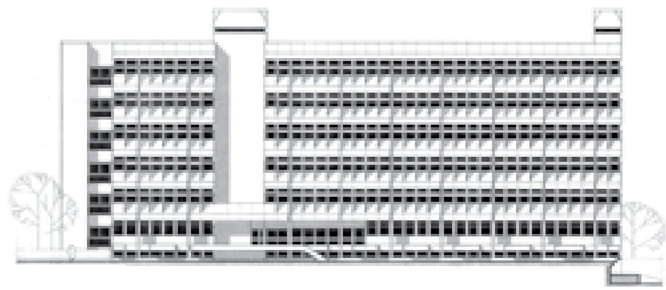
100 Milestones

in Chemistry Research at the Weizmann Institute of Science

Celebrating 35 years of the Perlman Institute of Chemical Sciences

מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE

100 Milestones in Chemistry Research at
the Weizmann Institute of Science

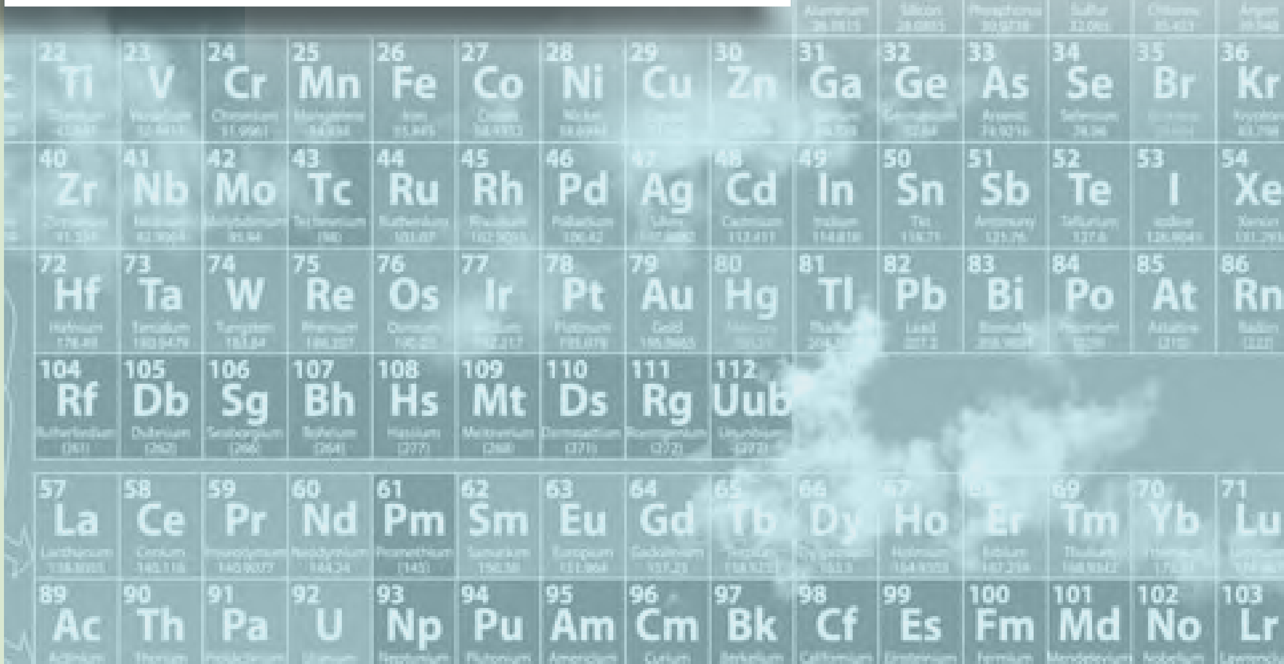


The Perlman Chemical Sciences Building

"The most all-penetrating spirit before which will open the possibility of tilting not tables, but planets, is the spirit of free human inquiry."

Dmitri Mendeleev, (1834-1907)

