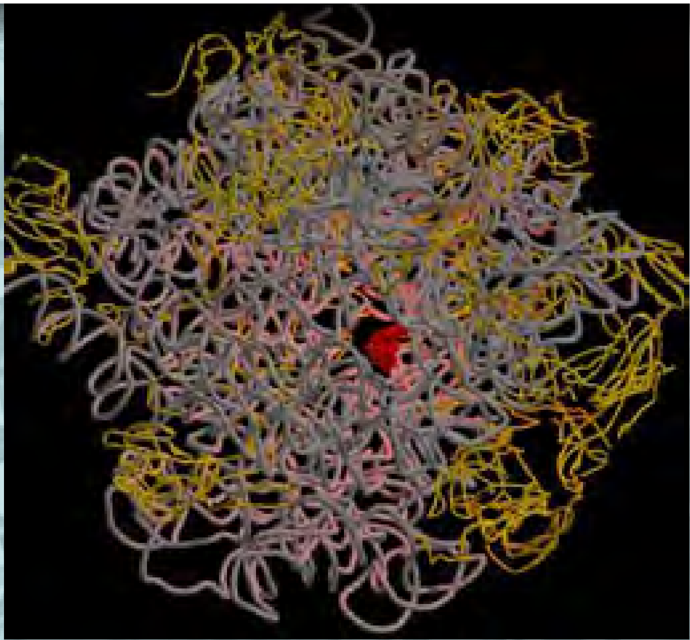
2001

The brittlestar, a starfish-like marine animal, has no eyes, yet it can detect shadows and escape from predators. Scientists had suspected that these creatures "see" through hundreds of crystals arrayed on their outer skeletons. Weizmann Institute scientists investigated the properties of these crystals and found that they are, indeed, lenses that both enable the brittlestar to perceive light and provide structural support. These lenses, hundreds of which are formed from a single calcite crystal, have provided inspiration to engineers working on miniaturized optical arrays.



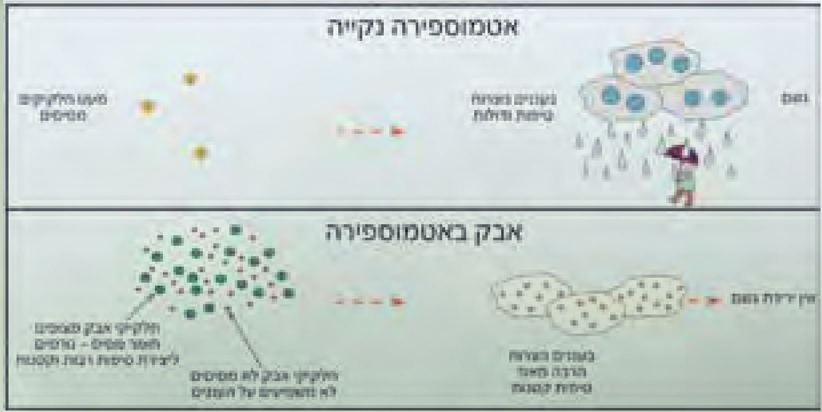
2001

A number of antibiotic drugs work by binding to bacterial ribosomes, preventing them from producing necessary proteins. With the determination of the 3-D structure of the ribosome, Institute scientists, together with German colleagues, revealed the exact actions of five different antibacterial drugs. These findings may lead to the design of better antibiotics.



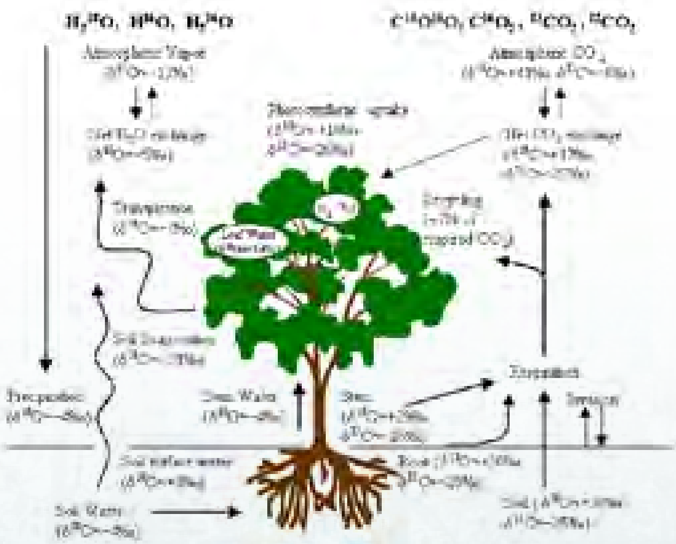
2001

The dust raised in giant sandstorms gets blown into the atmosphere, where it can act as seeds around which cloud droplets form. Institute scientists showed that the mineral make-up of the dust can affect rain formation. Using a chemical analysis of the dust combined with satellite data, they showed that the chemistry of the dust particle was the key: Particles that were naturally coated with soluble sulfur were those that suppressed rain formation.



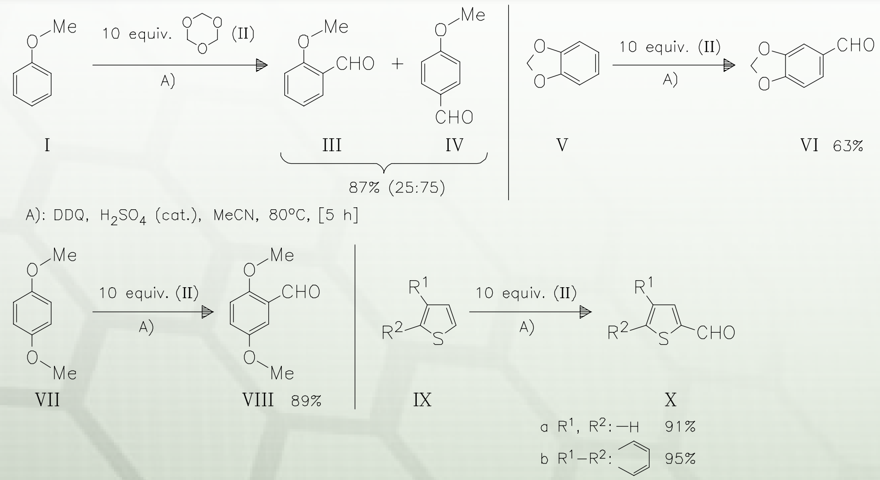
2001

Carbon dioxide is spewed into the atmosphere by fuel burning and natural decay, and absorbed by oceans and plants. How much of the 6.5 billion tons of CO_2 that enters the atmosphere each year is “inhaled” by plants? Weizmann Institute scientists developed a two-part method for getting an accurate picture of this uptake. The first is based on the fact that plants prefer CO_2 that contains the light oxygen isotope O16: Atmospheric ratios of molecules containing O16 to O18 reveal how much is locked up in plants. The second part takes into account rates of CO_2 absorption in different types of plants.



