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THE WORKSHOPS OF SCIENCE

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CONTENTS

	Page
A Thousand Years of History *(T. Laky)*	7
The Hungarian Academy of Sciences *(T. Laky)*	30
Books from all over the World *(T. Laky)*	66
Planning for the Progress of Science in Hungary *(T. Laky)*	69
From Mathematics to Practice *(T. Laky)*	76
Before Dedication *(T. Laky)*	91
Combating an Endemic Disease *(T. Laky)*	98
Centre of Pharmaceutical Research *(P. Teknős)*	109
Nutrition and Science *(P. Teknős)*	111
Safeguarding the Health of Workers *(P. Teknős)*	114
Specialists of Industrial Apprentice Training *(P. Teknős)*	119
Scientific Degrees *(T. Laky)*	123

A THOUSAND YEARS OF HISTORY

In the museums of Hungary old books and manuscripts recalling the country's millennial past are by far less numerous than ancestral weapons, ancient swords and rifles. And the museums truly reflect past history, for though the neighbouring peoples were quick to learn about the Magyar warriors and war leaders, centuries passed before the renown of Hungarian scholars and men of letters spread beyond the frontiers of this country.

ON THE BANKS OF THE RIVER DANUBE

In Heroes' Square, one of the finest in Budapest, a group of seven equestrian statues represents the seven chieftains under whose leadership the Magyar tribes reached the eastern part of Central Europe in the late 9th century and occupied the territory of present-day Hungary, situated in the Carpathian Basin on both sides of the River Danube.

History tells of the struggles and vicissitudes of a nomadic people who, swept out by the waves of the great migrations from their original home in the Urals and driven first through the steppes of southern Russia and then westwards by the conquering invaders, arrived finally in the region where Hungary now lies. It was here that the ancient Magyars—by

then a semi-nomadic people of 200 to 250 thousand—acquired by sword a new home for themselves and new pastures for their animals.

The newcomers were wholly ignorant of the fact that but a few centuries before their time the best part of their new country had under the name of Pannonia constituted a province of the great Roman Empire, where legions marched along well-built roads and citizens of Rome enjoyed a highly civilized existence. By the time of the Magyar conquest, however, most of this was already covered by the earth on which the forebears of the Hungarian people pitched their tents.

And thus the new dwellers of Pannonia settled down on the freshly occupied land. Step by step their nomadic ways of living became blended with the habits of the indigenous Slavic population: the tents gave way to huts made of mud, reed and sticks, and rudimentary forms of agriculture began to make their appearance. But spiritually they were still in darkness and could have no knowledge of the revival of the cultural heritage of the great vanished empires which was taking place in many parts of the contemporary world: in Arab universities, where young men from many a Christian country went to study astronomy, chemistry, arithmetic, geometry and medicine; in India, where the science of numbers had reached a high level; in China, where newspapers were already being printed; and in the countries, not so very distant from the land of the Magyars, where a new culture was emerging and the great traditions of ancient Rome were surviving in the glories of Byzantium.

The only writing the ancient Magyars knew consisted of runic symbols. A full century elapsed following the conquest before the first scribes, priests from the West, made their appearance in the country.

At the end of the 10th century King Stephen I, founder of the Hungarian monarchy, turned to the mighty Church of Rome for help in his efforts aimed at saving the Hungarian nation from disintegration, which he deemed inevitable unless it rid itself of its old ways of living, its tribal organization and its pagan rites. Emerging victorious from the struggles with the tribal leaders who were defending the old order, King Stephen I laid down the foundations of a powerful and centralized monarchy, and created thus the framework for further economic and social progress.

Priests came from Germany, Rome and Venice, bringing a new religion and a new culture to the land of the Magyars. The King's soldiers went along with the preachers of the Gospel, to bring force to bear whenever necessary on those who, clinging to the deities of their forefathers, refused to embrace Christianity. The first churches were erected to become strongholds of the new faith; a law provided that for each district of ten villages at least one church should be built. Besides being the nuclei of the new faith, the churches also became the first primitive centres of Western civilization, with the friars setting out to teach the people the more advanced methods of agriculture: ploughing, sowing and harvesting.

The people that had thus slowly come to adopt the agricultural way of living were compelled to give up one-tenth of their produce to the Church, which became the mainstay of the new instrument of oppression, the State. This was a high price to pay—but then the proceeds provided the only means to raise the population's educational level, paying as they did for the establishment of the first schools in the monasteries, the bases of future cultural development.

ITINERANT STUDENTS

It took some two centuries for the reforms introduced by King Stephen I to become fully effective and for the nomadic people to settle down definitely to agriculture.

By then the new states throughout Europe had consolidated their position and, as a consequence, life had become easier and travelling more secure. With peaceful conditions the longing for knowledge was quick to gain in intensity. Students from many parts took to the road, often in groups, heading for centres famous for their erudite masters. Far-reaching was the reputation of the law school of Bologna or of the universities, such as those of Salerno and Paris, which had come into existence through the association of the students' or masters' guilds, and where the young men from Hungary soon made their appearance among the students rallied there from all over Europe.

It was at about the same period that the first royal chancelleries were being set up in Hungary and the need arose for educated clerks versed in law to deal with the affairs of the court. Education in capitular schools was, however, entirely ecclesiastical in character and the knowledge it afforded hardly qualified for a chancellery post. There arose also other needs. In the castles of both the King and the oligarchs foreign physicians of renown were always welcome and preferred to the doctoring friars. This also aroused interest in the study of the medical sciences.

True, men of learning, on their return from universities abroad, would hardly undertake any independent scientific work in their country; most of them were satisfied with a clerical job or with that of assistant to some famous foreign doctor. During their wanderings they had none the less come

into close contact with the current trends of European culture which was thus brought to Hungary not only by foreign intermediaries but also by the country's own sons.

IN THE COURT OF KING MATTHIAS CORVINUS

In the preceding pages the cultural history of some five hundred years was briefly surveyed. Though Hungary had thirty-four kings during that period, King Matthias Corvinus (1443-1490, r. 1458-1490) was the first since Stephen I to endeavour deliberately to raise his country to the European cultural level.

Married to a princess of Naples, Matthias Corvinus brought the most celebrated Italian scientists and architects of the age to his court. The royal court of Hungary became thus a home of the humanist ideas of Italian Renaissance. To his splendid palace full of treasures of art the King attached a fine library which he equipped with great care and munificence. He ordered richly illuminated codices from Florence and had their silken, velvet or leather covers decorated with his family arms depicting a black raven. Hence the collective Latin name of these books: *Corvinae*. The library of King Matthias contained some 350 of these codices—a collection of incredible richness according to the notions of the age. "A shelter to delight the intellect"—this is how contemporary men of learning alluded to the library, housed in two great halls, one containing Latin and the other Greek books on medicine, astronomy, geography and Church literature.

The library as well as the liberality displayed by the King towards the world of learning attracted the foremost scholars and scientists of the day to Hungary. The men of science

living at the court of Matthias Corvinus united in the Danubian Learned Society, the Buda group of which was organized by the well-known German humanist Konrad Celtes in 1497, i. e. nearly a century prior to the foundation of the Florentine Accademia della Crusca. The Learned Society set itself the task of endeavouring to bring about international cooperation in the intellectual domain.

The mid-14th century saw the setting up of universities—the independent intellectual centres of their respective countries—in nearby Vienna, Cracow and Prague. In Hungary, the first university founded in 1367 at Pécs was only short-lived and so was the second one established in 1387. The third Hungarian university was set up by King Matthias Corvinus in 1467.

The King spared no effort in establishing the university, inviting to its chairs as he did foreign professors of the highest standards, among them Regiomontanus, the greatest astronomer of the period. Young men desirous of learning received their preparatory education in the capitular schools where they were taught reading and writing in Latin as well as arithmetic, geometry, natural history, astronomy and music. At the end of the 15th century there were 150 such schools in the country.

At the same period Hungarian students were also attending universities abroad. Three of the professors lecturing on medicine at the university of Bologna–Paulus Hungarus, Giovanni and Dionisio d'Ungheria—were of Hungarian origin.

It was also during the reign of Matthias Corvinus that the first book was printed in Hungary, a mere thirty years after the introduction of book printing. This book, the Buda Chronicle, was a work on the history of Hungary, written in the Latin language.

The refined culture of the Corvinian court, however, hardly penetrated beyond the walls of Buda Castle. Even the richest members of the feudal aristocracy which formed the immediate *entourage* of the King remained illiterate, and to the huts built of mud and sticks, or simply dug into the ground, where the majority of the country's population lived, often together with their animals, nothing of the treasures of knowledge and intellect found its way.

A COUNTRY DIVIDED IN THREE

Less than fifty years after the death of the great King, the strong royal power, the brilliant court and the placid circle of men of learning were already things of the past. As a consequence of the struggle that broke out between the rival oligarchs contending for power, the country fell into three parts: the central region was occupied by the Ottoman Turks, the western part came under the sovereignty of the increasingly powerful House of Hapsburg, and it was only in the eastern territory called Transylvania that the Hungarian people retained their national existence in a more or less independent principality which afforded also greater cultural possibilities.

That Hungarian culture could escape total ruin and survive at all in this unfortunate era was largely due to the Reformation. The doctrines of Luther and Calvin reached the country through the intermediary of Hungarian students educated abroad, who carried them into the villages and townships of the two parts not under Turkish occupation. Despite persecution, the new faith was quick to spread, its popularity being mainly due to the fact that its pastors spoke

the vernacular, in contrast with the Latin employed in the Roman Catholic ritual.

Without delay the Protestant churches proceeded to set up their schools where anybody could acquire the knowledge of reading and writing. The Catholic Church reacted with an accelerated development of its own institutions. Although the advance brought about by the rivalry between the two confessions was but a modest one—only two hundred of the country's several thousand communities had a school, with three quarters of all existing institutions having been set up but recently by the Protestants—it was none the less instrumental in making education more general.

The university in the country's western part was founded by the Catholic Hapsburg ruler, while that in the eastern region owed its existence to the Prince of Transylvania, the staunch supporter of the Protestants. Both universities strove to attract erudite professors, and those at the university of the eastern region drew princely salaries. In both parts of the country the major schools set up their own printing shops where textbooks were produced. A 144-page arithmetic meant for the broad masses ignorant of Latin was thus published in 1577, bearing the title *Debreceni Aritmetika* (Debrecen Arithmetic). In the early 16th century manuscript literature ceased to exist virtually overnight (probably no more than fifty codices were written over the whole century), for printing presses were now turning out books by the hundreds. The Bible, translated by the Protestants into Hungarian, circulated among the people in many hundreds of copies.

Although the devastating wars and the religious conflicts of the period constituted a grave obstacle to profound studies, general knowledge was undeniably gaining ground. In

the small village school there would always be a few children of ten to twelve years of age learning under the guidance of the pastor or schoolmaster. He who wanted his son to become a clergyman or a clerk had him enrolled later in some higher institution of one of the Churches, where he could study for a further six to ten years.

Nor was the cleric or the schoolmaster missing from the houses of the wealthy landowning nobility—the class that wielded the greatest political and social power at the period—whose children he would tutor. For although only a few of this older generation were literate, the acquisition of the conventional knowledge of the age was becoming the accepted practice in the upbringing of their children.

However, public education was, on the whole, still in its primitive stages. By the end of the era the best of the Hungarian pedagogues came to realize the fact that even in the two parts of the country where conditions were comparatively peaceful, the cultural level remained far below that of western Europe. The teaching of Latin took up most of the curriculum for several years in the Hungarian institutions of learning, while other disciplines such as history, geography, mathematics and astronomy—which in other countries had already made great progress—were almost completely neglected.