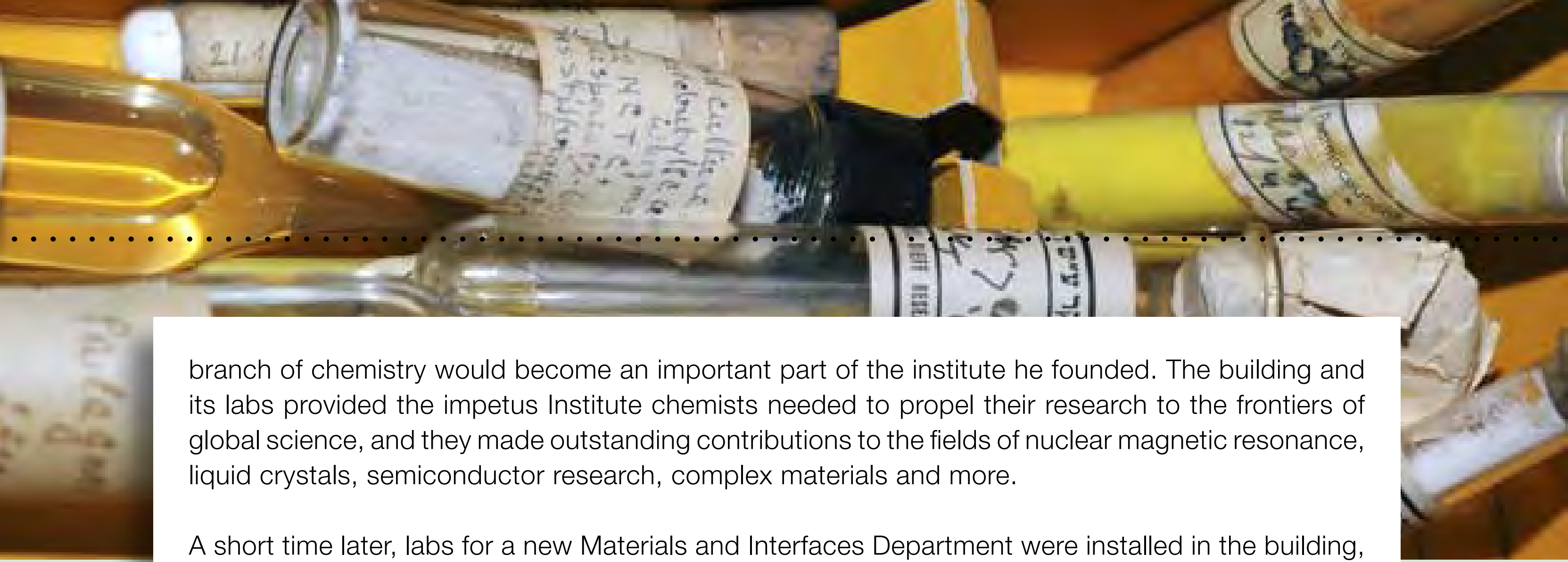
best known for his periodic table of the elements



Chemistry was the first field of research at the Weizmann Institute of Science, and it will play a significant role in shaping the Institute's future. The Institute's founder and first President, Dr. Chaim Weizmann, was a chemist who strongly believed in the value of basic research; but he also knew how to seize an opportunity and turn scientific findings into useful applications. He said: "I trust and feel sure in my heart that science will bring to this land both peace and a renewal of its youth, creating here the springs of a new spiritual and material life. I speak of both science for its own sake and science as a means to an end." But Weizmann, the visionary who foresaw the need for first-rate science in the land of Israel, could not have imagined the Institute – now one of the world's top multidisciplinary research centers – that has grown up around the original chemistry labs. If he were to visit the Institute today and peek into the various labs where physics, genetics, robotics or brain research is conducted, he might be amazed at the scientific questions we are daring to address. If he were to enter the chemistry labs, he would be doubly amazed – both by the advances that enable scientists to control chemical processes and delve into the secrets of nature with ever greater precision, and by the breadth of a field that currently encompasses everything from global weather phenomena to the atomic structure of biological molecules.

The Faculty of Chemistry was officially created in 1971, when all the Institute's various departments were organized into five faculties. Coinciding with the 100th anniversary of Dr. Weizmann's birth, the faculty experienced a "Big Bang": A significant, generous gift, made by Harold Perlman of Chicago in memory of his parents several years before, in 1969, enabled the establishment of the Perlman Institute of Chemical Sciences and the construction of the Perlman Chemical Sciences Building, dedicated in 1974. The six-story edifice's 7,435 sq. meters, home to the Isotope Research and Chemical Physics Departments, housed some of the most advanced chemistry labs of that day.

Harold Perlman was a philanthropic visionary and pioneer who understood the central role that materials science would come to play in chemical research; indeed, over the next 40 years this



branch of chemistry would become an important part of the institute he founded. The building and its labs provided the impetus Institute chemists needed to propel their research to the frontiers of global science, and they made outstanding contributions to the fields of nuclear magnetic resonance, liquid crystals, semiconductor research, complex materials and more.

A short time later, labs for a new Materials and Interfaces Department were installed in the building, where they continue to produce top-notch research to this day. Truly, the impact of the scientific activity taking place in the Perlman Chemical Sciences Building has gone far beyond the physical walls, leading to the development of additional research fields at the Weizmann Institute. Among these are the Structural Biology Department – which can boast a number of impressive achievements in recent years – and the Environmental Sciences and Energy Research Department.

Looking back over the record of the achievements of Weizmann Institute scientists in the various areas of chemistry, the creation of the Perlman Institute of Chemical Sciences and the Perlman Chemical Sciences Building stands out as a landmark. After that point in time, one can see chemical research branching out in all sorts of new directions. Like the spot on a tree trunk where the strongest limbs begin spreading out, giving shade to an entire patch of ground, the completion of institute and building in 1974 represents the generation of multiple new directions in the evolution of the Faculty of Chemistry, enabling its varied branches to spread and grow.

Prof. Daniel Zajfman
President
Weizmann Institute of Science

1934

The Daniel Sieff Research Institute was founded by British philanthropists and friends of Dr. Chaim Weizmann, Israel and Rebecca Sieff, in memory of their son. The building featured up-to-date labs and equipment, including Weizmann's lab and office. Part of the Organic Chemistry Department is still housed in the historic building, as is Dr. Weizmann's memorial laboratory.