2002

Institute chemists are world leaders in the field of green chemistry. One team managed to create chemicals called aromatic alkenes, used to produce non-steroidal anti-inflammatory drugs, from simple materials and oxygen from air, using a metal-based catalyst. The end products were aromatic alkenes and water, with no waste generated. Another research group used a similar metal-based catalyst to create a common compound used in plastics in a simpler, safer, cleaner and more energy-efficient manner. In 2007, an environmentally-friendly, efficient method for producing amide bonds, essential in many synthetic and biological materials, was recognized by *Science* magazine as a “breakthrough of the year.”

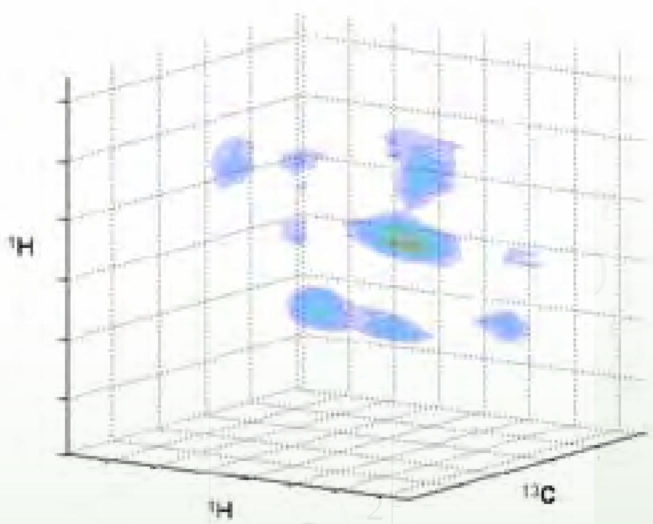


2003

The bacterium *Deinococcus radiodurans* can withstand three thousand times more radiation than humans. How does it do it? A team of Institute scientists found the microorganism has several survival strategies: Its DNA is packaged in a tight ring that keeps broken bits in place, where the DNA repair machinery can easily stitch them back into the strand. In addition, the bacterial cell contains four copies of the DNA, and after a repair job, the DNA checks itself against another copy. At least two of the copies are huddled in protective ring formation at any one time, so there's always a safe "backup."

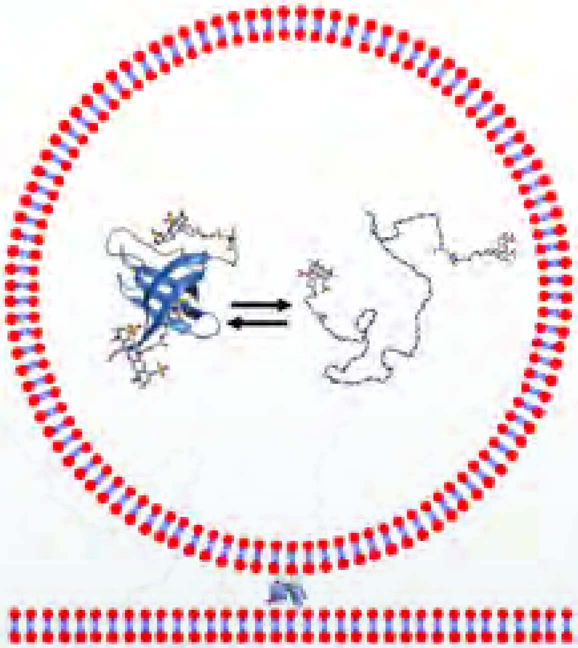
2003

Nuclear magnetic resonance (NMR) creates molecular images by measuring and interpreting the electromagnetic waves that atoms emit when placed in magnets. Collecting the data needed for obtaining three-dimensional images used to involve hours of data recording, until an Institute scientist developed a new approach to NMR whereby all the measurements involved can be performed at once — and completed within a fraction of a second. This method is currently being further developed for commercial and scientific use.



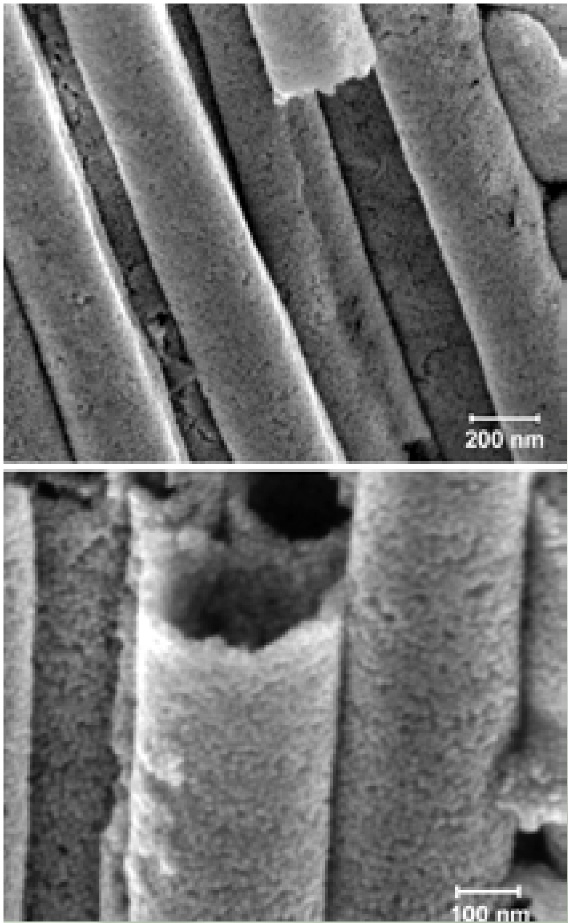
2003

To do their jobs, proteins fold up into intricate shapes. A team of Institute scientists managed to capture the stages of folding by following protein molecules one molecule at a time. They first trapped these molecules in vesicles, similar to small cells, in which they were free to move about. The vesicles could be attached to a surface and lit by laser, giving the scientists a clear optical signal showing the status of the encapsulated proteins. They found that the folding of these molecules is a very individual process – each taking a different route to arrive at the same final shape.