Yet during the century and a half when in Hungary the light of learning was nearly extinct as a consequence of Turkish rule and the country's disrupted state, the great scientists of the era—Copernicus, Kepler, Galileo, Harvey, Torricelli, and Newton—were doing away with the old concept of the universe and presenting the outlines of a new one to an astonished humanity.

The splendid mansions of Vienna were full of ambassadors and foreign guests—the capital of Imperial Austria housed the brilliant court of Maria Theresa, Hapsburg ruler over a large part of Europe, with a far-reaching influence due to family ties.

And in this city of brilliance, secluding himself from court life, a young Hungarian member of the Queen's Guard was putting to paper an essay with the title: "Humble Views on a Hungarian Learned Society." The guardsman, György Bessenyei, was the leader of a circle of *literati* stimulated by the ideas of French Enlightenment. What he was writing about were the wishes of a nation awakening to a new consciousness: that the Hungarian language should be developed and that education—in his opinion the principal tool of the nation's prosperity—should be fostered.

And high time it was, too, to revive the national consciousness before the imperial government's attempts to Germanize the country could be crowned with complete success. Was not Buda* the country's capital only in name, with the real seat of government in Vienna? Were not the country's industries underdeveloped because it did so suit Austrian interests? Agricultural production was in an obsolete state, the towns scarcely alive. With Latin the language of religion and science, French that of the court, and German of the bureaucracy, the Hungarian tongue was undeservedly pushed into the background. The first works of Hungarian historical science—those of Mátyás Bél, György Pray, and István Katona—were written in Latin, and so were the first

* Then the part of today's Budapest which is on the right (west) bank of the Danube. Buda and Pest merged into Budapest in 1872.

treatises on the country's geography and the books dealing with the past of Hungarian science. Even the first systematic treatise on the origins and history of the Hungarian language appeared in Latin. Bessenyei had thus every reason to write: "No nation on the Globe could ever acquire profundity of knowledge unless it brought the sciences into the orbit of its own vernacular tongue." Elementary schooling was at the time still largely confined to the instruction of religion and morals, reading, writing and the first four rules of arithmetic. About half of the villages were lacking even this, for scarcity of both schools and schoolmasters. Nor could any improvement—either quantitative or qualitative—be registered as far as grammar schools were concerned. As for the universities, their main purpose was to turn out useful civil servants. The only progress in this field was the establishment in 1770 of a faculty of medicine.

The first journal in the Hungarian language was launched in 1780 under the name of *Magyar Hírmondó* (Hungarian Courier) by a small group of enthusiasts fighting against oppression and for national existence. But nearly ten years had to elapse before Bessenyei's project matured into reality and the Hungarian Patriotic Society formed itself in the country's centre. Noble though the intent was, the efforts proved almost worthless. The vital element of an educated public opinion was still missing. There was no reading public to speak of, and the most important works were published in no more than two hundred copies, for no one except the schools and a few patrons of literature would purchase them. And the Hungarian language itself was still rather poor and inadequate as a vehicle of higher thoughts.

One of those inciting the nation to fight against Hapsburg oppression was Ferenc Kazinczy, a writer of great erudition

and high culture acquired in the course of his travels throughout Europe. A follower of Bessenyei, he gathered around himself the writers and poets of the age and together with them set about the task of enriching and reforming the Hungarian language.

"The first endeavour of him who wishes for the Hungarian people to become a nation of learning should be to enrich and polish its native tongue," said Bessenyei. This is what the writers and poets endeavoured to do, and while they were carrying out the task of "polishing" the national language, Hungarian linguistics was born. There appeared the first Hungarian grammatical work which followed the natural construction of the Hungarian language instead of being based on Latin grammar. The author was Sámuel Gyarmathi whose other work on the relationship between the Hungarian and Finnish languages may be regarded as an achievement of international significance, laying as it did the foundations of comparative linguistics. In the early years of the 19th century Miklós Révai, another outstanding Hungarian philologist of the period, published his Hungarian grammar written with a historical emphasis.

Hungarian grammatical and lexicographic literature saw a revival and served the important social requirements of the age.

As for the state of the rest of the sciences, the chronicler finds very little worth mentioning. For example, although the country's mineral deposits were varied and had been comparatively well explored, its geology remained almost wholly unknown. It was only in the fields of geodesy and cartography that some important work was done. Sámuel Mikoviny, an eminent scientist, prepared comprehensive maps on the various regions of the country, carrying out the

work of triangulation and determination of longitude and latitude. Mikoviny was a member of the Berlin Academy of Sciences and he is still quoted in international literature. His work was published and he was elected a member of the Berlin Society of Sciences.

In the field of medicine as yet practically no experimentation was done. Although the faculty of medicine was able to boast of five professors, instruction was based largely on textbooks, and only after students began to patronize a poorhouse in the city, did the conditions for rudimentary clinical work become established.

The little work that was done in mathematics did not go beyond occasional reviews of foreign methods, quite often outdated by the time of their publication. The author of one of them wrote about the mathematical culture of his times: "It cannot be deeply enough regretted that this country is clouded by such a dense mist of ignorance that the mere name of this divine science elicits admiration."

Pál Sipos, the first Hungarian mathematician known to have written an original treatise that was up to the standards of his times, had studied at the universities of Frankfurt, Göttingen and Vienna. His paper, whose most important contribution is an approximate definition of the circumference of the ellipse, was published in 1796 by the Berlin Academy of Sciences and won a gold medal.

"FOR THE PURPOSE OF REVIVING THE NATION'S LANGUAGE AND SPIRIT"

In this same period of the late 18th century new directions for the progress of mankind were marked out by a number of ingenious inventions. Electricity was discovered by Galvani, professor of anatomy at the university of Bologna; a series of inventions of the Italian Volta led to the construction of the first electrical apparatuses; and Watt's steam-engine was launched on its triumphant career. By 1789 dozens of steam-engines were in operation in England.

But even these great inventions which had provoked an industrial revolution in part of Europe, could not move Hungarian industry and science from the deadlock. The development of Hungarian industry was thwarted by the policies of the Austrian dynasty and such industries as existed were choking in the twofold grip of the backward political system of feudalism and a tariff system instituted with the consent of an aulic aristocracy. With only one mining and one engineering academy, and only two agricultural colleges in the whole country, even the training of technical personnel was rendered difficult. Neither the university—where the curriculum was tied to textbooks subjected to the pettiness of censorship—nor the academies were suited to become the workshops of scientific training. It was only owing to a few outstanding professors that they achieved more than the court of Vienna expected them to do: to turn out loyal subjects of the House of Hapsburg. Nor was elementary education in any way superior—the scarcity of schools, the low standard of teachers' training, the lack of funds, the shamefully wretched salaries of the schoolmasters, and general poverty, were all impediments to progress in the field.

The handful of Hungarian scientists were working in isolation, without even the meager support or appreciation. Farkas Bolyai, one of the most gifted mathematicians of the age who as a youth had carried out an exchange of ideas with Gauss, was leading a reduced small-town existence. His son János, a man of true mathematical genius, was a pupil at a military academy which regulated his days with a thousand-and-one rules and left him little time to pursue the studies to which he was passionately devoted. Sámuel Tessedik, a pioneer of agricultural progress in Hungary, had only a small plot assigned to him by some landowner to carry out his experiments and none but his own means to fall back upon when laying the foundation of the country's first college of agriculture.

Educational and linguistic reform in Hungary could thus not be put off any longer, and it had become imperative to create the conditions necessary for it.

At the 1825 Diet a member reproached the peers of the realm for speaking exclusively in foreign languages and neglecting the national tongue. His speech was received with astonished exclamations. Count István Széchenyi, one of the wealthiest aristocrats in the country, immediately rose to his feet and before a surprised but enthusiastically cheering House offered one year's income from his estates "for the purpose of reviving the nation's language and spirit." The noble gesture found immediate followers. This is how the Hungarian Learned Society came into existence.

But reforms alone proved inadequate for the restoration of freedom, and the nation was finally compelled to take up arms against the forces of oppression which had prevailed for over three centuries. Among the organizers and leaders of the War of Independence that broke out in 1848 could be

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found the foremost representatives of Hungarian intellectual life. Writers and poets as well as professors and students of the University rallied round the great lyricist Sándor Petőfi. The struggle against Austria went on for more than a year, and the House of Hapsburg was finally compelled to ask the Tsar of Russia for help in order to overcome the fighters for Hungarian independence.

The War of Independence was followed by a period of absolutist rule that lasted for nearly twenty years. It was only in 1866, when the defeat suffered from her ancient rival Prussia had weakened her position, that Austria found it to her interest to appease the Hungarian people. The compromise brought about in 1867 marked the beginning of the era of the Austro-Hungarian Monarchy, under which the Hungarian nation was comparatively independent in dealing with its internal affairs. The age of the bourgeois revolution had come to an end, and a new one, that of peaceful economic progress, commenced. The revival of science and culture as well as the reorganization of public health and public education were concomitant with the development of capitalist production and the rise of the middle classes. In the years that followed the compromise of 1867, the network of elementary schools began slowly to spread, and towards the end of the century the number of students attending the country's 164 secondary schools was also showing an upward trend. In 1868 the first secondary schools for girls and training college for schoolmistresses also opened their gates.

Gradually the universities also came to new life. The work of scientific training was especially intensified in Budapest University, where a number of new departments were set up and, under the guidance of renowned professors, certain branches of study attained a European level. In 1870 the

University was attended by 2,500 students whose number rose to 8,000 by the end of the century. Clinics and institutes, the workshops of training and research, were also beginning to take shape.

It was an era when, for the first time in Hungary's thousand years of history, Hungarian science was making a name for itself even beyond the country's frontiers.

THE PIONEERS OF HUNGARIAN SCIENCE

Though working under unfavourable conditions, in solitude and isolation, in an age when science was making rapid progress all over the world, a few Hungarian scientists were still able to attain universally important results.

The two Bolyais

They were father and son, Farkas and János Bolyai. The father's principal work *Tentamen juventutem studiosam in elementa matheseos . . . introducendi* was published anonymously in 1832-33. Sizing up the merits of the *Tentamen*, Gauss, that giant of mathematics, paid tribute to the author both for his thoroughness and originality. A modest scientist living in seclusion, the elder Bolyai brought up his son to become a mathematician and entrusted to him the task of solving the problem of the Euclidean parallels, a continuation of his own work. He who could prove the axiom of the parallels, he told his son, would deserve a diamond the size of the Earth.

The son took up the challenge and showed himself worthy of the trust. In 1823, at the age of twenty-one, he could al-

ready write to his father: "Out of nothing I have created a new, a different universe . . ." His search for a proof of the parallel axiom had led him on to new paths and indeed to the discovery of a new world—that of non-Euclidean space, a geometrical system that was to become known to the world of science as Bolyaian geometry.

It was, however, much later that the distinction which found its expression in this denomination was bestowed on him by posterity. Though his work appeared in print as an appendix to his father's *Tentamen*, the author of *Appendix Scientiam spatii absolute veram exhibens* was for a lifetime to wait in vain for the appreciation of his contemporaries in the world of science.

At present those engaged in mathematics all over the world are well acquainted both with the *Appendix* and with the name of its author, János Bolyai.