1938

A group of Institute chemists found that amino acids, the building blocks of proteins in all living things, can be broken down when mixed into water and exposed to ultraviolet light. The initial byproduct of this breakdown was ammonia (NH_3). The scientists noted that some amino acids broke down faster than others, while those with phenyl groups also underwent side reactions "leading to an insoluble coating on the quartz walls and to the formation of an unpleasantly smelling volatile product." They surmised that amino acids in green plants might be broken down in a similar way by simple chemical reactions involving water and light.

1938

A good deal of research in the Daniel Sieff Research Institute concerned the uses of natural and agricultural products, with the aim of strengthening the country's nascent economy. Its scientists applied the fermentation techniques developed by Dr. Weizmann to such materials as orange and grapefruit peels, creating useful chemical compounds and substances with new properties. In other research, fennel and anise oils were found to contain compounds that were chemically similar to the hormone estrogen, and these were proposed as a source of synthetic estrogen.

1940

Petroleum products were an important subject of Institute research; its scientists looked for ways of improving the refining process and of producing new industrial chemicals and materials. Methods for "cracking" the oil to create higher octane fuel were investigated, and an anti-knock compound developed. Institute research also led to a method for producing a type of synthetic rubber.

1941

During WWII, Institute scientists adapted their research to the creation of drugs and other substances that had been imported from Germany. When the war began, the scientists' efforts turned to the production of the quinine substitutes Atabrine and plasmoquine for treating the malaria that still plagued the population in Palestine and the Allied troops serving in the region. Another drug to come out of Institute labs at that time was Evipan, a barbiturate-based painkiller. A summary of research from that period reported the development of methods for the production of 22 new compounds, including "anti-malarials, dis-infectants, hypnotics, hormones, etc."

1947

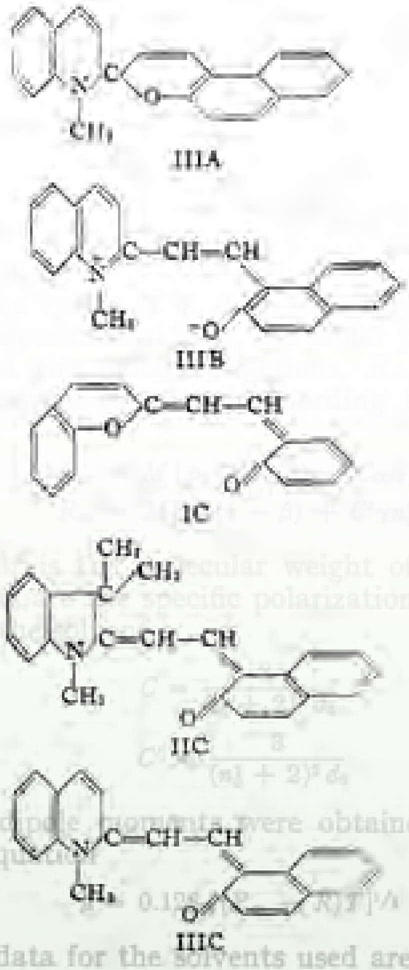
The Institute envisioned by Dr. Weizmann was to be a regional center for scientific advancement, its scientists working in fruitful collaboration with labs in such respected institutions as the University of Cairo. As late as 1947, Institute scientists were publishing the results of research conducted in collaboration with chemists at the American University of Beirut.

1949

The Daniel Sieff Research Institute officially became the Weizmann Institute of Science, in honor of Dr. Weizmann's 75th birthday. The new Institute was initially made up of five departments: two chemistry (isotope research and polymer research), together with biophysics, biochemistry and microbiology, and applied mathematics. The latest in scientific equipment – including a mass spectrometer and an X-ray diffraction unit – was installed in the Institute's labs.

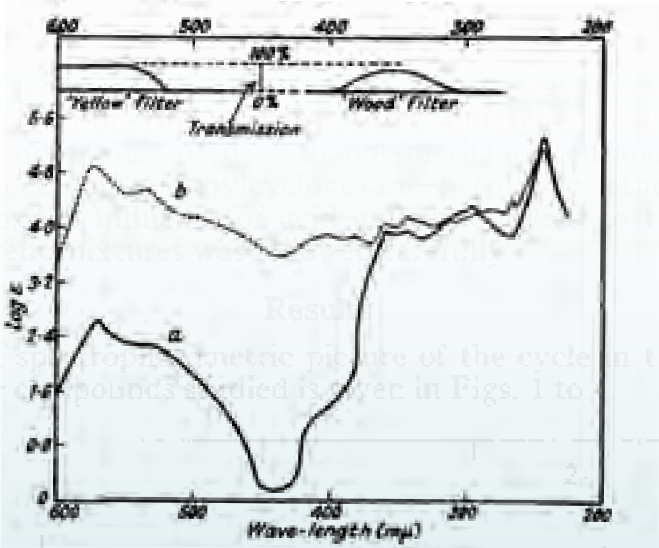
1950

Among the thousands of chemical compounds explored in the labs of the Institute were polycyclic spiropyrans — chemicals that change their color when exposed to light or heat. These substances were interesting because the change was reversible: Turn off the light, and they revert back to the original color. A team of Institute scientists teased out the chemistry of this change, finding how the distribution of electric charges on the spiropyran molecules affected the color change. These color-changing chemicals became the basis of ground-breaking work on optical data storage by Weizmann Institute scientists.