2003

Move over carbon nanotubes: Weizmann Institute chemists fabricated nanotubes from gold, silver and other metals. The team created the tubes unexpectedly when pouring metal nanoparticles through an aluminum oxide template studded with nano-sized pores whose walls had been chemically modified. The particles stuck to the pore walls and to each other, forming porous tube shapes that can be released from the template. Although the metal tubes lack carbon nanotubes' extraordinary strength and are larger in diameter, they have other unique properties (high surface area, metallic conductivity) that may make them ideal for a number of uses, such as catalysis and biomedical applications.

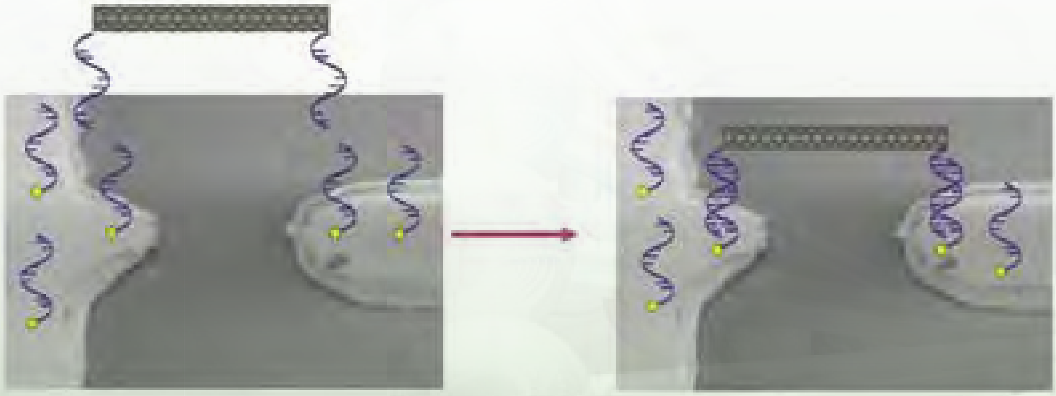


2004

Enzymes can act in a fraction of a second. Scientists solving an enzyme structure had the equivalent of a still photo, but a better understanding of its workings was still needed. Institute researchers succeeded in turning the "still photos" to "movies." They developed an innovative technique to capture the molecular configuration at each stage and assemble them into live-action-type footage. Their first "film" was of an enzyme involved in cancer metastasis, and it suggested stages at which blocking the enzyme's actions might be possible.

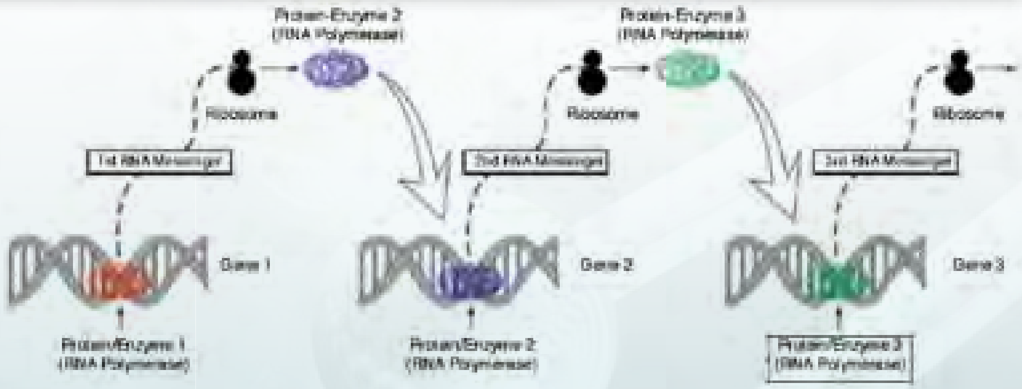
2004

DNA has found a new use in the field of nanoelectronics. Proof that these biological molecules might be used to assemble miniscule components came when Institute scientists created DNA strands that attached to tiny gold electrical contacts at one end and carbon nanotubes at the other, producing a minute transistor.



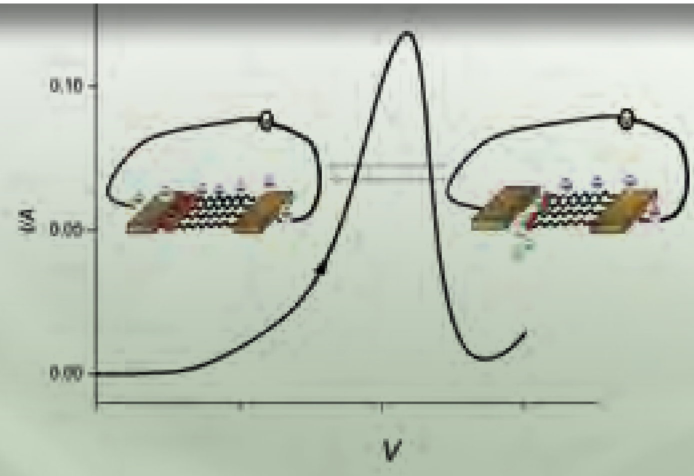
2004

Genes – "hardware and software rolled into one" – are smaller and more efficient than today's electronics engineers can even dream of. An Institute scientist decided to make use of nature's components, evolved over billions of years, to create circuits similar to electronic circuits. These circuits were the first to include multiple genes, each of which activates or deactivates other genes in the system, as well as various biological molecules. Gene circuits might eventually be able to perform more complex operations than the "yes or no" functions of electronic circuits, and may also pave the way to unique biosensors.