Ignác Semmelweis, the saviour of mothers

In the late 1840's the death rate at the Vienna maternity clinic—at the time one of the most important institutions of its kind in the world—was showing an alarming increase. There were periods when as many as thirty per cent of the mothers at the hospital finished in the cemetery. "Cause of death: puerperal fever." And it was not only in Vienna that this mysterious epidemic was raging; in the crowded maternity wards of Paris, London and other big cities, the death rate at times soared from the average level of five or ten per cent to twenty and even thirty.

Helplessly the doctors stood by. Where was it coming from, this deadly fever against which there was no protec-

tion and for which there existed no medicine? Some attributed it to the *genius epidemians*, the "epidemic spirit"; others again to the excitement and pains of labour or to the fears that beset women in childbirth.

There was, however, a young Hungarian doctor at the hospital, Ignác Semmelweis, who held different views on the problem. A man of deeply humanitarian feelings, he spent several years in restless research for the causes of the disease. He found that the infection was transmitted to the mothers by the doctors who had performed dissections on the bodies of the dead, and that he too was thus a cause of maternity deaths. The recognition of this horrible fact drove him to even more feverish activity in search for a medium that would remove the contagious matter from the doctor's hand. At that time bacteria were still unknown to science—Semmelweis could only discern the contagious matter by its smell. After long experimenting he finally found what he was looking for: a chlorinated lime solution for cleansing the hands, to be used by all those engaged in obstetrics.

By 1848 puerperal sepsis had ceased to ravage at the clinic. When Semmelweis later became head of a Budapest maternity ward, he was able to reduce the mortality rate to below one per cent—an achievement on which even several decades later only the most modernly equipped lying-in hospitals of Europe could pride themselves. Semmelweis was thus a pioneer in this field, though general recognition of his initiative came only some time after his death when his empirical results were also theoretically confirmed by the systematic investigations of Pasteur and Koch. The credit for scientific generalization and actual discovery must be given to others—yet the name of Semmelweis was praised by thousands of mothers.

Sándor Kőrösi Csoma, the wanderer of Tibet

In the cemetery of Darjeeling a Hungarian inscription can be found on one of the gravestones. The memorial erected over the grave by the Asiatic Society of Bengal bears the epitaph: "A poor and lonely man from Hungary, lacking both funds and applause but fired by patriotic zeal, searched for the home of the Magyars and in the end collapsed under the strains of his journey."

Sándor Kőrösi Csoma was, in the words originally spoken by István Széchenyi, the "poor and lonely man from Hungary" who in 1819 at the age of 35, with only 200 florins in his pocket and a satchel on his shoulder, set out on foot for Asia where popular belief supposed the brethren of the kinless Hungarian people to live.

At this period the major part of Asia was still unexplored and from early youth Sándor Kőrösi Csoma prepared himself for the task of searching in an unknown country for his kindred people. As a student without means, he first attended grammar school, then went on to the University of Göttingen, where, under the guidance of excellent professors, he mastered the oriental languages.

His journey through the Balkans, Greece, Egypt and India was full of hardships and vicissitudes. Heading for central Asia, he reached the western part of Tibet. Here, penniless and without any hope of going further, he accepted the British Government's proposal to undertake the preparation of a Tibetan grammar and dictionary. Settling down in a lama monastery in a most inhospitable region and working from morning till night in the icy cold of a little cell, he collected within a year and a half some forty thousand Tibetan words. Meanwhile his modest allowance was

withdrawn, he was arrested on the charge of espionage, and it was only after many ordeals that in 1834 he was finally able to publish his work, the first systematic grammar of the Tibetan language and the first Tibeto-English dictionary. His activities were appreciated by the whole scholarly world and he was elected a member of several learned societies.

Kőrösi Csoma spent seven more years in India, studying the dialects of northern Bengal. At the age of 58 he again took to the road in pursuance of his original project to find the Asian relatives of the Magyar people. On his way he fell seriously ill, and after so many struggles his tired body finally found rest at the Darjeeling cemetery.

Sándor Kőrösi Csoma never found the original home of the Magyar people, but he did achieve the utmost a scholar may aspire to: his contribution to the advance of universal science added to the reputation of his country.

Ányos Jedlik, a Hungarian pioneer of electrical engineering

The history of physics regards Saxton as the builder of the first electric engine and attributes to Werner von Siemens both the formulation of the dynamoelectric principle and the invention of the dynamo itself. Yet they were both preceded in the field by Ányos Jedlik, a Hungarian physicist working and experimenting single-handed.

The son of a poor peasant family, Jedlik pursued his studies with great strength of mind and tenacity. In 1821 he took a degree at the University of Pest in mathematics and physics, to which a year later he added one in philosophy and history. Setting out on his teaching career at a denominational grammar school in a provincial town, he carried out his first ex-

periments at the physical laboratory of the institution. It was here that he constructed in 1828—five years before Saxton—his electromagnetic motor, which is still preserved in good working order.

A few years later he was already professor at the University, where he was among the first to deliver his lectures in Hungarian instead of Latin. An ardent supporter of the cause of the Hungarian War of Independence, he suffered persecution after the collapse of the revolution. Later he was restored to his chair and, living in even greater seclusion than before, devoted all his powers to experiments on electricity. Formulating the principle of the dynamo in 1856, he constructed his machine in 1861. In this he was ten years ahead of Siemens, who was, however, wholly ignorant of his Hungarian precursor—as indeed he must have been, for Jedlik was in no position to publicize his invention.

His name became known to the contemporary world of physics only in 1873 when at the Vienna World Exhibition he presented another of his inventions, designed about ten years earlier. This, an apparatus which generated electric sparks of 90 cm length and 1.5 million volts, may be considered a forerunner of the pulse generator employed at present in nuclear fission. This apparatus with its immense sparks and thunder became the sensation of the Exhibition and was much admired by colleagues from abroad.

Although the world is ignorant of a number of his experiments which deserve world-wide recognition, Jedlik must be ranged with those who helped to launch electric energy on its victorious career.

In the early years of the century wherever oil or ore and coal prospecting was carried out, a device constructed by a Hungarian scientist was generally employed: the Eötvös balance, which helped to identify the composition of underground strata. The invention was of immense significance at the period, contributing as it did to the development of mining and oil prospecting.

Loránd Eötvös, worthy successor of Ányos Jedlik in his chair, made himself a name also in other domains of research. His first results to earn world-wide recognition were attained in investigating the phenomenon of capillarity, that is, the action by which the surface of a liquid, when in contact with a solid, is elevated or depressed. Working out a method for the measurement of surface tension in liquids, he laid down the rule that became known as Eötvös's law. His discoveries in the field of capillarity are equally important from the theoretical and the practical point of view and provided a strong stimulus to research in the field of physical chemistry.

His life-work was well known and highly appreciated in the scientific world. Elected a fellow of numerous learned societies abroad, Eötvös was a member and later on the president of the Hungarian Academy of Sciences.

THE HUNGARIAN ACADEMY OF SCIENCES

Were a cameraman to prepare a film on the Hungarian Academy of Sciences, he would certainly choose to begin by presenting the surrounding panorama. The left bank of the Danube traversing Budapest is lined here with the fine buildings of the town centre, and it is here that the noble arc of Chain Bridge spans the river. The centenary seat of the Academy occupies the northern side of a square situated at the Pest end of Chain Bridge and skirted by stately buildings. On the opposite bank of the river the imposing complex of the former Royal Palace, standing out against the background of the Buda mountains, offers a splendid view.

The Academy, built in Neo-Renaissance style, was completed in 1865. The necessary funds were raised by country-wide subscription, and it was thus by the joint efforts of the whole nation that Hungarian science, already making important contributions to the universal progress of mankind, received its headquarters which has remained the seat of the supreme institution of Hungarian scientific life to the present day.

At the time of the inauguration of its headquarters, the Academy, founded in 1825 as the Hungarian Learned Society, was already looking back on a past of forty years. The circumstances of its foundation and the events of the years that followed it—events that determined both the country's destiny and the activities of the institution—were surveyed in a previous chapter of this volume (see pp. 21-22). And though the Academy's history of nearly a century and a half offers a hundred subjects for narrative, the present work will have to limit itself to a few details illustrative of the organization and the functioning of the network of scientific institutions which exists at present in this country.

The Hungarian Learned Society owed its existence to the demand for national independence. Rallying those striving for the revival of the Hungarian language and for the cultivation of the sciences in the national tongue, the Society was founded not at the wish or on the initiative of the country's rulers but, to the contrary, in opposition to Hapsburg oppression and to mark a nation-wide movement of the partisans of Hungarian culture. And it was for this very reason that many obstacles had to be overcome before the Society could settle down to regular work in 1830. The heroic period that followed the foundation and the beginning of actual work was marked by the desire for activity and by the search for the right path, a period when all the men of science, literature and politics who had assisted at the birth of the Society were imbued with the wish for the revival of national life and science.

Assembling the prime of a nation fighting for independence, the Hungarian Learned Society chose the optimistic

motto "After rain comes sunshine". And at the initial period it seemed that the wish expressed in the motto was coming true.

THE FIRST STEPS

The first election of members to the Hungarian Academy of Sciences took place in the opening session of the learned society in 1830. At the same time the first sections—those of linguistics, philosophy, the historical sciences, mathematics, law and the natural sciences—were set up. The first general assembly, which marked the beginning of actual work, was held a year later. On this occasion twelve honorary members as well as twenty Hungarian and two foreign corresponding members were added to the regular members of the Academy elected in the preceding year.

The majority of the newly formed sections consisted, however, of but a single outstanding representative of the particular discipline, and could hardly be regarded as a centre of organized scientific activity. The emphasis of the Academy's work lay on the cultivation and propagation of the Hungarian language, and it was, accordingly, the department of linguistics that disposed of the best defined working programme. With a number of celebrated poets and writers among those engaged in this work, a major venture was immediately embarked on: the compilation of a comprehensive dictionary of the Hungarian language, to be systematically composed at weekly meetings. Other possibilities for developing and cultivating the Hungarian language were also found by the linguists. Animated by the wish to foster the national stage, they began to translate into Hungarian the works of English, Italian, French, Spanish

and German drama. The Academy offered a prize for original Hungarian dramatic works. The rules of Hungarian orthography were published together with a systematic Hungarian grammar, dictionaries, textbooks, and alphabet boards for elementary school teaching.

Gradually work commenced in the other departments also. The archeologists began the systematic collection and classification of finds unearthed in Hungary. The work of copying the historical documents connected with Hungary found in the Paris, London and Brussels archives as well as the record offices in Italy, Germany and Spain commenced as early as the 1830's. The first publications of the Academy also date from this period. They include the imposing volumes of a collection of early Hungarian written records and the Hungarian translations of Greek and Latin classics as well as of the works of the great European poets and the foremost foreign scientists of the 16th to 19th centuries.

The organizing of extensive study tours abroad and the offering of prizes for outstanding achievements in the fields of science and the arts were also part of the Academy's programme aimed at fostering the favourable development of cultural life in the country.

In the course of those prolific years a great number of Hungarian and also foreign scientists were elected to the Academy, which was beginning to command the respect of the world of science even outside Europe.

The period of great expectations was, however, of short duration. In 1849 came the collapse of the nation's armed struggle for independence and the rulers of Austria, having regained their power, mercilessly proceeded to retribution. In the following era of the dungeon and the gallows, the whole country was submitted to measures of retaliation.