1951

A suggestion from a member of the Electronics Department to an Institute chemist led to one of the seminal papers in the field of optical data storage. The two scientists realized that chemical compounds that change their color under a beam of light – and remain stable until changed back again with a second action – might perform high-speed memory storage functions similar to the electronic computer, then in its infancy. The chemist proposed a memory storage system based on the properties of these compounds, and he invented the term “photochromism,” still applied to the field today.

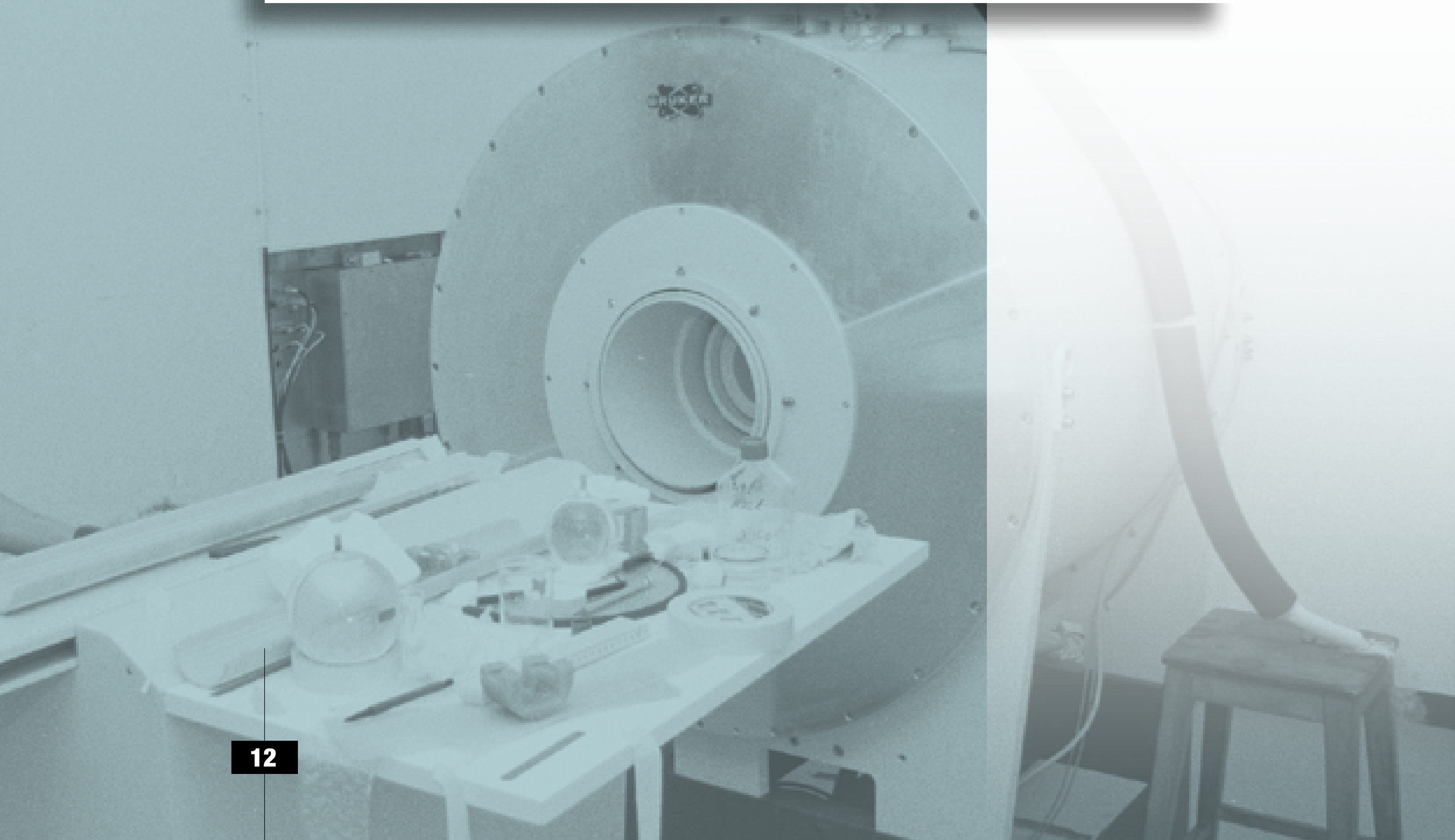


1952

The Weizmann Institute was a world leader in isotope research, and it boasted a unique apparatus for separating isotopes – elements that are heavier or lighter than the regular ones, due to a non-standard number of neutrons in the atomic nucleus. The Weizmann facility produced heavy oxygen, and for many years, it supplied most of the world's demand for this isotope. Heavy oxygen is used in a wide variety of research in chemistry, physics, biology and medicine, and in PET scan technology.

