CAMPUS MUSEUM IN THE OSKAR-UND-CÉCILE-VOGT-HOUSE OF THE GREEN HEALTH CAMPUS BERLIN-BUCH

CAMPUS art

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Inhalt

Introduction

The Berlin-Buch health region is located to the north-east of the German capital. For more than a century it has been known for its clinics, biotechnology companies and research institutions. The Max Delbrück Center for Molecular Medicine in the Helmholtz Association (MDC) is the largest and most well-known institution, but the campus has many other components.

The Campus Museum offers a look back into history. It is located in a building erected in 1928/29, to house the Kaiser Wilhelm Institute for Brain Research, which began operations in conjunction with its neurological clinic in 1930. The institute had been founded in 1916 by Oskar Vogt. From then until 1937, he headed what was at the time the world's largest and most modern neuroscience institute. Research focused on the histological-anatomical and functional layers and field structures of the brain. In addition, the institute gained its reputation by the work of Nikolai Wladimirovich Timoféeff-Ressovsky, a Russian geneticist, on gene mutations and the structure of genes, work carried out in part with Max Delbrück.

Starting in 1937, Vogt's successor Hugo Spatz placed an institutional focus on various neuropathological conditions including brain tumors. From 1939/40, the institute became involved in examining the brains of euthanasia and war victims. In 1947, the institute and clinic were handed over to the German Academy of Sciences in Berlin and were renamed the Institute for Medicine and Biology. The site developed into a well-known center for cancer research, with work on chemical carcinogenesis, oncogenic viruses, biochemistry, immunology, genetics and radiobiology and clinical treatments for tumors. Cardiovascular research was established as a second focus from 1956, in a manner that also combined research with clinical practice. In 1972, the various Academy institutions in Buch were reformed into the central institutes for molecular biology, cancer research and cardiovascular research.

With the unification of the two German states in 1990, the Academy institutes were closed down in accordance with the unification agreement. In their place, in 1992, the Max Delbrück Center for Molecular Medicine (MDC) was established on the campus. Beginning in 1995 the site became home to biotechnology companies in the BiotechPark, with an innovation and start-up center.
In 2000 the Leibniz Research Institute for Molecular Pharmacology (FMP) moved from Friedrichfelde to the Campus Berlin-Buch.

The early vision of the Campus Berlin-Buch was to combine research with clinics, and this characterizes the campus to this day. In the meantime, this combination of basic and clinical research has become a successful model that has been adopted by many other institutions, including the German Cancer Research Center, which was founded in Heidelberg in 1964.

The history of medical research in Berlin-Buch is impressively reflected in the Campus Museum, which opened to the public at the end of the 1990s. It is housed in the original building of the former Kaiser Wilhelm Institute for Brain Research, which was renamed the Oskar-und-Cécile-Vogt-House in 1992. Scientific equipment from a century of biomedical research is on display on the ground floor, giving visitors a chance to view the stages in the history of medicine and research.

This brochure describes some of the equipment on display, including instruments used at different times in the campus research facilities.

Those who are interested can also visit the digital platform, whose web addresses can be found at the end of this brochure under “Further Information“.

We hope you enjoy exploring the history of biomedical research in Berlin-Buch!

The Campus Museum

Timoféeff-Ressovsky‘s workplace, 1931-1945

As mentioned in the foreword, the Kaiser Wilhelm Institute (KWI) for Brain Research, which had been established in 1916, became the first institute on today‘s Campus Berlin-Buch in 1930. Its founding director was Oskar Vogt, who worked for decades with his wife Cécile Vogt, carrying out research into the biological mechanisms underlying diseases of the nervous system. The

Vogts hoped to identify their genetic causes, so in 1925 Oskar Vogt convinced the Russian geneticist Nikolai Wladimirovich Timoféeff-Ressovsky to come to Berlin with his wife Elena Alexandrovna Timoféeff-Ressovska, a geneticist in her own right, to set up a laboratory at the KWI. This laboratory became the nucleus of a future department for genetics in the new building in Berlin-Buch, which was officially opened in 1931.

The KWI for brain research achieved early prominence mostly through Timoféeff-Ressovsky's work on gene mutations and the structure of genes, partly carried out in collaboration with Max Delbrück.