Under this absolutism the Academy too was placed under tight control. Its governing bodies were filled with aristocrats siding with the dynasty, who usurped thus in the name of the ruling power the places due to the scientists. On government demand changes were offered in the Charter of the Academy. This coercive measure was aimed at restraining one of the Academy's most important activities, that of the cultivation of the Hungarian language which was a part not only of the scientific programme of the institution, but also of the struggle against Austrian oppression and for national independence.

Many scientists had to go into exile, others were deprived of their university chairs and forced into retirement from cultural life. The members of the Academy, reduced in number, were allowed to hold their meetings only in the presence of an Imperial commissary.

Terror though provoked a stubborn passive resistance on the part of the nation, and the Academy, with its handful of Hungarian scientists, became a bastion of the anti-Hapsburg fight for national language and culture. It was this passive resistance that characterized the period, manifesting itself in every commemoration of a Hungarian writer, poet or linguist of former times. By 1858 resistance had assumed the form of a nation-wide movement of protest against the new

Charter imposed on the Academy. In addition to the wish to insure the future of Hungarian science, this angry mood of protest was a major component of the success of the public subscription to the costs of the Academy building, a subscription to which—to quote the words of a contemporary record—"the dwellers of even the humblest lodge and cottage have brought their pennies".

A decade had to pass before the Academy was, in 1858, again in a position to elect new members. This time, however, a whole range of Hungarian and foreign scientists of renown were affiliated, thus, for example, Ányos Jedlik, Hungarian inventor of the electromagnetic motor and the dynamo; the orientalist Ármin Vámbéry, a pioneer in Turkish philology; the German physicochemist Robert Bunsen; the English chemist and physicist Michael Faraday; the German linguist Jacob Grimm; the German geographer Alexander Humboldt; the German chemist Justus von Liebig; the English historian Lord Macaulay; the Belgian mathematician Lambert-Adolphe-Jacques Quételet, and several other celebrities of the age.

Even in this period of hardships the Academy produced some outstanding results. The 1850's saw the publication of several excellent series of books and booklets which afforded the Hungarian historians and archeologists a vehicle to give regular publicity to their work. Several important literary, historical, archeological and philosophical contributions of Hungarian and foreign scholars were also made accessible in book form.

In the early 1860's as scientific life slowly revived, some headway was made in building the Academy edifice. Its completion in 1865 provided Hungarian science with suitable headquarters.

Failing to recognize the importance of the social transformation and the wave of industrialization that followed the Compromise of 1867 with Austria, the Academy was unfortunately guided by earlier traditions rather than regard for the future. This accounts for the fact that in the course of the reorganization which took place in 1870, the six sections were amalgamated in such a way that all natural sciences were confined to a single department. Linguistics and the liberal arts were allotted to the first section, historical, philosophical and literary sciences to the second; and mathematics together with the natural sciences only to the third.

This relegation of the natural sciences into the background left an enduring mark both on the Academy and on Hungarian scientific life as a whole; seventy years later, in the 1940's, as much as 63 per cent of the Academy's membership was still made up of representatives of linguistics, the historical and social sciences, and philosophy, while only 37 per cent of all academicians were cultivating mathematics and the rest of the natural sciences.

Yet it was exactly the representatives of the "neglected" branches of sciences who made a name for Hungary in the international world of knowledge. Loránd Eötvös attained world renown with his physical research work and with the torsion balance that bears his name. Equally well known were the Hungarian mathematicians: Gyula König, an eminent scholar of algebraic analysis; Lipót Fejér, whose investigations into the harmonic series were internationally appreciated; and Frigyes Riesz, whose outstanding results lay mainly in the field of the theory of real functions and of functional analysis. Universally known was Donát Bánki, a

pioneer of motor construction whose engine and turbine named after him counted for brilliant achievements at the time. So were the physicist and mathematician József Petzval, inventor of the first photographic lens, Elek Sigmond, chemist, physicist and renowned pioneer in the field of soil colloids, and many other Hungarian scientists.

From the Academy, however, they received scarcely more than moral support. The institution continued to limit its activities to fostering the philological and historical sciences. In the field of linguistics some important results were achieved, but beyond this, all the Academy could produce were some five to six volumes per year and a limited number of new scientific journals.

But over the subsequent years even these modest achievements lost much of their lustre. A few decades ago the Academy was still surrounded by "dignified" silence—the silence of isolation and emptiness. The board of directors was composed of an archduke, two high prelates, nine counts, two barons, three royal councillors, and—as against the seventeen representatives of the ruling classes—only seven untitled scientists. It became a commonplace to speak of the Academy as unscientific; its meetings afforded the grievous sight of a society of old men out of touch with real life. What now were the reasons for this degeneration of an institution which had started under such favourable auspices and which was always able to resume its activities even in the most adverse circumstances?

A few dates—turning-points in the country's history—will furnish the explanation.

History has not treated this small country kindly; the disasters that repeatedly befell the nation were quick to efface the memory of the short periods of peace and quiet. The era

of prosperity and progress ushered in by the formation in 1867 of the Austro-Hungarian Monarchy—which after so many struggles insured the nation comparative freedom and independence—was brought to a sudden end by the outbreak of the First World War in 1914. For four long years the trains rolled along to the front, carrying the sons of the Hungarian people into death for the imperialist aspirations of the Monarchy and her German allies. But Austria-Hungary and her allies lost the war, and the Hungarian people, embittered by privation and hunger, attempted to rid itself of the causes of its sufferings, the system of the monarchy and rule of the big landowners and capitalists. Fired by enthusiasm over the success of the workers' and peasants' revolution in Russia, the hitherto oppressed working masses in 1919 succeeded in establishing the rule of the working people as embodied in the Hungarian Republic of Councils. Under a régime holding out new hopes, a great number of scientists took part in the preparatory work of a long overdue and necessary reform of the Academy.

But within a few months the first workers' and peasants' state on Hungarian soil collapsed under the blows of the joint forces of international reaction. Thereafter the anti-democratic fascist rule of Horthy weighed heavily on the country for a quarter of a century. Horthy—the former aide-de-camp to Emperor Francis Joseph I, and organizer of the counter-revolutionary forces of the country which joined hands with reaction abroad to overthrow the people's government—had himself made Regent of Hungary. His régime which began with cruel acts of reprisal against the workers and peasants grew into a dictatorship bearing heavily on the country's public life. In the Europe of the 1920's, Hungary was the first country where a fascist-type political system

established itself, whose leaders were later content to conform to German and Italian fascism both in internal and external politics. And 1939 saw the outbreak of the Second World War . . .

Conservative-minded, sterile and impotent cultural policies, an increasingly suffocating political atmosphere and the terroristic methods of a government which was to an ever greater degree currying the favour of Hitler, provided but a poor breeding ground for creative scientific work. With fascism spreading like a plague, a whole range of prominent scientists were compelled to leave the country. The great composer and musical scientist Béla Bartók left, as did many outstanding mathematicians, chemists and engineers, seeking both refuge and a freer scope for their creative powers abroad.

Those remaining in the country pursued their activities under great difficulties. All over the world scientific research was adapting itself to the exacting standards set by practical requirements, and well-equipped centres of scientific research were being set up at a rapid pace. The development of Hungarian science, on the other hand, was greatly hampered by the lack of funds. Such research work as was carried out within the narrow bounds of the university departments, the laboratories of a few major industrial concerns, and the experimental farms set up on some large estates, could hardly compete with the countries where the research worker was given a broad scope of experimentation and had not only his own knowledge but also the necessary tools of research, an ample staff of assistants and sufficient financial aid for support.

In spite of all these adversities Hungarian science was able to produce some conspicuous results. A case in point

is the mathematical school that was steadily gaining in prestige. The development of this branch of learning encountered little resistance by the State, for it did not require any expensive tools of research nor the creation of special conditions—just "good brains, a sheet of paper, and a pencil" would suffice to produce outstanding results. Several branches of the medical science also won appreciation at this period. Although here, too, the necessary tools of research were lacking, the country, with its prevalence of mass diseases, malnutrition and abject poverty, provided an immense number of patients for the many excellent physicians who were spurred on to ever greater achievements by the ardent desire to improve health standards.

In several other domains Hungarian science attained international repute. Three Hungarian engineers, Ottó Bláthy, Miksa Déri and Károly Zipernowsky, invented the alternating-current transformer system; engineer Kálmán Kandó constructed an electric locomotive that bears his name to this day; Géza Zemplén acquired international standing in the field of carbohydrate research; the chemist József Vargha became well known for his achievements in the processing of coal. Honorary degrees as well as awards from universities and scientific institutions abroad were conferred on a good number of Hungarian scientists. Albert Szent-Györgyi, the Hungarian chemist of world repute, made himself worthy of the highest scientific distinction, the Nobel Prize.

The aristocrats and prelates who were sitting on the Academy board as the "representatives" of science had, however, precious little to do with all this. Only marginal and accidental contacts existed between the world of science and the institutions intended to direct scientific activity. To the former belonged the scientists earning a modest income and

working strenuously in the universities, clinics and laboratories; to the latter, the wealthy magnates who would range the "direction of scientific activity" with the rest of their aristocratic pastimes. Nor could the gap between the two worlds be bridged in the solemn sessions of the General Assembly or in the scientific conferences with their often insufferable boredom.

A PROLOGUE TO THE PRESENT

Amidst the thousands of Budapest houses left in ruins by the Second World War, the edifice of the Academy also stood there torn by bullets and shells, with glassless windows staring blindly on the Danube and on the arcs of a Chain Bridge submerged in the river. And yet, perhaps never before did the century-old motto "after rain comes sunshine" seem more promising than at that time.

The immense socio-economic changes that were taking place all over the country gave urgency to the long-felt need for a reform of the Academy, and this time reorganization also held out the promise of a revival.

In 1948 a Committee on Science was set up by the Hungarian government. The Committee, composed of prominent scholars genuinely concerned for the future of science in their country, was entrusted with the task of preparing the reform of the Academy and working out the up-to-date organizational forms of scientific life.

At present, with the country's 120 different modernly equipped research institutes forming an organic network and carrying out coordinated scientific work based on a predetermined programme, one can only wonder how all this

came about practically out of nothing and within less than twenty years at that.

The socio-economic structure of the country provided a suitable basis for setting up the new organization. In a country where industry, mining and the banks were taken over by the people, and the people gained full command of all economic resources; where the development of the forces of production as well as the raising of the living standards and the cultural level are based on purposeful planning; in short, where the road of socialist development was chosen, it is obvious that organization of science must form an integral part of the planned order.

The aim was thus to endow the individual branches of learning with centres of research where the scientists could engage both in investigations into the fundamental principles of their respective discipline and in research work directly connected with production and economic progress.

While formerly the Academy did not dispose of a single research institute, the Committee on Science, in the course of its short-lived existence of but a few months, established no less than twenty-six new institutes. At the request of the government, the Committee also worked out proposals for the improvement of the material conditions of scientific workers. On the basis of these proposals the salaries of some four thousand scientists and research workers were considerably raised, and automobile transportation, holiday centres and other facilities were also put at their disposal.

The preparatory work and the primary tasks connected with the reorganization of scientific activities in this country were thus carried out by the Committee—the rest devolved on the Academy which was coming to new life.

An autumn day of 1949 saw the three large mahogany folding doors thrown open which lead from the white Renaissance-style corridor on the first floor of the Academy building into the stately assembly hall. The foremost representatives of Hungarian science took their places, and the epoch-marking General Assembly of the Hungarian Academy of Sciences began. This time the governing bodies of the institution were elected by scientists and composed—contrary to the practice of a long previous period—again by those alone worthy of the distinction: the scholars and scientists themselves. Professor István Rusznyák, a distinguished physician, became president of the Academy and has held this post to the present day.