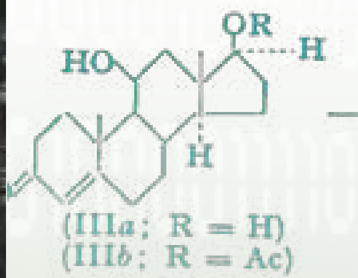
1954

Weizmann Institute scientists constructed a high-resolution nuclear magnetic resonance (NMR) spectrometer, one of the first such devices to be built in the world and a forerunner of present-day magnetic resonance imaging (MRI) scanners. The machine was used for pioneering spectroscopic studies, as well as to investigate molecular structure and dynamics.

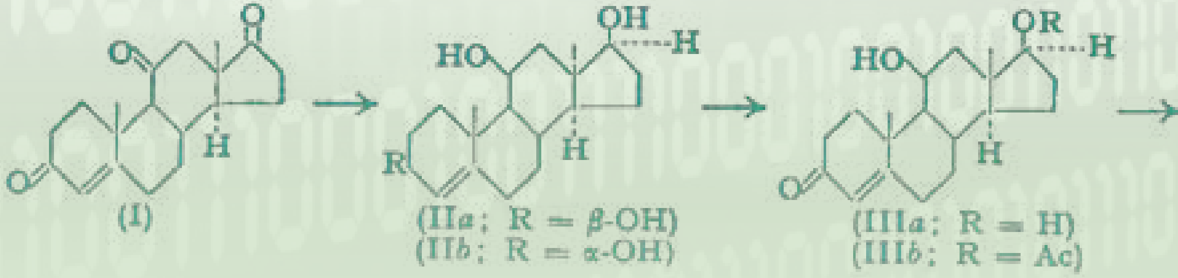


1954

WEIZAC, the first electronic computer in the Middle East, and one of the first in the world, was a coup for the mathematics department, but the Institute's chemists were among the first to benefit from it. Crystallographers and polymer scientists, for instance, found they could do several weeks worth of calculations in a mere hour or so.



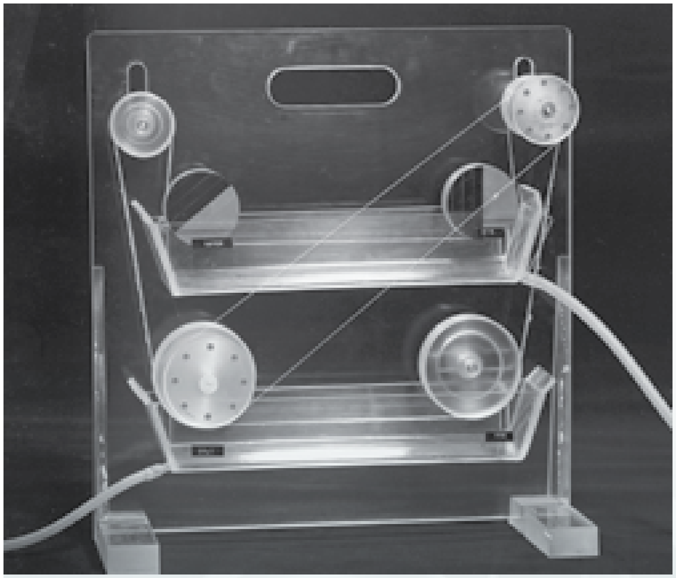
simply and in exc
nt hydrolysis.



11-Ketotestosterone (IVa) was prepared simply and in excel
monoacetate (IIIb) by oxidation and subsequent hydrolysis.

1955

One of the dreams of Institute scientists was to build functioning "mechanochemical machines" that would work in the same way as living tissue. A team of scientists created one such device out of collagen fibers, which are found in animal connective tissue. When subjected to dissolved salt, the fibers expanded or contracted, thereby operating a set of wheels. Though the dream was ahead of its time, the research advanced the study of the properties of living tissues, enabling the scientists to gain crucial insight into the dynamics of biological materials.