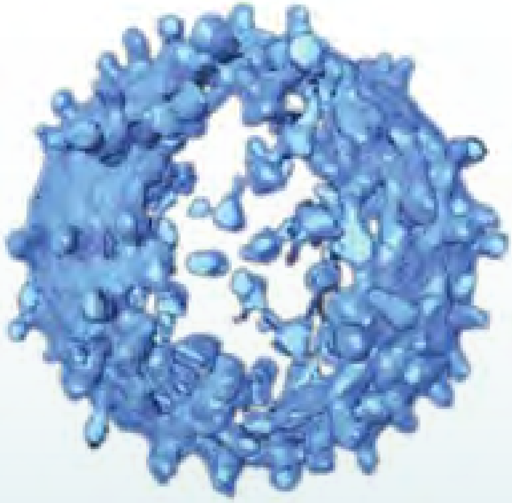
2005

To design a nanoswitch, Institute scientists began with the chemistry of the bonds between organic molecules and metal wires. Their research had shown that a chemical bond, in which electrons are shared between molecules and metal, causes the current flowing through them to be many times higher than if the two are merely touching. With this insight, they designed a special type of switch used in electronics, in which the current peaks and then drops off as the voltage increases. In the nanoswitch, the drop occurred when a chemical change in the organic molecule switched the bond from chemical to physical.



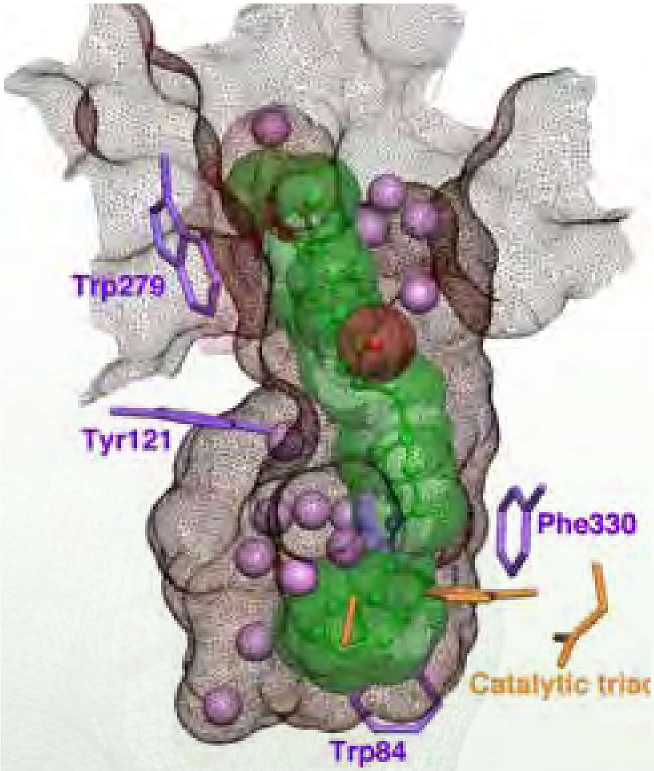
2005

Retroviruses such as HIV and leukemia viruses must get inside cells to replicate their DNA and cause infection. To accomplish this, they fuse their outer envelopes with the cell membrane. Institute scientists, working with German colleagues, succeeded in capturing the first 3-D images of a retroviral envelope protein complex that initiates fusion. The protein complex was unlike those known from other viruses. The findings have given the scientists some important clues to the mechanism of infection, and may aid in the design of drugs to block that process.



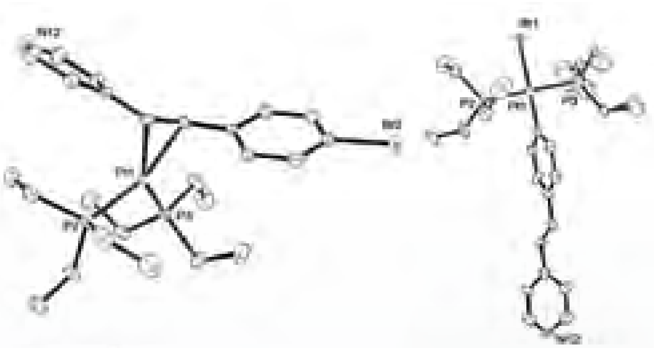
2005

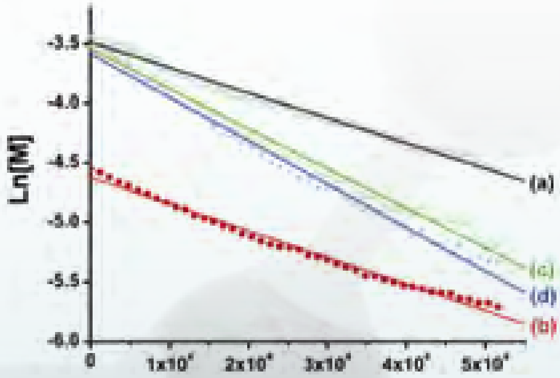
Weizmann Institute scientists showed exactly how one drug for colon cancer causes devastating side effects such as nausea, vomiting and diarrhea. The drug only becomes activated when one of the body's enzymes snips off a part of the drug molecule, and the scientists suspected that the side effects might be caused by an interaction with another, similar enzyme. They captured images of this drug in the act of binding to the second enzyme, AChE, and saw how a misfit caused the drug molecule to stick inside the enzyme structure. These findings may help researchers to design a side-effect-free drug molecule.



2005

Do metal complexes walk their way to chemical reactions? Institute chemists used NMR to track platinum complexes as they "walked" around the six-sided carbon rings in organic molecules before reaching the reaction sites. Understanding the routes these complexes take may result in new methods to control chemical reactions involving metals and organic molecules.