In the museum you can see Timoféeff-Ressovsky's workplace, transported here from the second floor but otherwise in its original condition. It was in this laboratory that Timoféeff-Ressovsky began his work on the mutagenic effects of X-rays. He used the Drosophila fruit fly as a model due to its ease of use: this small insect only has eight chromosomes and produces a next generation of offspring just ten days after the larva hatches. The geneticist irradiated fertilized eggs and larvae with X-rays to induce mutations. He examined the animals under the binocular magnifying glass, then switched to the microscope for images with better resolution and magnification. It was at this desk that he made the crucial observation that there is a linear relationship between the dose of X-ray radiation applied to a fly and its rate of mutation. In other words, irradiated animals developed altered body parts, and the stronger the radiation, the more significant were the changes.

On the wall to the right of the workplace hangs a publication that arose from his investigations, in 1934. In it, Timoféeff-Ressovsky became the first scientist to use the term "genetic engineering". Just one year later, he published a seminal paper on gene mutations with the physicists Max Delbrück and Karl Günther Zimmer. Here the authors suggested for the first time that genes should be understood as complex atomic structures. The work is now known as the "Three Men's Work" or because of its green cover, the "Green Pamphlet". Its publication is considered the beginning of modern genetics in Germany.

The importance of Nikolai W. Timoféeff-Ressovsky's work goes far beyond Berlin-Buch. He coined the idea of genes as molecular assemblies, which is still relevant today.

You can find more information about the life and work of Nikolai Wladimirovich Timoféeff-Ressovsky in the brochure on the history of science or at www.campusart.berlin.

Incubator, around 1940

The development and growth of organisms usually require special conditions. Incubators are used to create and maintain microclimates by closely controlling conditions such as humidity and temperature. Originally, these devices were developed to hatch chicken eggs. One of the pioneers who introduced these devices into microbiological laboratory practice was Robert Koch.

The most important element of the devices were thermostats. Closed glass containers filled with mercury were used to regulate the temperature. Two wires were melted into the glass wall of these contact thermometers at fixed points and acted as switches for the upper and lower limits of temperature. When the temperature rose, the mercury reached one or both wires. That activated or deactivated a heating element, which kept the temperature of water in the incubator's copper jacket constant, within a specified range.

In addition to chicken eggs, the incubators could also be used to hatch insect eggs. The geneticist Timoféeff-Ressovsky and others used incubators like this one to grow fly eggs and larvae under controlled conditions. The comparatively simple technique of thermoregulation can therefore be seen as a crucial method on the path to modern genetics and molecular medicine.

Incubators are also used in modern laboratories. Nowadays they are digitally controlled, but in principle they do not differ significantly from the devices seen here. They are still used to hatch eggs, and to grow cells as well. They are indispensable tools for modern biology.

Pulse counter with Geiger-Müller counter tube, around 1955

Nikolai W. Timoféeff-Ressovsky and Max Delbrück irradiated fertilized fly eggs and larvae to study the resulting mutants. To record the radioactive isotopes and interpret the results of their experiments, it was crucial to know the amount of radiation that was being used. This was the purpose of the Geiger-Müller counter.

The instrument consists of a metal tube that is closed at both ends. A wire runs through the tube along the axis and leads out at one end through a glass insulator. The tube forms the cathode, the wire the anode, and a DC voltage is applied between them. A gas in the tube generates free electrons whenever radioactivity strikes it. The electrons travel to the anode, where they are detected as short pulses of current that are audible as crackling sounds from the speaker. The device is sensitive enough to detect the release of a single electron.

The Geiger-Müller counter was developed by Hans Geiger and Walther Müller at the University of Kiel in the 1920s. An innovation in the detector was to record particles or quanta of radiation with electrical impulses. The Geiger-Müller counter cannot distinguish different types of particles because their momentum is the same. However, it is very well suited to counting incoming particles or quanta, hence the name “counter”. This device was therefore crucial in confirming, for example, the theory that the number of mutations induced by radiation are proportional to the amount that flies have been exposed to. This fact led to the idea of genes as assemblies of physical molecules.

Polarimeter, around 1890

A polarimeter is an optical measuring instrument. It is based on the fact that light consists of waves that oscillate in a certain direction, for example up and down or left and right. The direction is called the plane of polarization. Many biochemical substances are optically active. This means they affect the polarity of light rays that are shined on or through them, or rotate the waves one way or the other. Polarimeters can be used to measure whether substances are optically active and what type of activity they have, i.e. whether they rotate to the left (L) or to the right (D). In addition, the instrument can also be used to determine concentrations of substances.