1956

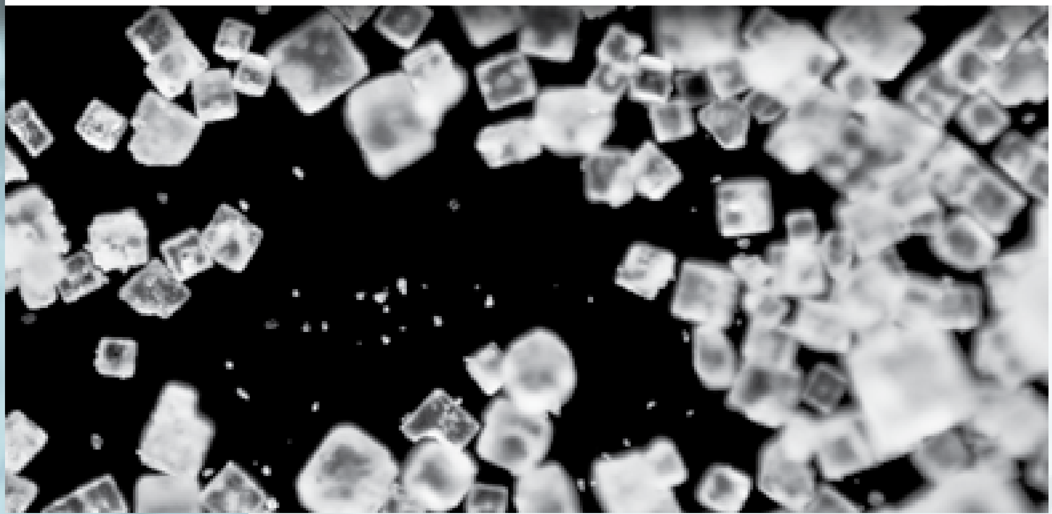
A landmark international symposium on Macromolecular Chemistry was held at the Institute. This meeting signaled the rising standing of the Institute chemists in the global science arena, especially their “pioneering work on polyelectrolyte chemistry.” Touted uses for the new synthetic polymers highlighted at the symposium included blood clotting, soil conditioning and films for reservoirs to prevent evaporation.

OPENING CEREMONY
of the
INTERNATIONAL SYMPOSIUM ON
MACROMOLECULAR CHEMISTRY
UNDER THE AUSPICES OF
THE COMMISSION ON MACROMOLECULES OF
TERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY
E WEIZMANN INSTITUTE OF SCIENCE, REHOVOT
and
DEDICATION
of the
MICHAEL AND ANNA WIX AUDITORIUM
THE WEIZMANN INSTITUTE OF SCIENCE, REHOVOT
Tuesday, April 3, 1956, 10.00 a.m.

OUVERTURE
du
SYMPOSIUM INTERNATIONAL DE
CHIMIE MACROMOLECULAIRE
SOUS LES AUSPICES DE
LA COMMISSION DES MACROMOLECULES
DE L'UNION INTERNATIONALE DE CHIMIE PURE ET APPLIQUEE
ET DU WEIZMANN INSTITUTE OF SCIENCE, REHOVOT
et
DEDICATION
MICHAEL AND ANNA WIX AUDITORIUM
THE WEIZMANN INSTITUTE OF SCIENCE, REHOVOT
Mardi, 3 avril 1956, 10.00 h.

1957

How does one measure the molecular weight of a new polymeric substance when it's dissolved in a solution? This is not a trivial question, as accurate measurement is the basis of nearly all chemical experimentation and theory. An Institute scientist attempting to determine the molecular weight of polyelectrolytes in solution using a light scattering technique found that the method would only work if he added a pinch of cooking salt to the solution. He then provided the chemical explanation as to why this should be so.

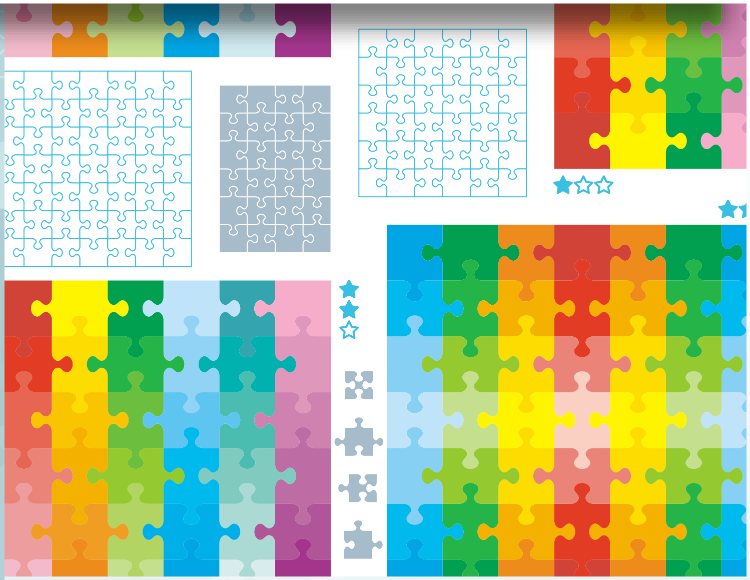


1959

Throughout the Institute's early decades, Weizmann chemists investigated the structure, properties, and performance of polymers — long molecules consisting of strings of smaller subunits. (DNA, proteins, polysaccharides and synthetic plastic materials are all polymers.) Among other things, the scientists studied the properties of electrically-charged polymers (polyelectrolytes) and their interactions with ions and other small molecules. Practical inventions to come out of this research included a spray-on polymer solution for preserving fruit, special plastics for covering greenhouses, fire retardants, improved polyesters, pesticides and specialized membranes.

1960

The still-growing Weizmann Institute underwent reorganization as new fields of research opened up. The chemistry departments in 1960 included photochemistry, organic chemistry, isotope research, x-ray crystallography and infrared spectroscopy. The NMR Department was absorbed into Nuclear Physics in 1962, and a Chemical Physics Department was established.