The new statutes adopted by the first post-war General Assembly summarized the aims and tasks of the Academy in the following words:

"... The Academy is to study the productive forces of the country as well as the scientific achievements of mankind; is to prepare a plan of scientific development, outlining the tasks on the national level; is to keep a record of those engaged in scientific activity and of the equipment necessary and suitable for scientific work; is to ensure, in a systematic manner, the availability of both personnel and equipment required for scientific research.

"The Academy is to foster individual scientific research.

"The Academy is to contribute to raising the cultural level of the working people by the systematic dissemination of knowledge. This purpose should be served by the library of the Academy as well as by lectures and publications."

These important new tasks made it imperative to re-examine the organization of the Academy. First of all it was necessary to ensure that all scientists worthy of membership should be affiliated. At the reconstitution meeting many

prominent scholars were elected to the Academy who were formerly passed over because of their political conviction or other reasons.

The reorganized Academy began its activities in six sections. The first two largely corresponded to the earlier division: Section I again became that of linguistics and literary science; Section II, equally in accordance with traditions, that of the social and historical sciences. The newly formed four sections, on the other hand, reflect the endeavour to adapt the internal proportions of Hungarian science to modern requirements—in other words, to give due emphasis to the natural and technical sciences.

Accordingly, mathematics and the natural sciences were allotted to Section III, biology and agrarian science to Section IV, medicine to Section V, and the technical sciences to Section VI.

In the assembly hall, with the portraits of sometime royal patrons of Hungarian culture looking down from the walls and the allegoric representations of Science and the Arts in the frescoes decorating the ceiling and the spandrels over the windows—in the hall which saw so much enthusiasm and so many events both hopeful and depressing of Hungarian scientific life, the important meeting came to an end. It was the first for decades at last to give hope of sunshine after rain, of purposeful activities, of encouraging possibilities for creative work, of science coming to fullness on Hungarian soil.

In December 1949 the new Charter of the Academy was enacted by Parliament. Under the Act the Hungarian People's Republic is to give the Academy " . . . every facility to become the supreme scientific institution of the country. Its responsibilities are to include the study and the advance-

ment of the scientific achievements of mankind, with primary regard to scientific and technical research directly bearing on the development of the forces of production, without neglecting at the same time provision for the intensive cultivation of disciplines in other domains of knowledge. The Hungarian Academy of Sciences will thus mobilize the forces of science in the interest of the prosperity of this nation and serve thereby also the universal advance of progressive-minded mankind."

Such were the beginnings. The sequel already forms part of the present.

THE ORGANIZATION OF THE ACADEMY

References to the organization of the Academy have already been made in the foregoing, but before proceeding now to describe the actual work of the institution which directs scientific activities in this country, it seems appropriate to outline its autonomous functions in some detail.

The governing body of the Academy is its General Assembly. In the yearly convened General Assembly, the honorary and regular members of the Academy are entitled to vote while the corresponding and associate members have a voice but no vote. (Membership now totals 200, of which 89 are regular, 69 corresponding, 27 honorary and 15 associate members.)

In the most important issues concerning the activities of the Academy as a whole, the right of decision rests with the General Assembly.

During intervals between two General Assemblies the work of the Academy is directed by a presidium consisting

of the president, the vice-president, the secretary-general, the deputy secretaries-general, the secretaries of the sections and the elected members of the presidium.

The scientific tasks of the Academy are carried out by the sections as well as the institutes and committees subordinated to them. Headed by the sectional boards elected by, and from among, their members, the sections of the Academy are at present the principal directive and control organs in their respective domains of science.

To the six sections constituted at the 1949 General Assembly, two new ones were added shortly afterwards. A section of chemistry was set up with the chemists formerly in Sections III and IV as its members, and a section of biology was formed from the biologists earlier belonging to Sections IV and V.

The activities of each section cover several branches of learning and are carried out in a number of research institutes. Of the research institutes which have come into being in the course of the years, thirty-nine are controlled by the Academy directly. These institutes are primarily engaged in basic research and in investigations into the major questions of principle connected with the respective branch of learning.

Section I of the Academy includes, in addition to the specialists of the various branches of philology (Hungarian linguistics; Finno-Ugric linguistics, concerned with the only European language related to Hungarian, as well as with their common origins; Slavic linguistics; general linguistics, etc.) and the literary sciences (Hungarian literature; modern philology; literary theory; bibliographic history; bibliography; documentation, etc.), also the scholars of orientalism, musical science (folk music, music history), classical philology, ethnology and library science.

Under Section I of the Academy there are four research institutes.

The *Bartók Archives* undertake to collect the material associated with Béla Bartók, to preserve the musical legacy of the great Hungarian composer and to make it accessible to research, furthermore to collect and to publish Hungarian musical relics and sources of Hungarian music history. Research both in Hungarian and universal musicology and music history belongs also in the activities of the Archives whose work is primarily aimed at building up Bartók documentation on an international scale.

The *Folk-music Research Group* under Zoltán Kodály carries out its work as an independent institute. The group's history goes back to 1832 when the Academy set itself the task of collecting as well as publishing the songs of the Hungarian people. It was, however, not before Béla Bartók and Zoltán Kodály took up the collection of Hungarian folk songs on a country-wide scale in the early part of the century, that a comprehensive picture was gained of Hungarian folk music. In 1934 the Academy entrusted Béla Bartók with the preparatory work of a large-scale collection of Hungarian folk songs. After Bartók's emigration, this work was taken over by Zoltán Kodály. The latter, in 1946, transferred his own collection to the Academy where an editorial staff was set up to put in order and publish the material. This editorial staff formed the nucleus of the Folk-music Research Group of the Hungarian Academy of Sciences established in 1953.

The tasks of the group include the central direction of folk-song collecting in this country, a survey of the collection work carried out until now, and the launching of work in the still unexplored territories. In conformity with long-

standing tradition, the group endeavours to discover the connections between Hungarian folk music and that of other peoples. The final goal is to publish the complete material of Hungarian folk song; to survey the traditions of Hungarian working-class folklore and the activity of popular song-writers of the past century; to prepare monographs on regional folk music and on the music of the gypsies in Hungary; to explore the history of folk music as well as of the musical instruments of the people; to carry out research work on the music of related and neighbouring peoples.

Two other important institutes of Section I are those of linguistics and of literary history.

It was in 1951 that the *Institute of Linguistics*, founded in 1949 as an institution of the Ministry of Cultural Affairs, was placed under the control of the Academy. The Institute is dealing with the problems relating to the theory, principles and methodology of linguistics, and engages in research on the Slavic, Romance and Germanic languages as well as on such oriental languages as are important from the point of view of Hungarian philology. It is here that the descriptive grammar of the Hungarian language, the comprehensive dictionary of the Hungarian literary language, the explanatory and etymological dictionaries as well as the dictionary of synonyms are being prepared. The research workers of the Institute are compiling linguistic maps on the Hungarian language and on the dialects spoken by national minorities living in Hungary. Investigations in the field of both general and Hungarian phonetics are carried out at the Institute. Another important mission of the Institute lies in the cultivation and refinement of everyday language and in the widespread popularization of the results of linguistic research. Short lectures on good Hungarian, a regular feature on the

programme of the Hungarian Radio, are also edited by the staff of the Institute of Linguistics.

The *Institute of Literary History* was formed in 1956 of the various study groups and individual researchers engaged in editorial work on critical editions and bibliographies in university departments and other institutions. Preparing monographs and treatises on specific questions, the collaborators of the Institute endeavour to bring about a synthesis of Hungarian literary history by means of specialized research and of exploration into the material. The activities of the Institute include the collection and publication of Hungarian literary relics, the critical reviewing of outstanding works and achievements in the field of literary history abroad, and the utilization of possibilities in this country for research work on world literature with special regard to the links between Hungarian and world literature.

The activities of *Section II* cover the fields of philosophy, economics, political and legal science, sociology, archeology, art history, education, geology and geography. Seven institutes of the Academy serve the purposes of these disciplines.

Attached to the Academy in 1955, the *Institute of Political and Legal Science* was controlled originally by the Ministry of Cultural Affairs and later on by the Ministry of Justice, assisting first in the problems of higher legal education, and later solving questions directly related to jurisdiction.

The present-day tasks of the Institute fall partly into cultivating and developing Marxist political and legal science, and partly into doing research on scientific organization, and on political and legal life in the Hungarian people's democracy so as to assist the work of political organization, legislation, the application of the law, and legal education.

The *Transdanubian Scientific Institute* is probably the only one of its kind in the country to have its sphere of action "geographically" defined. Transdanubia, where the Institute of multiple activities was set up in 1943, is the western region of Hungary and rich in cultural traditions. Belonging for over a decade to the Ministry of Cultural Affairs, the Institute came in 1955 under the control of the Academy. It is at present engaged in investigations into the problems of mining, industry and agriculture in the Transdanubian area, and in the study of earth surface, climate, hydrology, soil and flora as well as economic conditions, population, the history of the labour movement, the geographic aspects of settlement, and the material and spiritual characteristics of folklore in the region.

The Academy's *Institute of Philosophy* was established in 1957 with the purpose of fostering and intensifying the cultivation of Marxist philosophy. The tasks devolving on the Institute consist in working out the philosophical problems which pose themselves in connection with the construction of socialism, and in solving, in cooperation with experts in the fields concerned, the ideological, methodological and logical problems arising in the course of progress in the natural and social sciences. The Institute is also engaged in making accessible all that is progressive in the spiritual heritage from Hungarian philosophers of former ages.

The *Geographical Research Group* is engaged in the study of the territory of Hungary from the viewpoints of natural and economic geography as well as in the cultivation of general and regional geography. The research workers in the Group carry out investigations into the general phenomena of morphological evolution and the effects of recent crustal movements and attempt to outline the country's geomorphological, soil, phyto- and hydro-geography. Their tasks also include the delimitation of economic regions and investigations into the geographical distribution of the forces of production, industrial and agricultural demography, and the development of settlements.

The *Institute of Economics* was set up with the purpose of centralizing the direction of research work carried out before in various university and ministerial departments, and of rendering the cultivation of modern economic science both more systematic and more effective. The tasks of the Institute include research work in the major areas of economics and investigations into the laws and rules of economic life especially in a society engaged in building socialism. The Institute also studies some of the problems of the capitalist economic system, with special regard to questions relating to the development of economically backward countries, and gives due attention to the current bourgeois theories of political economy. It endeavours to contribute towards laying the scientific foundation for economic policy in Hungary, to foster the improvement of planning methods, to promote the extensive development of the economic sciences, and to become the theoretical and organizational centre of all related research activity.

The *Archeological Research Group* of the Academy was formed in 1958 from researchers at the university departments and the museums. The Group are active in several directions: as well as conducting archeologic excavations in the country, they are also engaged in investigations of a number of theoretical questions.

The headquarters of the *Institute of Historical Research* occupy a restored old building in the historic surroundings of ancient Buda Castle. Initially poorly staffed, the Institute

The *Transdanubian Scientific Institute* is probably the only one of its kind in the country to have its sphere of action "geographically" defined. Transdanubia, where the Institute of multiple activities was set up in 1943, is the western region of Hungary and rich in cultural traditions. Belonging for over a decade to the Ministry of Cultural Affairs, the Institute came in 1955 under the control of the Academy. It is at present engaged in investigations into the problems of mining, industry and agriculture in the Transdanubian area, and in the study of earth surface, climate, hydrology, soil and flora as well as economic conditions, population, the history of the labour movement, the geographic aspects of settlement, and the material and spiritual characteristics of folklore in the region.