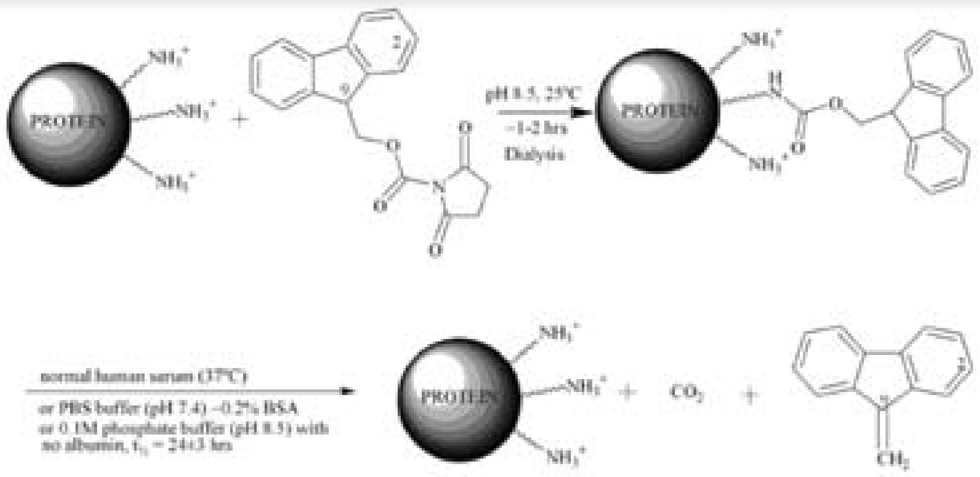


2005

The results of Weizmann Institute experiments in generating hydrogen fuel in a solar-energy-based process were presented at the Solar World Congress of the International Solar Energy Society. A consortium of European research institutes and industries joined WIS to investigate scaling up the technology, which involves a chemical reaction of zinc with water and recycling the resulting zinc oxide in a solar plant. Institute scientists are already researching the use of solar energy to purify other metals for generating hydrogen via reactions with water in controlled manner.

2005

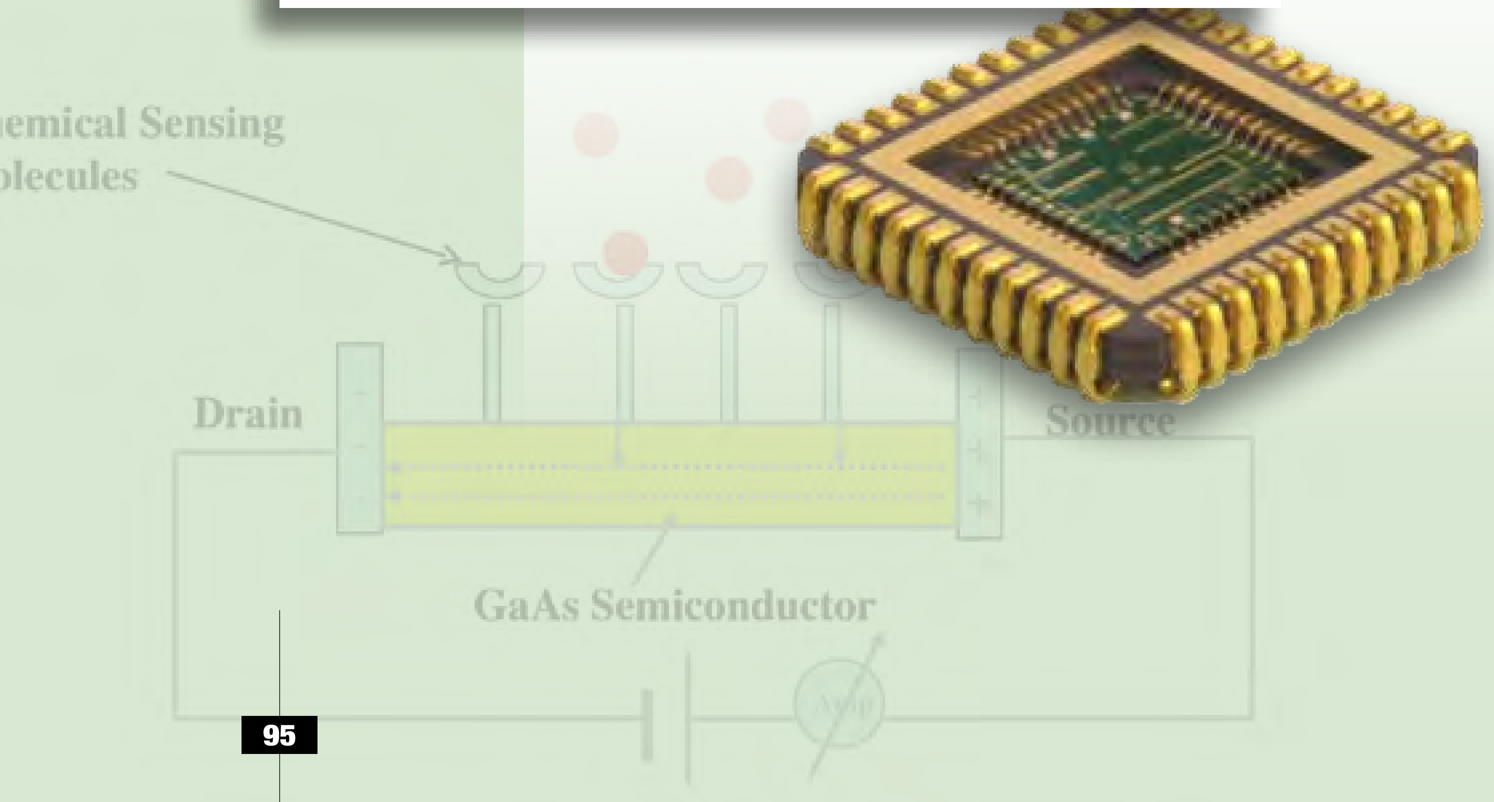
Many small proteins or protein fragments might be effective drugs, but they're cleared from the body too quickly to work properly. Adding mass to the protein can keep it in the bloodstream, but this also generally renders it inactive. The trick, discovered Institute scientists, is to design molecular "chains" that weigh down the protein temporarily. They designed connecting links to chain-like molecules of polyethylene glycol that dissolve slowly in the bloodstream, freeing the light drug molecules over a period of hours or days. In tests, one injection of a drug for Type 2 diabetes kept down glucose levels in rats for three days.