The polarimeter consists of a light source (not on display here), a polarizer and an analyzer. The latter are optical filters that only allow waves of certain levels of polarization to pass through. Seen from the perspective of the light source, after passing through the polarizer, all light waves oscillate in the same direction. Another way to put this is that the polarizer produces light that is linearly polarized. On its way to the analyzer, this light passes through the polarizing tube in the middle. This contains a substance to be analyzed. The analyzer has a disc that can be rotated along a standardized circular scale, which permits reading the degree of polarization.

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2

This display exhibits two polarimeters made in Berlin:

1 ***Polarimeter from Schmidt & Haensch***, workshops for scientific instruments, Berlin, built around 1890.

2 ***Polarimeter from Steindorff & Co.***, Optical-Mechanical Factory, Berlin, built around 1920.

Instruments like these permitted scientists for the first time to quickly and easily determine concentrations of optically active substances, such as glucose, that are crucial for cell physiology.

The disadvantage of manual polarimeters is that they are not easy to use and experience is required to obtain accurate readings. Today’s scientists, therefore, use automatic, electronically controlled polarimeters.

You can find out more about the companies Schmidt & Haensch and Steindorff & Co., as well as about polarization microscopy, on the website of the virtual microscope museum: https://mikroskopmuseum.mdc-berlin.de, in the videos bearing their name.

Laboratory table with optical bench, around 1950

This tiled laboratory table with an “optical bench“ dates from the 1950s. Optical benches like these were used by Erwin Negelein and other scientists. Negelein was initially employed as a mechanic at the institute. He went on to study chemistry and worked as a biochemist and cell physiologist in the department of Otto Warburg, who later won the Nobel Prize. Negelein combined knowledge from his two fields to make optical measurements over the course of chemical processes. If a substance is oxidized or reduced during a process, for example, the amount of light of a defined wavelength that it absorbs changes. Thus, the spectrum of the light changes when shined through a sample of the substance. The changes in absorption are measured with this optical bench. The device is therefore called the Erwin Negelein absorption spectrophotometer.

The instrument consists of a three-stage crank resistor (built ca. 1910), which permits regulating the light intensity from the lamp. It also has a resistor-controlled light source, a lens to focus the light beam, and an iris diaphragm to regulate the width of the light beam. Color filters permit masking out unwanted spectral components. There are also a sample cuvette and a photocell connected to a mirror galvanometer, with which the photocurrent is measured.

The Institute for Medicine and Biology was founded on the campus in 1947, with Walter Friedrich as founding director. This later became the Institute for Cell Physiology of the German Academy of Sciences in Berlin, and its founding director was Erwin Negelein. Work at these facilities focused on characterizing and identifying basic biochemical processes and the molecular components involved in the interactions. Newly introduced methods of measurement, such as the optical bench, made this possible. Erwin Negelein used the device exhibited here to examine enzymes involved in the metabolism of carbohydrates and amino acids and other processes.

Negelein made important contributions toward elucidating the structure and function of nicotinamide adenine dinucleotide phosphate (NADP). His former mentor, Otto Warburg, received the Nobel Prize in Physiology or Medicine in 1931 for “discovering the nature and function of the respiratory enzyme”.

You can find out more about the life and work of Erwin Negelein and Otto Warburg in the brochure on the history of science or at www.campusart.berlin.

Manometer and reaction vessels, “Warburg Apparatus“, around 1920s

Manometers are devices that can be used to measure the pressure of a gas. In the 1920s, Otto Warburg and Erwin Negelein combined them with vessels in which biochemical reactions took place. They succeeded in determining aspects of the gas metabolism of tissues and cells – such as how much oxygen was consumed in a reaction, or how much carbon dioxide was produced. This manometric device is known as the Warburg apparatus.

You can find out more about the life and work of Erwin Negelein and Otto Warburg in the brochure on the history of science or at www.campusart.berlin.

Glukometer GKM 01, around 1980

Being able to determine the concentration of glucose in liquids is crucial for research, as described above for polarimeters, and for clinical purposes such as diagnosing diabetes. The Glukometer GKM 01, exhibited here, was the first commercially available device for analysis based on a biosensor. It was developed here on the Campus Berlin-Buch.

In 1970 Frieder Scheller, an electrochemist, was appointed to a position at the Central Institute for Molecular Biology (ZIM) of the Academy of Sciences of the GDR in Berlin-Buch. Here he worked on enzymes and biosensor research. In 1980, Scheller's research group launched the Glukometer GKM 01 on the European market. This device permitted determining the concentration of glucose in liquids quickly and accurately. It was therefore soon used in practices and clinics to record glucose concentrations in blood and urine samples from patients.