The Academy's *Institute of Philosophy* was established in 1957 with the purpose of fostering and intensifying the cultivation of Marxist philosophy. The tasks devolving on the Institute consist in working out the philosophical problems which pose themselves in connection with the construction of socialism, and in solving, in cooperation with experts in the fields concerned, the ideological, methodological and logical problems arising in the course of progress in the natural and social sciences. The Institute is also engaged in making accessible all that is progressive in the spiritual heritage from Hungarian philosophers of former ages.

The *Geographical Research Group* is engaged in the study of the territory of Hungary from the viewpoints of natural and economic geography as well as in the cultivation of general and regional geography. The research workers in the Group carry out investigations into the general phenomena of morphological evolution and the effects of recent crustal movements and attempt to outline the country's geomorphological, soil, phyto- and hydro-geography. Their tasks also include the delimitation of economic regions and investigations into the geographical distribution of the forces of production, industrial and agricultural demography, and the development of settlements.

The *Institute of Economics* was set up with the purpose of centralizing the direction of research work carried out before in various university and ministerial departments, and of rendering the cultivation of modern economic science both more systematic and more effective. The tasks of the Institute include research work in the major areas of economics and investigations into the laws and rules of economic life especially in a society engaged in building socialism. The Institute also studies some of the problems of the capitalist economic system, with special regard to questions relating to the development of economically backward countries, and gives due attention to the current bourgeois theories of political economy. It endeavours to contribute towards laying the scientific foundation for economic policy in Hungary, to foster the improvement of planning methods, to promote the extensive development of the economic sciences, and to become the theoretical and organizational centre of all related research activity.

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consists at present of three sections engaged in research on the history of Hungary, with an additional section devoting its work to universal history.

The activities of *Section III* of the Academy cover the mathematical and physical sciences and astronomy. The fact that the Section disposes of seven research institutes indicates the prominent position held by these three important branches of the natural sciences in present-day Hungary.

The *Institute of Mathematical Research* was set up with the purpose of strengthening the links between theory and practice in mathematical research. Work at the Institute covers the fields of probability theory, mathematical statistics, biometrics, the theory of differential, integral and functional equations, and the theory of functions of real and complex variables. Investigations into mathematical logic, algebra and geometry, the development of numerical and graphical methods, and the study of the application of mechanical computation methods also belong to the Institute's sphere of activity, further, the work embraces the applications of the results of theoretical mathematics to other branches of sciences as well as to economic planning and the solution of technical, industrial, agricultural and other problems. Studies on the teaching and the history of mathematics are also carried out at the Institute whose work is discussed in greater detail in another part of this volume (see pp. 77-78, 83-85).

The activities of the *Research Centre of Computation Techniques* are also surveyed elsewhere (see pp. 80-83). Let it suffice to mention here that the principal task of this institution consists in introducing and developing in Hungary the up-to-date computation techniques based on electronic computers, and in providing a basis of experimentation for certain branches of cybernetics requiring their use. Established in 1960, the Centre continues the work of the Academy's study group on cybernetics which took up its activities in 1956 and constructed the first electronic computer in this country.

The *Astronomical Institute* is one of the oldest and most popular scientific institutions in Hungary. As early as the beginning of the past century there was an observatory on top of Gellért Hill towering above Budapest. This, however, was destroyed in 1849, during the Hungarian War of Independence. In 1870 a well-to-do landowner had his own observatory constructed, which he granted to the State in 1899. This was actually the predecessor of the observatory which is standing now on one of the western hills surrounding Budapest. Work at the present-day premises of the Institute began in 1929 with but a very small scientific staff. For a long period belonging to one of the universities, the Institute was placed under the control of the Academy in 1951. Astronomical work is now carried out here both on the theoretical and on the practical level. It is from here that the country's sputnik-spotting stations receive their scientific instructions, that the time-signal service is directed and controlled, and that a country-wide geodesic survey network is furnished with the necessary data. The principal work at the Institute is the study of variable stars.

Solar-physical Observatory. In the last decades of the past century Hungarian observatories carried out some important solar observations the results of which can still be profitably utilized. Research was taken up again in 1940 when a department of solar physics was set up in the Budapest observatory. This department later became independent and was transferred to Debrecen, an important provincial university town, where it was assigned suitable premises. Engaged in

observation and research in solar physics, the observatory places the data obtained at the disposal of interested institutions both in Hungary and abroad.

The seat of the *Institute of Nuclear Physics* is also in Debrecen. The institution continues the work of the university's former Institute of Experimental Physics where research in nuclear physics began in 1936. Later, a laboratory for uranium analysis and radioactive tracing was installed here with the assistance of the Academy. The results achieved by the university institute facilitated its transformation in 1954 into an independent academic one. At present it is engaged in experimental nuclear research and in the solution of related scientific and technical problems, while also carrying out basic investigations in the field of nuclear physics.

The *Central Institute of Physics Research* was established in 1950. The aim was to provide an up-to-date base for research in experimental physics, a work not only of great scientific value but also of fundamental importance from the point of view of several sectors of the national economy.

In the first period of its development the essential facilities and laboratories for experimentation were set up. A new phase in the life of the Institute opened in 1955 when the U.S.S.R. put an experimental atomic pile at Hungary's disposal with the aim of promoting the development of nuclear research in this country. This made possible not only further progress in the field of atomic research but also the application in the national economy of the new methods developed in the course of the utilization of atomic energy for peaceful purposes.

Originally only a section in the Central Institute of Physics Research, the *Study Group for Theoretical Physics* has worked since 1954 as an independent research unit. Its

activities centre on the field of the statistical theory of the atom and atomic nuclei, the quantum-mechanical many-body problem and its applications, the theory of solids, quantum chemistry and the theory of nonlinear space.

Section IV of the Academy, that of the agrarian sciences, embraces soil science and agrochemistry, plant cultivation and improvement, horticulture, plant pathology and entomology, sylviculture, animal husbandry, veterinary science, agricultural engineering, agroeconomics and agricultural management, agrometeorology and agricultural history. Four research institutes belong to the Section.

The *Research Institute of Agroeconomics*. As early as 1945, the first year that followed the country's liberation, cooperative farms were already set up in Hungary, primarily on former big estates divided up among the poor peasantry. The process of collectivization was completed some years ago with the individual farmers throughout the country united in farmers' cooperatives. It became, accordingly, imperative to work out for the new large-scale farms the scientific procedures and methods of modern farming as well as the theoretical bases and practical solutions of the problems of optimum field size, work management, the organization of working processes, the measurement and pay of performance. Destined to deal with these and the related questions on the theoretical level, the Research Institute of Agroeconomics gives also practical advice to the cooperative farmers coming to consult it.

The *Research Institute of Animal Hygiene*. The tasks of this institute include the study of problems pertaining to veterinary bacteriology, virus biology and parasitology as well as the prevention of diseases in domestic animals, the development of prophylactic methods, the extensive propa-

gation of the results and the promotion of their practical application. Particular emphasis is laid on the solution of problems of animal hygiene posed in large-scale farming, and especially on the study of diseases in young animals. Among the Institute's many-sided activities figure the preparation of a map of Central Europe's tick fauna, and the study of the parasites of fish as well as the methods of protection against them.

The *Institute of Agricultural Research*. The premises of this institute at Martonvásár—at an hour's distance from Budapest by car—are situated on a model farm and surrounded with experimental plots marked with small signboards. The scientific staff of the Institute investigates heterosis and the genetical and biological effects of hybridization and breeding conditions. Their research work extends beyond theoretical problems to the improvement of seed strains affording considerable assistance to agricultural practice.

The *Institute of Soil Science and Agrochemistry*. Although Hungary has a vast expanse of excellent cropland, there are large areas with sandy, acid or eroded soil. The problem of transforming dead soil into fertile land has engaged the attention of scientists for many years. Studying the chemical, physical and microbiological properties of the country's various soil types, research workers at this institute endeavour to work out the methods of improving barren soil and land of low fertility.

Section V of the Academy is that of the medical sciences. The Section directs scientific activity in all branches of medicine related to the structure, function and disease of the human body (anatomy, pathology, surgery, obstetrics, psychiatry, etc.) and the fields of public health and nutrition.

The work of the *Research Institute of Experimental Medicine*, operated by this Section, is described in some detail in another chapter of this volume (see pp. 91-97). Besides this institute, medical research in this country is also carried out in the various clinics, where study groups are working under the sponsorship of the Academy.

Section VI, of the technical sciences, comprises geology, geochemistry, geodesy, geophysics, hydrology and water-supply management, mining metallurgy, thermodynamics and thermoenergetics, heavy-current electrotechnics, engineering, automation, telecommunication, architectonics, community planning, architectural history, transport and communication techniques, light industry, silicate metallurgy and the history of technical sciences. Seven research institutes are directed by this Section.

The *Automation Research Laboratory* is engaged in basic research connected with automation—i.e. programming, regulation and control engineering—providing a basis for further research in the various branches of industry.

The *Geodesic Research Laboratory* tries to solve the scientific problems connected with the shift in geodesy from the geometrical to the physical emphasis. The institution takes part in the international geodesis research programme, carrying out the part of the programme in Hungary. Developing scientific methods for geodesic measurements, evaluating measurement data and constructing instruments suitable for these methods are also among the tasks of the Laboratory.

The *Geophysical Research Laboratory* carries out basic investigations in the field of geophysics and has established and maintains the necessary observatory stations. In addition to participating in international geophysical research,

the Laboratory also renders assistance to the country's various industrial research institutes. It is primarily interested in investigations into the electromagnetic fields of the Earth, with special regard to the problems of telluric and atmospheric electricity and of earth magnetism.

The work of the *Geochemical Research Laboratory* is devoted to fundamental questions of principle in geochemistry – primarily to investigations into the natural migration of elements—which have a direct bearing on the country's supply of mineral raw materials. The migration phenomena studied by the institution are of decisive importance from the point of view of mineral, rock and ore formation. The Laboratory is also engaged in the preparation of a detailed geological map of Hungary's numerous mountains of volcanic origin as well as in the genetic mineralogical and petrological examination of such mountain regions.

The *Study Group of Industrial Economics* examines from both a theoretical and practical viewpoint the actual conditions and requirements of home industry. The research problems of the Group include the more efficient utilization of the available fixed capital (buildings, machinery, etc.), the drafting of appropriate wage policies, investigations into the factors influencing the productivity of industrial production, etc.

The *Institute of Industrial Physics* was set up with the purpose of reorganizing and intensifying basic research in telecommunication techniques. Research work at the Institute centres primarily on an exhaustive study of a number of important materials essential to the further development of telecommunication and vacuum techniques, such as tungsten, molybdenum and other metals of high melting point; germanium, silicon, silicon carbide and the semi-conductor

crystals, the intermetallic compounds; luminescent substances, etc. The aim is to determine the action mechanism of the phenomena under investigation and to pass on the established results to industrial research for application.

The *Mineral-oil Research Laboratory*. In Hungary, several oilfields of considerable importance were discovered quite recently. On the other hand, petroleum research in this country dates back to a much earlier period. At present it is the task of the Mineral-oil Research Laboratory of the Academy to carry out fundamental research work pertaining to oil production in Hungary and to develop the methods of practical scientific research. The Laboratory is engaged in investigating the physical properties related to the reservoir rocks and fluids occurring in the oilfield. It also studies the interactions of those rocks and fluids for the possible application of fluid pressure for more economical oil extraction. Measurement methods are also worked out to insure an accurate estimate of the geological hydrocarbon reserves.