Molecular Controlled Semiconductor Resistor (MOCSER)

2005

Weizmann Institute scientists developed a tiny sensor based on organic molecules that can detect problems from asthma to hidden explosives. The sensor, named MOCSER (MOlecular Controlled SEmiconductor Resistor), is already being developed as a diagnostic tool to detect levels of nitrous oxide that could signal an asthma attack in exhaled breath. So small that 28 can fit on a standard computer chip and able to detect substances down to a few hundred molecules, MOCSER technology may find uses from border security to pollution control.

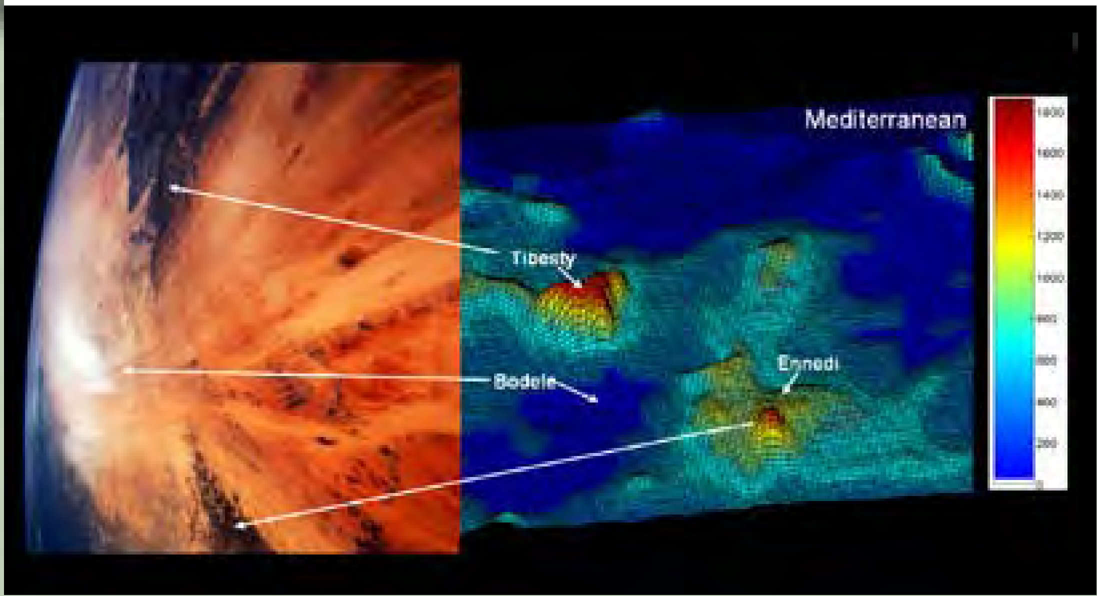


2006

Tests for trace amounts of water in other substances are complicated and time-consuming, but they're often necessary for industrial and scientific processes. With a new method of detection, an inexpensive and easy test might be done in around five minutes. The water sensor devised by Weizmann Institute scientists consists of metal complexes imbedded in a thin film deposited on a surface such as glass. The metal complexes "steal" electrons from the water, which then change the film's color. Levels as low as a few parts per million can be detected by this method.

2006

Without a steady supply of African dust blowing across the Atlantic, the Amazon might be a wet, but largely barren desert. An Institute scientist revealed that a valley in Chad comprising just 2% of the Sahara's area supplies 56% of the many millions of tons of mineral-laden dust reaching the Amazon each year. The reason: The valley's funnel-like shape creates of giant wind tunnel that accelerates air currents.



2006

A bacterial protein turns out to have talents it never uses. Scientists studying a protein used by certain bacteria to convert sunlight into energy found that it is also an excellent conductor of electricity. The protein, called bacteriorhodopsin, is related to light-capturing proteins in our eyes. Normally this protein reacts to light by pumping protons across the bacterial cell membrane. The scientists showed that the light reaction in a specific segment of the protein could also induce it to conduct an electrical current that is tens of thousands of times stronger than that which would be expected in a protein.

2006

HIV, the virus that causes AIDS, continuously mutates, affecting the type of cells it infects and the progression of the disease. Institute scientists investigated the two major types of the virus. They found that the difference came down to a lineup of amino acids on a hairpin-shaped structure. The replacement of a negatively-charged amino acid with a positively-charged one caused one arm of the hairpin to shift position, changing the topography of the surface used by the virus to bind its target cells. This minor change in protein shape caused the virus to attack a different type of cell.

Human Immunodeficiency Virus (HIV) Anatomy

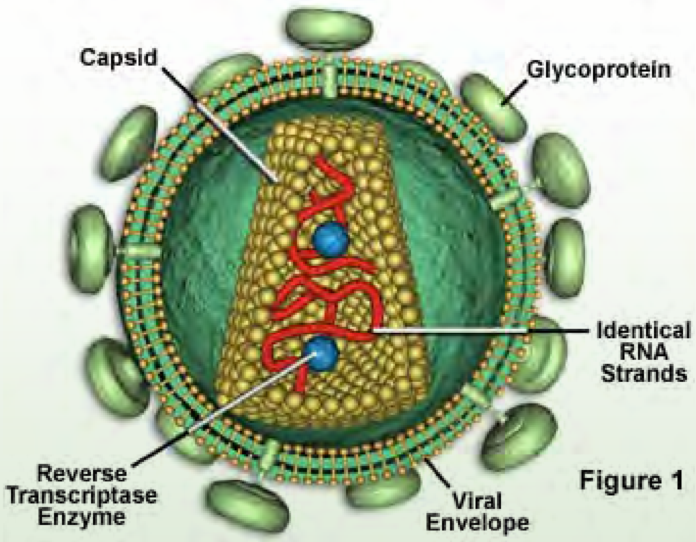
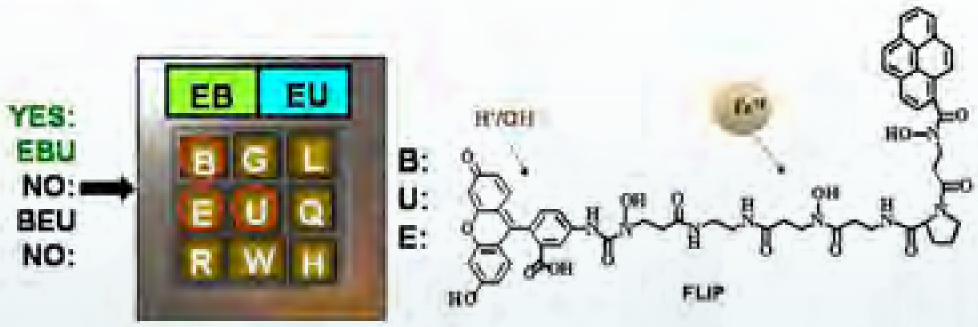