The Glukometer GKM 01 had a special feature, a completely new principle for making measurements. Scheller used an enzyme electrode as the biosensor. The samples were brought to body temperature, 37°C, in a water bath. The glucose in the samples was oxidized enzymatically, producing hydrogen peroxide. This could be measured electrochemically. This principle and the device are the results of research carried out on the Campus Berlin-Buch. The Glukometer GKM 01 is proof that basic research can indirectly lead to practical applications. The device exhibited here is now technologically outdated. Modern devices are significantly smaller, but are still based on the same principle.

Chemical workplace under a fume hood, around 1950

Many chemical reactions produce gases. Chemical workplaces are therefore often located under fume hoods like this one, which dates to around 1950. The hood quickly extracts gases, dust and aerosols and protects the experimenter from inhaling toxic substances.

The workplace has connections for water, electricity (rear left) and natural gas (rear right), which simplifies the work. The side walls of the fume hood are firmly built and offer protection from uncontrolled reactions or fire. The panes are made of safety glass and can be moved in the front so that a scientist can stretch their hands underneath and work.

One piece of equipment particularly stands out in this workplace. It consists of glass balloons attached one above the other. This device is called Kipp's apparatus after its inventor, the Delft pharmacist Petrus Jacobus Kipp (1808-1864). It can be used to produce gases that are used in the laboratory. Substances that react with each other are brought together in the flask. An example is the reaction of zinc with hydrochloric acid, in which zinc chloride and hydrogen are formed in the reaction $Zn+2HCl=ZnCl_2+H_2$. Hydrogen gas is trapped at the top and can then be used.

Kipp's apparatuses were regularly used in laboratories to produce gases until the late 20th century. Accordingly, chemical workstations under fume hoods were standard equipment in biomedical research facilities well into the late 20th century. Today, gases are industrially manufactured and sold in gas cylinders. They are purer and drier than gases produced by Kipp's apparatus.

Microbalance, 1960

The Campus Museum displays several types of scales. Some have their own housing, while others do not. Glass housing is a typical feature of analytical balances: scales that can accurately weigh substances with a resolution of 0.1 thousandths of a gram (1 milligram = mg). Even more accurate scales that have a resolution of a thousandth of a milligram (1 microgram = µg) are called microbalances. The glass housing is necessary because the breath of a person standing in front of the scale is enough to influence measurements. The scales were also placed on vibration-resistant tables so that vibrations from the surrounding building did not affect measurements. Here you can see a microbalance from 1960 from the company W. Zschörnig K. G./F. Küstner, with was seated in Dresden and Freiberg.

Microbalances are used in basic research to measure extremely small masses. They are so precise that they lend themselves to quantitative analysis. This means they can be used to very precisely determine how much of a substance has been used in an experiment, so that the values can be used to calculate and control results.

Color test kit for determining the pH value, 1900

This small case contains a color test kit from the Munich company F. & M. Lautenschläger from 1900, which uses color indicators to determine the pH value of substances. This value indicates the concentration of hydrogen ions and measures how acidic or basic a liquid is. The lower the concentration of hydrogen ions in the solution, the higher the value. The pH scale runs from zero to 14. Solutions with a pH of seven are neutral; those below are acidic, and those above seven are basic or alkaline.

pH values are very important for biomedical investigations; they directly influence a wide range of biochemical and cell-physiological processes. The results of an experiment carried out in an aqueous environment can only be interpreted correctly if the pH at which the experiments were carried out is known. This can be calculated when the concentration and strength of the acids and bases in a solution are known. However, such calculations do not provide exact values, only approximate ones. To precisely determine pH values, test kits such as the one shown here were used starting in the early twentieth century. The method is based on the discovery that so-called indicator dyes change their color under different pH values. These include litmus, which is red at pH values below 4.5 and turns blue above 8.3. The phrase "litmus test" even found its way into common parlance. The disadvantage of individual indicators is that they are specific to particular pH levels and thus only cover a narrow range of measurements. The test kit presented here therefore contains a mixture of indicators which, used together, cover the entire pH scale. Such mixtures of indicator dyes are called universal indicators. To measure the pH value, the indicators are added to a sample of the measuring solution and their subsequent color is compared with the corresponding color scale to determine various pH values.