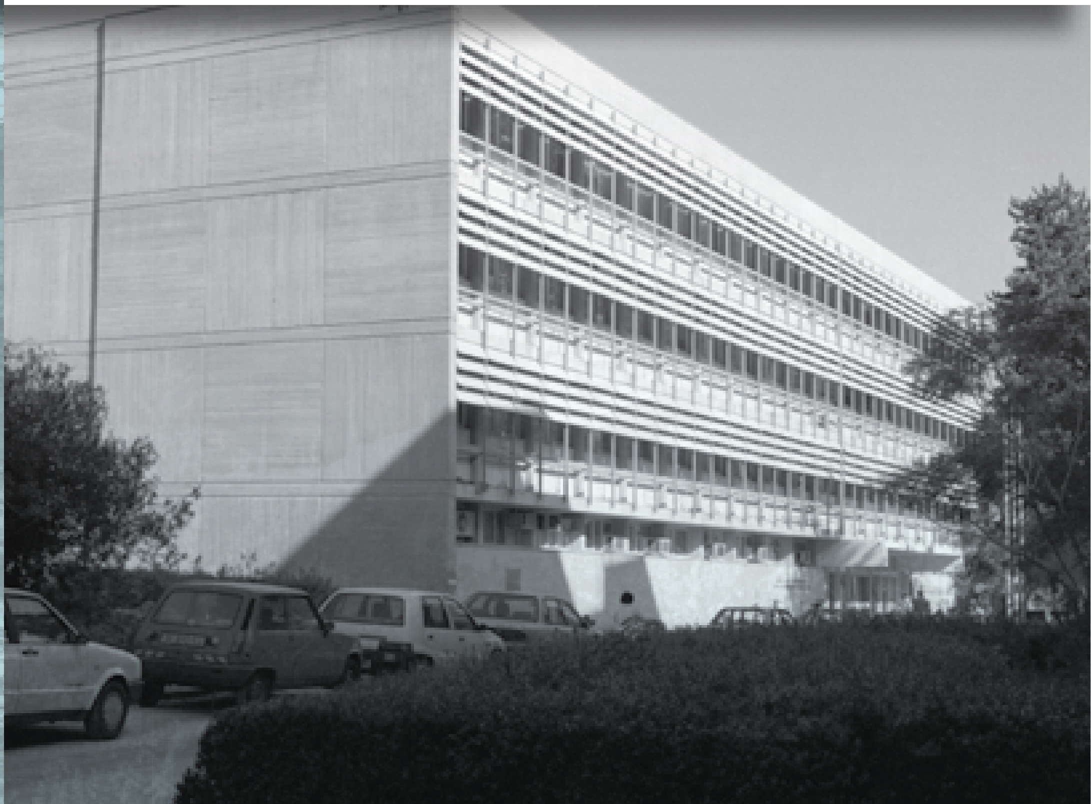


1961

Plants and animals are natural storehouses for all kinds of chemical compounds that affect the human body. Over the years, Institute scientists investigated a number of plant and insect compounds, developing methods to isolate substances with drug-like properties. These included thebaine, extracted from an Asian poppy, which was used as a starting material for the preparation of the anti-addiction drug Naloxone and the analgesic drug codeine. Later research in this area yielded natural substances with anti-cancer and anti-retroviral properties.

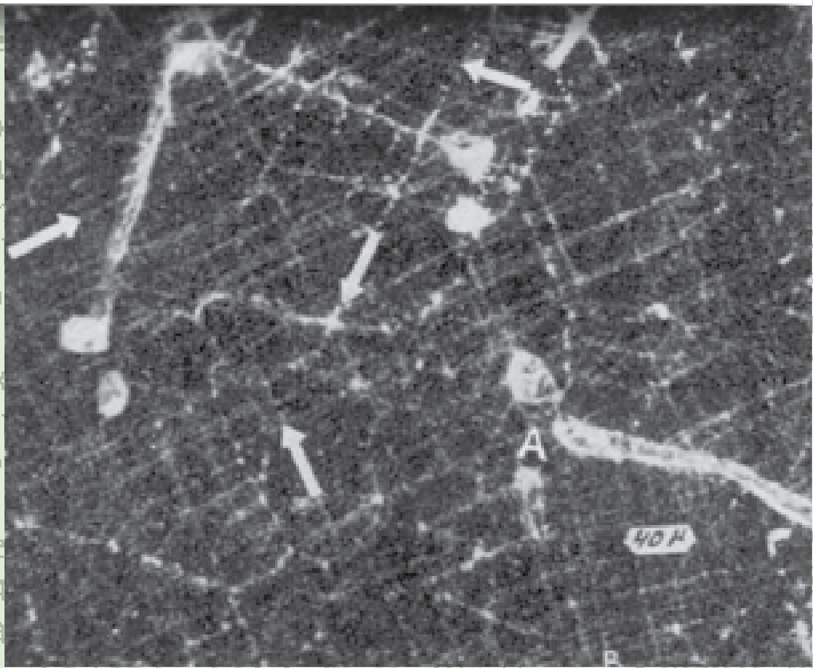
1964

A new building was erected adjoining the Daniel Sieff Research Institute to accommodate advances in chemistry research. Originally named for Ernst. D. Bergmann, the first scientific director of the Institute, the building housed the Organic Chemistry Department.