Figure 1

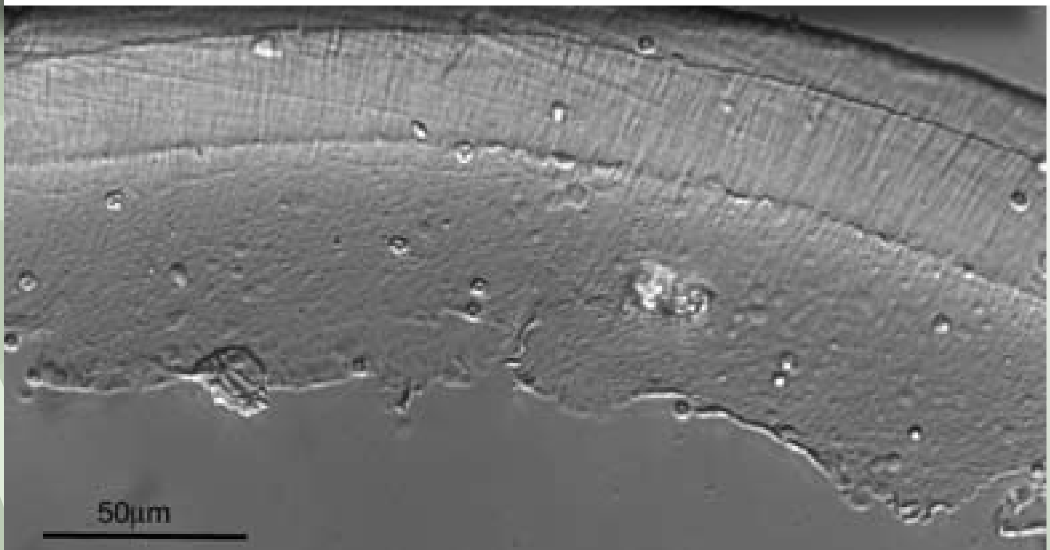
2007

A tiny molecular keypad, similar to a car's anti-theft device, was created by Institute chemists. The device's mechanism is an organic molecule with fluorescent probes at either end linked by an iron-binding molecular chain. The inputs – iron ions, acids, bases and ultraviolet light – are applied in varying combinations to reversibly change the probes' color. When the correct sequence of inputs is entered, the keypad "unlocks."



2007

An Institute chemist revealed how a thin membrane in the ear participates in the process that enables us to hear sounds in a wide range of frequencies. The tectorial membrane in the inner ear sits above the outer hair cells – which amplify sound in the form of mechanical vibrations – and connects to the inner hair cells – which convert these mechanical vibrations to electrical signals and pass them to the auditory nerve. The scientist found that the membrane's structure ranges from thin and rigid at one end, to thick and flexible at the other, and each spot is expected to vibrate at a different rate.

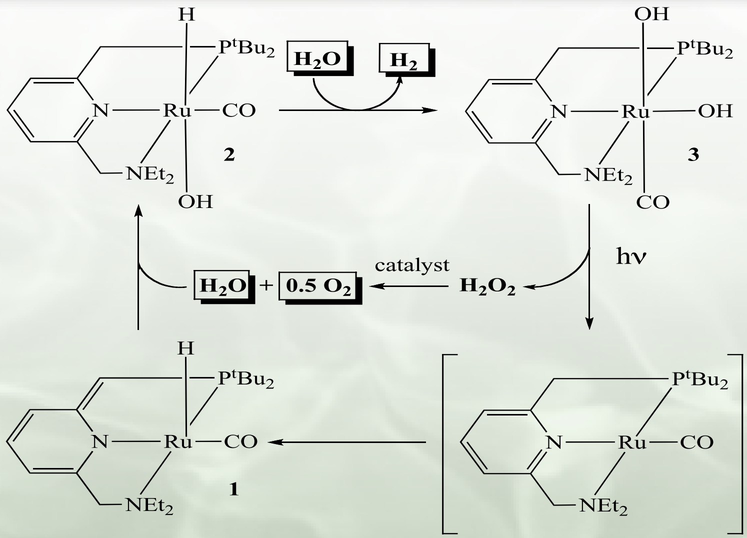


2008

Tiny carbon nanotubes tend to form disordered clumps, making them hard to manipulate and use. Weizmann Institute scientists applied a principle they called “order through chaos” to get the nanotubes do the hard work, themselves. The tubes assembled themselves into unusual, orderly serpentine configurations. Like their macro-sized counterparts, which are turned into antennas, cooling elements and radiators, serpentine nanotubes might have many applications, including cooling elements for miniature electronic circuits, optoelectronic devices or single-molecule dynamos.

2009

Water is a simple molecule made of one oxygen and two hydrogen atoms. If we could figure out how to efficiently split the molecule apart, we might have a clean, abundant source of hydrogen for energy. Institute chemists have designed a "smart" molecular complex that can do just that. Combining organic molecules with a metal, they managed to create a complex (or compound) that facilitates this difficult chemical reaction in three stages. What's more, the third stage, which is driven by light alone, produces oxygen, and the starting complex is regenerated.