The ability to determine pH values quickly and easily is a basic procedure for modern biomedical research. The instruction manual for this test kit shows that using it could be quite complicated. Color test kits are therefore no longer used in modern laboratories. They are not precise enough for most uses today.

Around 1930, Fritz Haber developed glass electrodes that are still used in modern pH meters. These permit establishing pH values to a precision of two decimal places. An early example of such devices is the pH meter and its measuring electrode, from Clamann & Granert, Dresden, also on display here, from 1966. This device is much easier to use than the test kit. The glass electrode is immersed in a calibration liquid whose pH value is known, then in the liquid to be tested, and the pH value can be read directly on the device. Modern pH meters also work according to this principle.

Type 13 refrigerated centrifuge, 1963

A centrifuge is a device used to separate mixtures of substances into their individual components. It exploits mass inertia by whirling containers with mixtures of substances in a uniform circular motion. The greater inertia of substances with a higher density cause them to migrate outwards due to the centrifugal force: they will be at the bottom of the containers after centrifugation. Components with lower densities are displaced proportionally, and reach the center through the circular movement. This means they collect at the upper end of the container after centrifugation.

One simple case where this is used is to centrifuge a blood sample to separate the denser blood cells from blood plasma, which is less dense. The benchtop centrifuge from the Heinz Janetzki company exhibited here in the museum is sufficient for such simple applications.

In comparison, a refrigerated centrifuge offers two innovations and advantages. On the one hand, it can reach higher speeds. This means it generates higher centrifugal forces and can thus separate components whose densities differ only slightly. This is crucial for biochemical and molecular biological questions because the differences in the density of proteins, for example, are smaller than those of cells and liquids, such as blood samples. The second innovation, as the name suggests, is the combination of a centrifuge with a refrigeration unit. This is also crucial for biochemical and molecular biological applications, since components with small differences in density have to be centrifuged for a correspondingly long time to reliably separate them. The cooling unit ensures that this happens at a constant temperature. Refrigerated centrifuges are still used today in blood banks, clinics, and biomedical research facilities.

Sledge and double sledge microtome, around 1930

Workstations like this one were used for histological examinations: studies of the shape or anatomy of cells or tissues and how they change in cases such as disease. Such anatomical assessments require examining the tissue under the microscope. This requires cutting it into very thin sections so that light can penetrate the object, which is necessary in transmission light microscopy. It is impossible to make tissue sections that are thin enough by hand – they need to be thinner than a human hair and evenly preserve tissue structure. Thus, to make the sections, scientists use a device called a microtome. In one type, a sledge microtome, the knife is guided through the tissue along a sled. Double-sledge microtomes were used to produce tissue sections with uniform thicknesses from larger specimens such as entire organs. Here, the blade is guided through the object by being held in two sleds.

This makes precision cutting devices such as the microtomes exhibited here, from the company R. Jung, Heidelberg, indispensable for histology. Without them, it would have been impossible for early neuroscientists such as Oskar and Cécile Vogt and Korbinian Brodmann to systematically analyze brains and determine the types of cell and tissues they found.

Ultramicrotomes can make even thinner slices. One such instrument is on display next to the electron microscope.

You can find more information about the production of permanent histological specimens in the video with this title, on the website of the virtual microscope museum: https://mikroskopmuseum.mdc-berlin.de.

You can find more information about the life and work of Oskar and Cécile Vogt in the brochure on the history of science or at www.campusart.berlin.

Electron microscope, 1966

This electron microscope was made by the factory for television electronics in Berlin and dates from 1966. It has a resolution of about one nanometer. Using electron-optical and light-optical post-enlargements, it achieves a total enlargement of a factor of about one million. The first electron microscope was developed in Berlin by Ernst Ruska and built in 1933. He received the Nobel Prize in Physics for this achievement in 1986.

Electron microscopes achieve incomparably higher magnifications than light microscopes because they work with electron beams, which have wavelength 100,000 times smaller than that of visible light. They have become indispensable instruments for anatomical and histological studies. Subcellular structures and viruses can only be made visible with electron microscopes because light microscopes do not achieve the necessary resolution.

You can find more information about the design and function of electron microscopes in the video with this title on the website of the virtual microscope museum: https://mikroskopmuseum.mdc-berlin.de.