Section VII of the Academy coordinates scientific activities in the field of the chemical sciences, theoretical and applied, organic and inorganic. Four research institutes operate under the auspices of the Section.

The *Chemical Structure Research Laboratory* is engaged in the study of the chemical structure of molecules and macromolecules in relation to various substances. Using the most advanced physical methods and instruments, it works on the solution of structural problems connected with several branches of chemistry, encouraging the development and increased application of the physical methods employed in chemostructural research.

The basic research in chemistry carried out at the *Central Institute of Chemical Research* is of a character that exceeds

the scope of university departments owing to the major technical equipment involved. The Institute is divided into sections for contact catalysis and absorption, molecular structure, polymerization kinetics and the mechanics of organic reaction, and, last, nuclear chemistry, the latter comprising the groups of applied nuclear chemistry, isotope synthesis, metrology and radiation chemistry.

Previous to the establishment of the *Research Institute of Technical Chemistry*, basic research work of a techno-chemical character was carried out primarily in the chemical technology departments of two universities in the country. However, the increasing demands on chemical technology made it necessary to coordinate the available scientific personnel and apparatus, and to set up a separate institute. The tasks of this institute include the study of the theoretical principle and the methodology of chemical technology; systematizing the theory of physical and chemical procedure; research on the intensification of chemical processes; investigations into reaction mechanisms; and the working-out of ways and means to save energy and to reduce the size of apparatus in the principal mechanical, circulative and heat- and matter-transmission procedures.

The formation of the *Stereochemistry Study Group* has enabled the intensification and diversification of research in a field cultivated up to then in university departments only. The Group is engaged in stereochemical research on the theoretical level, cooperating both with the institutions which carry out pharmaceutical research and with the pharmaceutical industry.

Section VIII of the Academy, the "youngest" of all, is that of the biological sciences. It embraces botany, zoology, antropology, genetics, biochemistry, biophysics, hydrobiology, microbiology and radiation biology. Several scientific institutions operate under this section.

The *Institute of Biochemistry* is engaged in basic biochemical research. Protein research has taken a new direction all over the world, with scientists endeavouring to find out the connections between the structure of proteins and their functions. No protein research of this type had ever been carried out before in Hungary when in 1950 experiments were taken up in the newly established Institute.

Set up in 1927 on the shores of Lake Balaton, the country's finest and biggest lake, often designated as the Hungarian sea, the *Institute of Biological Research* was until the Second World War divided into a hydrobiological and a general biological section. In this period many research workers came to the Institute as guests, especially during the summer. In fact, most of the work was done by just such non-permanent researchers whose interest rarely exceeded the limits of their specific subject. This fact accounts for the lack of uniformity and system which characterized the activities of the Institute at that time. In 1951 the Academy took over the Institute, where emphasis is since laid primarily on hydrobiological investigations and on experiments pertaining to basic research in zoology. In the field of hydrobiology the reproductive processes and the relationship between organism and environment are the main subjects of study. Investigations into the physiology of algae and experiments on their mass cultivation, comparative studies and research on oecological problems connected with aquatic plants of higher order and the metabolism of aquatic animals are also carried out at the Institute.

In the vicinity of Budapest and yet far away from the hubbub and the polluted air of the capital, the *Institute of Botan-*

ical Research stands amidst a park of tropical and subtropical plants, its existence unnoticed and unknown by the general public. In addition to geobotanical research and ecological and comparative investigations into plant associations, the activities of the Institute also include the preparation of the country's plant-geographic map, while the several thousand plants of the park are to form the basis of the prospective Central Botanical Gardens.

The *Institute of Genetics* carries out basic research related to micro-organisms and genetic studies on plants of a higher order.

In addition to the research institutes, study groups in the various university departments and clinics are also engaged in scientific work controlled by the Academy. Research workers in these institutions are also on the Academy staff and the subject-matter of their investigations is in most cases closely related to, and coordinated with, the scientific programme of the academic institutes. The Academy, moreover, sponsors research in some twenty of the country's institutions of higher education.

The committees

In present-day Hungarian life of science a significant part is played by the various committees acting as the directive and supervisory bodies to handle various questions of principle with regard to the special branches of sciences. The setting-up of permanent committees and complex committees to deal in a systematic manner with the tasks pertaining to their respective branch of learning is provided for in the statutes of the Academy which point out that "... These

committees will discuss matters of practice and principle relating to their specific domain; undertake the organization of debates, the reading of papers, sittings, conferences and scientific sessions; hear reports from candidates for a higher academic degree on the progress of their dissertations; and work out proposals connected with the essential organizational and other questions of the branch of science concerned."

Among the numerous committees working directly under the Presidium of the Academy, suffice it to mention the Committee on the Publication of Books and Periodicals, the Committee of International Relations and the scientific subcommittee of the Hungarian Unesco Committee. Special committees, such as the Committee on Cybernetics, the Demographical Committee, the Committee on the History of Science (comprising the Hungarian editorial committee of the projected Unesco publication "History of the Scientific and Cultural Development of Mankind"), etc., were set up to deal with the problems requiring the cooperation of scientists representing several branches of learning.

The Psychological Committee, another of those working under the Presidium, has a research institute of its own, the *Institute of Child Psychology*. In addition to research in general, developmental, educational and clinical psychology, the Institute maintains a clinic for outpatients.

The *Academy Library* is also directed by a presidential committee, the Library Committee.

A further agency of the Academy is the Committee on Scientific Qualification, instituted by the government in 1951 to provide for the post-graduate training of successive generations of scholars and scientists. The Committee on Scientific Qualification selects the young specialists qualify-

ing for post-graduate research, is responsible for their organized training as well as the award of the various post-graduate academic degrees. (For a detailed treatment of the system of academic degrees and their conferment in Hungary see pp. 123-126.)

A great number of other committees, eighty in all, are working within the framework of the Academy sections. Their membership, totalling several hundred, consists both of academicians and outstanding practical experts. Special editorial committees devote their work to editing the bulletins of the sections, published in the Hungarian language, which survey the scientific achievements in their respective fields, and to the *Acta* series comprising 29 scientific journals published in foreign languages.

In addition to the research institutes of the Academy there are some eighty independent institutions of a similar character attached to the ministries and other national agencies. Systematic research work is, moreover, carried out in the country's seven hundred odd university and college departments and in some four hundred various other institutions such as libraries, archives, museums, industrial laboratories, etc.

This small country of but ten million inhabitants can boast of having some twelve thousand people employed in scientific research institutes, and with a total staff of about the same order working at the various universities and colleges. Within this total, researchers at the institutes number close to four thousand, and teaching and scientific personnel at the universities about four and a half thousand.

Relying on such significant material and spiritual resources, Hungarian science was able to attain notable results. In a number of disciplines, such as mathematics and medicine, Hungary belongs indisputably to the vanguard on an international level, and several sectors of Hungarian science—animal hygiene, analytical chemistry, thermodynamics and hydrodynamics are the most conspicuous cases in point—have acquired international reputation.

International recognition manifests itself in many ways. An important fact is the success of the works of Hungarian scientists published in foreign languages. Several of the foreign-language scientific works edited by the Publishing House of the Hungarian Academy of Sciences—about 240 over the past decade—have won international acclaim. Invitations from abroad are another sign of appreciation, and there is hardly an international scientific conference of any importance where Hungarian representatives of the discipline concerned are not invited to attend and read papers. At present, Hungarian scientists belong to over a hundred distinguished scientific societies and institutions all over the world, and many of them lecture in universities abroad and hold honorary degrees from foreign universities.

BOOKS FROM ALL OVER THE WORLD

At the premises of the Hungarian Academy of Sciences the mail arrives each day with several cases full of books and periodicals. Over two thousand scientific institutions in 98 countries maintain contact with the Hungarian Academy of Sciences for a mutual exchange of publications.

All scientific institutions in Hungary are in a position to participate with their own publications in the international exchange of books and periodicals. The biggest turnover is that of the Academy whose periodical publications (46 in Hungarian and 30 in foreign languages) regularly report on Hungarian achievements in the various branches of science. In addition, the most outstanding Hungarian scientific works are also published in foreign languages by the Publishing House of the Hungarian Academy of Sciences.

For 130 years now the Academy has circulated throughout the world the works of Hungarian scholars and scientists. Shortly after the establishment of the Academy, the foundations of its library were laid by its then president who in 1826 made a gift of his family library of thirty thousand volumes to "the Hungarian learned society." This noble example was followed by others and it is from these private grants that the basis of the collection was formed.

To build up an up-to-date catalogue, it is necessary, however, to provide for the systematic acquisition of books and

periodicals. The Academy therefore sought to establish contacts with the major scientific institutions of Europe and America, proposing to them as early as 1831 the mutual exchange of publications. In 1833 the founder of the Academy, Count István Széchenyi, personally presented in Munich, London and Paris the first Almanac of the institution. The same year saw the conclusion of exchange agreements with ten institutions of international standing, among them the academies of Berlin and St. Petersburg, the Scientific Society of Philadelphia, the Bohemian Learned Society, the Academy of Munich, the Royal Society in Edinburgh and the Academy of Florence. In the letter addressed to learned societies abroad, when initiating the exchange scheme, the Academy formulated the principles guiding it in the following words: "In presenting the first volume of its Almanac, the Hungarian Academy of Sciences is led by the love of art and science, a sentiment which unites the whole of mankind in a big community of kindred souls. The Hungarian learned society, moreover, offers its ready assistance in the matters of science, and begs to ask for the same willingness on the part of your honoured selves."

Within the hundred years following this notable event, exchanges have been consistently maintained, and since 1946, the volume has assumed significant proportions. In 1962 the Academy received 8,242 books and nearly 5,000 complete volumes of periodicals from abroad, while some 7,000 periodicals and 4,700 volumes of books were sent out to all parts of the globe.

These exchanges provide a vehicle for the works of Hungarian scholars to reach the interested scientific circles abroad—mainly with those publications contained in the four-language *Acta* and *Studia* series—and the means of

access for Hungarian specialists to the works of their foreign colleagues.

The exchange of publications is not a matter of commercial interest. Based on the principle of mutual assistance rather than on financial considerations, the traffic of books provides a real proof of the endeavours aimed at peaceful coexistence and the universal progress of mankind.

The Library of the Hungarian Academy of Sciences contains at present over 625 thousand books and 124 thousand periodicals, with an additional 200 thousand manuscripts and the microfilm records of several thousand works listed in the catalogue.

The innumerable relics of the history of Hungarian science preserved on the storey-high shelves of the Library include more than a thousand incunabula and some 6,300 Hungarian works dating from periods earlier than the 18th century. The Library also prides itself on a collection of Orientalia which, with its over 30 thousand volumes and 16 thousand manuscripts, compares favourably with any in Europe. The archive of manuscripts contains a rich collection of manuscripts of Hungarian writers and scientists.

In Hungary's towns and villages several thousand libraries function. The Academy Library too is accessible to anyone, yet its primary purpose is to serve scientific research. Young and elderly scholars work here day in and day out at the tables of the big reading-room and the microfilm library, in the newspaper room and the research rooms of the archive of manuscripts and the Oriental Department, intent on enriching their own work with the treasures of human knowledge.