1964

Even materials that are "set in crystal" can be chemically reactive. Institute chemists made pioneering strides in the field of topochemistry – the chemistry of reactions that take place in crystallized solids. Among other things, they showed that the shape of the molecular crystalline structure determines the outcome of the reaction. This body of work has since become fundamental to many branches of chemistry and solid-state engineering.

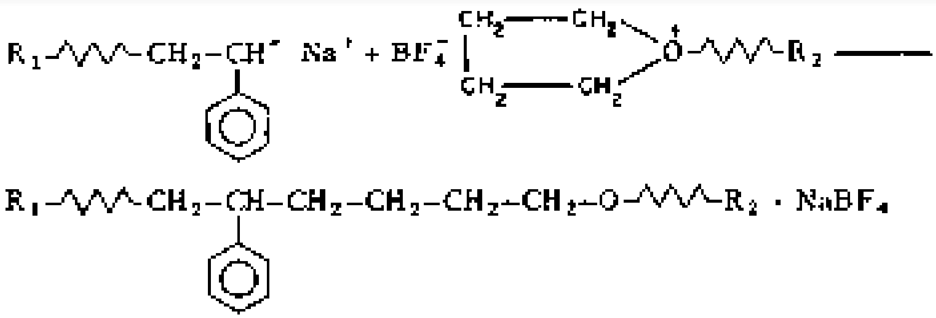


1965

Synthesizing antibiotic and other drug compounds for therapeutic use means they should be produced cheaply and efficiently on an industrial scale. Institute scientists took a novel approach, developing a range of chemically active polymers that are used for the preparation of various substances, including antibacterial compounds and biologically active peptides.

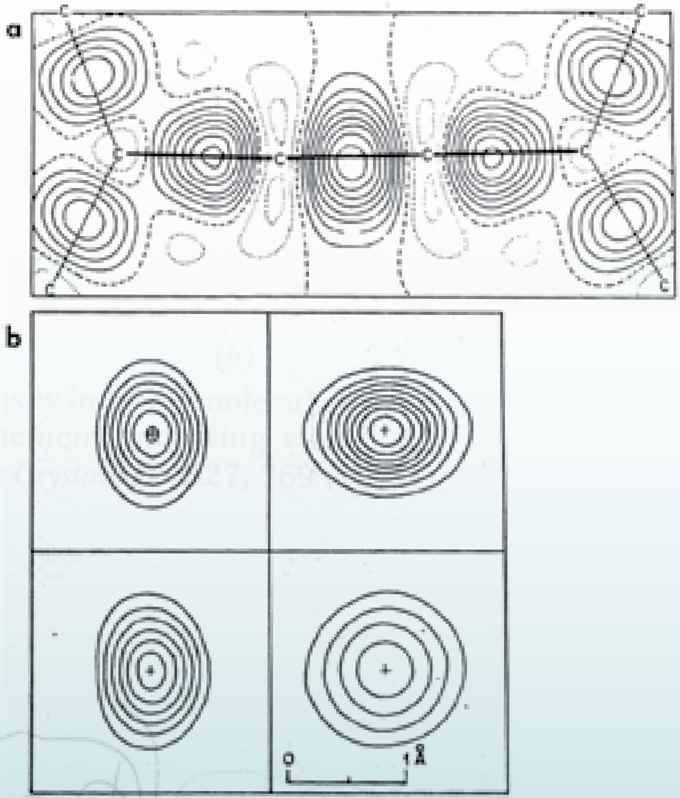
1966

Some of the polymer research at the Institute involved "living polymers" – chain-like molecules that continue to grow as long as monomers are available, or until the process is halted by a terminating chemical reaction. Institute chemists found a new way of terminating the polymer chain growth by mixing two types of living polymers, one with a negative charge at the end of the chain (anionic), and the other with a positive charge (cationic). This resulted in a new type of "block co-polymer" having different properties than either of its constituent polymers.



1966

The chemical bonds between the atoms in molecules are functions of the electrons that are shared between them. Understanding the nature of these bonds goes to the very heart of chemistry. An Institute chemist developed a method for “dissecting” molecules to reveal the distribution of their electrons and thus how the various atoms bind to each other. This method, which provided scientists with a deep understanding of chemical processes, has become a standard tool in a number of areas of chemistry.



1968

Scientists often investigate the structure and reactivity of substances at the molecular level and need to quantify the forces that hold molecules together or those involved in various molecular reactions. Institute scientists developed a method, called the “consistent force field,” for calculating the forces exerted within the molecule. This method makes it possible to elucidate the structure of molecules, as well as to calculate the binding energy of their components. In biological systems, it allows researchers to determine and quantify the structure of a protein or to compute the binding energy needed to activate molecules such as enzymes.