The Microscope Exhibition

The exhibition “Invisible-Visible-Transparent” shows the unique connection between science and the optical industry that arose in the Berlin/Brandenburg region at the beginning of the 19th century. Microscopes built by Berlin engineers and opticians were used by Berlin scientists to establish a novel concept: the cell theory. This states that all organs are made up of cells. Cells cannot be seen or recognized without microscopes. The exhibition shows the wide range of Berlin/Brandenburg microscope manufacturers who sold their instruments worldwide during this time, and also introduces the important scientists who made groundbreaking discoveries in medicine with these instruments.

The exhibition consists of three parts:

1 In the ***Max Delbrück Communication Center***, you will find highlights from microscope production in Berlin and Brandenburg. Here 42 selected exhibits are presented from the 30 best-known manufacturers in the region. In addition, scientists from the Max Delbrück Center for Molecular Medicine explain modern microscopic techniques in video presentations. This station is part of the ‚Life Science Learning Lab‘ (“Gläsernes Labor“) training concept, which is designed specifically for school children.

2 In the ***Campus Museum in the Oskar-und-Cécile-Vogt-House*** a wide range of exhibits from regional microscope production in Berlin/Brandenburg are presented. Here you can see the around 100 microscopes from almost 50 manufacturers.

3 Last but not least, the ***virtual museum*** (mikroskopmuseum.mdc-berlin.de) presents the collection in its entirety. The virtual museum bridges the gap between history and modern times. Some videos present the manufacturers of the historical instruments alongside famous scientists who worked with these devices. The presentations show important synergies that arose from this close cooperation between science and industry. A series of videos introduce you to new microscopy methods that have been developed in recent years and thus open up completely new perspectives for biomedicine. Scientists from the MDC use examples from their research to illustrate the insights they have gained with these state-of-the-art processes

Further Information

Further Reading:

Heinz Bielka "History of the Medical-Biological Institute Berlin-Buch", Springer-Verlag Berlin, Heidelberg, New York, 2nd edition, 2002

"Geneticists in Berlin-Buch", published by the MDC for Molecular Medicine, 2008

Further information on the history of science can be found at www.campusart.berlin, where you will also find portraits of famous scientists, who worked on Campus Berlin-Buch during the past 100 years.

At www.campusberlinbuch.de you will also find information on guided tours and tours through the exhibitions on campus.

You can find information on current research projects at www.mdc-berlin.de & www.leibniz-fmp.de.

You can also gain an insight into some of the laboratories at the annual Long Night of the Sciences. You can find information on this at:
https://www.langenachtderwissenschaften.de/

Interested students and teachers are recommended to visit the "Gläserne Labor" of the Campus Berlin-Buch:
www.glaesernes-labor.de
This educational institution offers over 20 experimental courses on molecular biology, cell biology, neurobiology, chemistry, radioactivity, and ecology.

Besuch planen

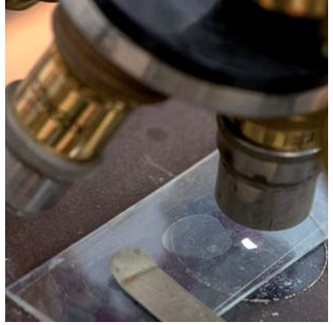
Directions to the campus can be found at:
www.campusart.berlin
Admission to all exhibitions is free.
Outdoor areas are accessable from sunrise to sunset. To visit the Jeanne Mammen exhibition, the microscope exhibition and the Campus Museum, please register at:
info@campusberlinbuch.de

Imprint

Publisher: Campus Berlin-Buch GmbH, Robert-Rössle-Str. 10, 13125 Berlin-Buch, www.campusberlinbuch.de
V.I.S.D.P.: Dr. Ulrich Scheller, Dr. Christina Quensel
Text: Dr. Jochen Müller
Editors: Dana Lafuente, Prof. Dr. Helmut Kettenmann, Annett Krause, Dr. Ulrich Scheller
Proofreading: Jutta Kramm
Translation: Russ Hodge
Photos: David Ausserhofer; Matthias Lindner: on pages 11, 16 right, 17, 18 left, 20 left; Katharina Bohm/MDC: page 22
Layout: CCGB, Maria-Nicole Becker
Printing: Druckerei Braul, Berlin-Pankow
Contact: Telephone: +49 (0)30 - 94 89 - 29 20, email: info@campusberlinbuch.de
Published: Juli 2022

We thank the Max Delbrück Center for Molecular Medicine in the Helmholtz Association (MDC) for support and the LOTTO-Stiftung Berlin for funding.

LOTTO STIFTUNG BERLIN



A view at the museum.