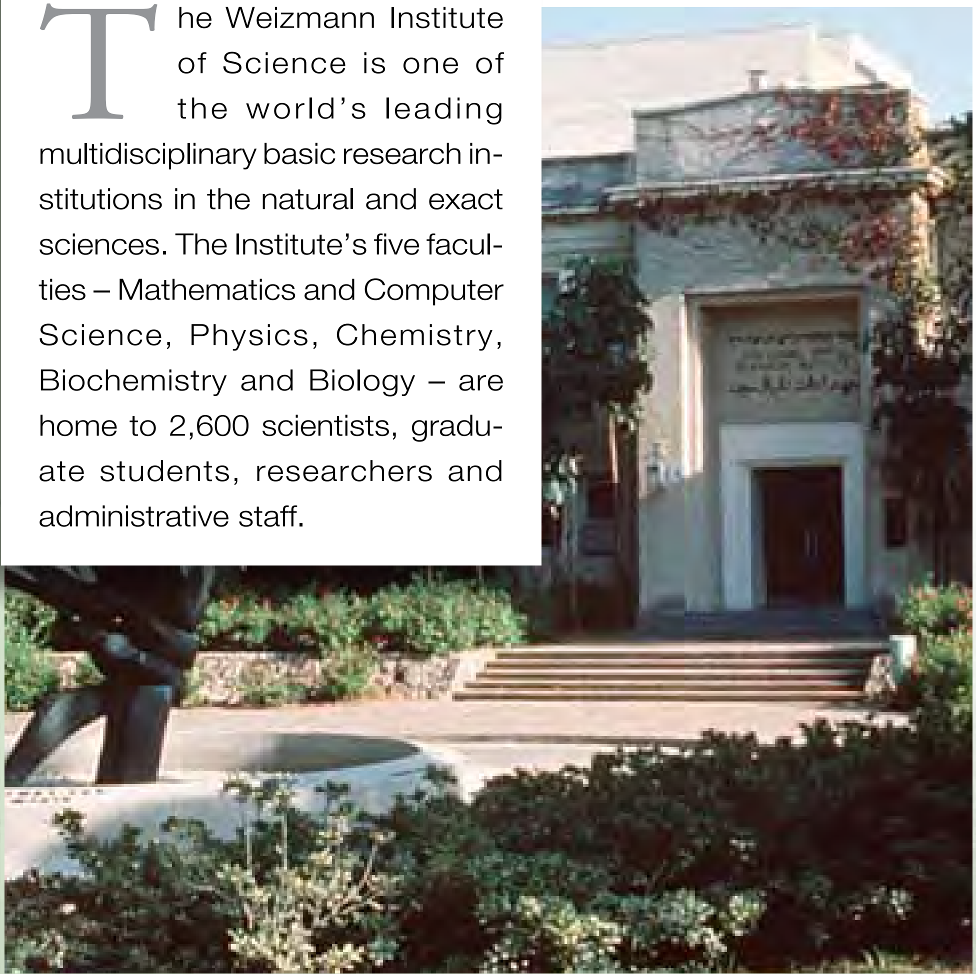


The Weizmann Institute of Science at 60

Looking Forward

The Chemistry Faculty's research today is as visionary as photochromic memory, mechanochemical machines and new methods of probing molecules' innermost secrets were in their day. A few predictions: Institute chemists will continue to develop NMR and other scientific technologies, which will find new and exciting applications in fields from biology to physics. They will continue to invent new nanomaterials and to explore existing ones, finding novel applications and improving their manufacture or use. Chemists and biologists will continue to interact in new and interesting ways, resulting in unique biosensors and new means of diagnosing and treating disease. Institute chemists will continue to invent new approaches to developing solar and alternative energy resources. And these will be just the beginning.

The Weizmann Institute of Science is one of the world's leading multidisciplinary basic research institutions in the natural and exact sciences. The Institute's five faculties – Mathematics and Computer Science, Physics, Chemistry, Biochemistry and Biology – are home to 2,600 scientists, graduate students, researchers and administrative staff.



Daniel Sieff Research Institute

The Daniel Sieff Research Institute, as the Weizmann Institute was originally called, was founded in 1934 by Israel and Rebecca Sieff of the U.K., in memory of their son. The driving force behind its establishment was the Institute's first President, Dr. Chaim Weizmann, a noted chemist who headed the Zionist movement for years and later became the first President of Israel. In 1949, the Institute was renamed and formally dedicated as the Weizmann Institute of Science, in honor of Dr. Weizmann's 75^{th} birthday. Over the years, the Weizmann Institute has grown with the country, and it has been the site of a number of milestones in Israeli science. Institute scientists were pioneers in the field of cancer research in Israel. Others planned and built the country's first electronic computer, one of the first in the world; yet others founded the first nuclear physics department and erected a particle accelerator next door. They were the first to establish a company for transferring knowedge from academia to industry (Yeda), and they initiated the founding of a science-based industrial park near the Institute. The Institute has also been the site of pioneering research in brain studies, nanotechnology and new methods for exploiting solar energy.

Institute scientists' research has led to the development and production of Israel's first ethical (original) drug; the development of new computer languages; the solving of three-dimensional structures of a number of biological molecules – including one that plays a key role in Alzheimer's disease; inventions in the field of optics that have become the basis of such advanced devices as virtual head displays for pilots and surgeons; a method for separating isotopes that is used around the world; the discovery and identification of genes that are involved in various dieases; advanced techniques for transplanting tissues; and the creation of a nanobiological computer that may, in the future, be able to act directly inside the body to identify disease and eliminate it at the molecular level.

Arthur and Rochelle Belfer Building for Biomedical Research

Today, the Institute is a leading force in alternative energy research, in the creation of new scientific fields such as biomatics and in advancing science education in all parts of society. Programs offered at the Davidson Institute of Science Education, on the Weizmann campus, target exceptional and science-oriented students as well as high school dropouts, elementary through high school teachers, and students of every age. The Clore Garden of Science offers fun-filled interactive science activities for people of all ages.

The Joe Weinstein and Major Max L. Shulman Ecosphere at the Clore Garden of Science

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