PLANNING FOR THE PROGRESS OF SCIENCE IN HUNGARY

The unprecedented expansion of research activity in science is undoubtedly one of the most exciting phenomena of the century. According to statistical data compiled by Professor D. Price of Cambridge University on the growth of the number of the world's scientific journals, four such periodicals appeared in 1665, seven in 1700, nine hundred in 1850, nine thousand in 1900, and eighty thousand in 1950. At the present rate of increase he estimates their number to double each eight to ten years.

In an editorial note of the reference periodical *Chemical Abstracts*, the same conclusion is reached for the field of chemistry, when a 10 per cent rate of increase is estimated in the number of publications from all parts of the world reviewed in the period between 1907 and 1960, excluding war-year relapses. In 1960 the *Chemical Abstracts* reviewed 132,160 publications.

The Auger Report published in 1961, which sums up the investigations of the UNO and Unesco into this problem, also estimates the annual rate of increase in scientific research activity at 10 per cent.

Nor do the figures alone reflect the haste with which every country, within the limits of its means, is developing new bases of scientific research. But with the present accelerating tendency towards specialization, only the richest coun-

tries will be able to afford large-scale research work which must accompany every new development.

Although much has been done in Hungary in the interest of building up a network of research institutes and of raising both the numbers and the level of training of their scientific staff, a compromise had finally to be made between the requirements of scientific progress and the country's financial means.

The proportion of national income appropriated for research and development in Hungary increases from year to year (having reached by 1962 two per cent of the budget), but even this generous support falls short of enabling Hungarian science to keep abreast of progress in every field. Recognition of this fact has led to the logical conclusion that it was preferable to select a number of specific fields of research and to concentrate on them all material and productive efforts. It was on the basis of these considerations that the Hungarian government in February 1962 set up a plan for long-term scientific research.

The selection of those branches of science to be most intensively developed caused no small problem. It had to be decided whether priority should be given to the traditional disciplines of established fame or to those of more recent standing but with a promising future. Any decision on this point was made increasingly difficult by the fact that the more vigorous development of certain branches would inevitably lead to a slowing-down process in others.

In 1959 the government invited the country's scientists to submit their proposal for the development of science in Hungary. The programme that finally emerged was the result of two years of collective effort in which over two thousand researchers and practical experts participated and in the course of which all scientific institutions in the country put forward their recommendations.

These propositions essentially conformed with the country's general development plans for the next few decades. As a matter of fact, in Hungary all phases of development are subject to scientific planning, the raising of living standards just as well as the transformation of the economic structure or advancement of the cultural programme. Short-term plans usually cover periods of three or five years, but since these comparatively short periods are insufficient for outlining the broad perspectives of development, a long-term plan of twenty years is projected, of which the consecutive five-year plans form successive stages, the current one being regarded as its first quarter.

In establishing the main direction of further economic progress, the long-term plan envisages an intensive development of certain branches of industry and the increase of agricultural yields, the most thrifty utilization of the country's natural resources, town and village development with the construction of several hundred thousand dwelling units, and a broadening of the bases of public education.

Reflecting the general plan of the country, the long-term programme of scientific research is essentially a synthesis of the propositions of the scientific institutions and the requirements of the national economy. The plan itself is, of course,

not final nor immutable; it constitutes what was considered the most advantageous one at the time of its preparation and it is bound to undergo modifications consistent with the progress of the country.

The long-term scientific plan embraces research activities essential from the viewpoint of the nation's interests or the intrinsic development of a given discipline. Thus it follows the main directions of the research programme and at the same time summarizes the 73 principal tasks envisaged in the latter.

Of first importance among these principal tasks are the basic investigations into theoretical questions in mathematics and physics and the research projects directly related to the country's economic progress. Research work aimed at advancing the branches of Hungarian industry which have attained international standards—such as telecommunications, pharmaceutics, etc.—is a case in point. The principal tasks also include the accelerated development of the most important branches of the social sciences, of linguistics, the historical sciences and jurisprudence.

The tasks thus selected will determine the activities in the specific disciplines for some time to come, for it is by fostering the underlying branches of science that the basis for developing the country's most important industries is created. On the other hand, in the industries where Hungary falls considerably short of international standards, scientific activity will have to confine itself to adapting and employing the results attained in other countries.

Consistent with this, the government under the current five-year plan has allocated the sums available for research and development in the following way: research in engineering, telecommunications and precision mechanics is to have

a 34 per cent share; the chemical, light and food industries 20 per cent; agricultural research 15 per cent; public health, medicine and biology 11 per cent. The residual 20 per cent is reserved to meet unforeseen requirements and expenses of research not covered by the long-term plan, thus allowing for greater flexibility in research activities.

The fact that the allocations to some domains of research are larger than to others, is in itself not indicative of the rate of development in these fields of science. The material requirements of the various branches of science show wide variations; research in some fields is dependent on expensive instruments as well as lenghty and costly experimentations, while in other fields (for instance, basic mathematical research) the cost of research is negligible.

PROBLEMS AND MAIN LINES OF RESEARCH

The question now arises as to how these principal tasks, once set, will give rise to synchronized and systematic scientific activities.

The 73 principal problems were allotted to a number of different institutions. The Hungarian Academy of Sciences tops the list with 32; the rest were distributed among the ministries and other national bodies, which will be responsible for the continuity and coordination of the research work connected with them. The solution of the major part of these principal problems will, as a matter of fact, require the cooperation of researchers in several branches of science and in a number of institutions belonging to them.

A few examples will suffice to illustrate the point. One of the principal problems is: "developing up-to-date internal-

combustion engines," i. e. research on the economical production of low-consumption diesel engines of modern design. Another task is research on the development of "wireless—especially microwave—telecommunication systems," in other words, work on the improvement of radio techniques, especially broad-bend microwave systems, and on the development of special electron valves and microwave instruments required for this. From what has been said, it must be clear that the solution of these problems will necessitate the combined work of various disciplines.

The main problem complexes or lines of research which are designated for five-year periods include a number of fairly well defined problems, most of them not new. Now, cooperation between experts of various specialization is arranged so that research workers have the chance to continue work in their own fields. The subjects are in the main not new ones: the experts formerly engaged in them will continue their work and, if necessary, have recourse to the assistance of new co-workers and to special equipment, whereas scientists who have completed work on a given problem, will be given the choice of a new research subject from among the most important tasks set by the long-term scientific plan.

The realignment of research has already resulted in coordinating the activities of researchers working in several hundred scientific institutions. The fact is that although the activities of the individual research institutes were always based on methodical planning, the lack of organizational unity in management and especially in the over-all programme has in the past frequently led to unnecessary parallelism. In one instance, investigations into the problems of semiconductors were carried out in eight different laboratories throughout the country and in other, three different institutes

were engaged in bentonite research. Having a centralized management in the various fields has insured the expedient distribution of available talent and facilities, thus effecting the coordination of complementary research activities. The government has already set the development targets and the corresponding tasks of research for the second five-year plan period (1965-1970). An increase of 70 per cent is envisaged in the sum earmarked for scientific research, while the number of research workers is to increase by 25 per cent and that of the auxiliary personnel by 70 per cent. These are, of course, only estimates which may be modified to some extent in consequence of later developments in the national economy as well as scientific achievements attained in the meantime.

Hungarian science has already embarked on the course set by the long-time plan. And though it might not be able to keep abreast of progress in every direction, it is following resolutely its self-imposed goals.

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In the following, the reader will become acquainted, through the example of a few scientific branches picked out at random, with the actual work carried out in the workshops of Hungarian science.

FROM MATHEMATICS TO PRACTICE

The past decades saw the introduction of mathematical methods in a number of scientific branches other than astrology, physics and the technical sciences, their classical fields of application. Industrial concerns and plants have, to an increasing degree, called in the aid of mathematicians in the solution of various problems of transportation, storage, management and production.

For some thirty years this trend has been discernible all over the world, but in Hungary, mathematics was considerably late in conquering new fields as compared to the U.S.S.R., the U.S.A. or the countries of western Europe. Nor was this the fault of Hungarian mathematicians, who for several decades past already ranked with the most distinguished representatives of the discipline in the international field.

The basic reason for this neglect lies in the fact that in the decades preceding the country's liberation in 1945, this branch of science received but little assistance from official circles.

"The science of mathematics was looked upon in Hungary very much like camomile, the medicinal herb which grows wild, is picked by country children and still has a good market abroad. Hungarian mathematical knowledge likewise grew by itself, its fruits were collected by a few eccentrics, and as its achievements were highly appreciated by the cultured nations of the West, it lent itself perfectly as propaganda flattering the national vanity of the régime. As a consequence of this attitude on the part of the ruling classes during the pre-liberation era, all that was best in Hungarian mathematical talent was practically dissipated. The outstanding Hungarian research workers in the field emigrated in alarming numbers. Marcell Riesz, György Pólya, Gábor Szegő, Mihály Fekete, Ottó Szász, János Neumann, Tibor Radó, Aurél Wintner and Pál Erdős—to name only the most prominent ones—were all forced to leave the country. There was even a time when in the U. S. A. alone, more Hungarian professors of mathematics were working than in Hungary." (From an address delivered in 1955 at the festive session of the General Assembly of the Hungarian Academy of Sciences, celebrating the 10th anniversary of the reorganization of Hungarian science.)

The ranks of Hungarian mathematicians were decimated both by the fascist terror and by the Second World War. With the libraries burnt out during the war, practically nothing of the heritage of the past was left, except the great traditions of Hungarian mathematical research, embodied in the searching spirit and the techniques acquired by the mathematicians in the school of the two celebrated scholars Lipót Fejér and Frigyes Riesz.

With the establishment of the people's democracy in Hungary, mathematics received a new impetus. A number of professorships were set up in mathematics and the teaching of mathematics in the universities became more extensive. In 1950 the Institute of Mathematical Research of the Hungarian Academy of Sciences was brought into being with the double task of carrying out basic research and promoting the practical application of mathematics.

The result was an unprecedented upswing in mathematical research. Scientific investigations in the pre-liberation period were lacking in versatility, owing to the fact that the few leading scientists who had stayed in the country had to draw mostly on each other's similiar conceptions for their subjects of research. Following the liberation, on the other hand, not only the previously cultivated branches of research were further developed and extended, but there also emerged a new Hungarian school of algebra and the calculus of probabilities. In several branches of mathematics completely neglected or scarcely cultivated before in this country, investigations were taken up and considerably intensified.

THE SPREAD OF MATHEMATICS

Meanwhile, research work developed new exigences in other branches of science as well. Economists, medical researchers, biologists, psychologists and workers in several other fields of research came to realize the inadequacy of their previous methods and the fact that the tools and methods of mathematics were indispensable in up-to-date research work. The economist trying to hit on the most advantageous investment plan for the long-term development of some branch of industry and to decide on the number of new plants going into operation as well as the rate of machinery replacement, will hardly be able to dispense with the tools of mathematics. The medical researcher will also have to rely on mathematics in his study of intricate biological phenomena.

It will be worthwhile to examine a few instances of the spread of mathematical methods in the fields referred to above.

A few years ago the application of mathematical methods in economic research was still the exception rather than the rule in this country. Then some economists, having come up against problems which proved unsolvable by means of the traditional methods, called upon mathematics for assistance. It was thus that the first input-output tables were drawn up to measure the effects of the development of a particular economic sector on the rest of the branches of the national economy.

By now research work based on mathematical methods and carried out jointly with economists has become a frequent practice. Let it suffice to mention here but one particularly interesting and important instance. In the current work of planning the new economic, administrative and settlement network of Hungary, the representatives of numerous branches of science other than economics and mathematics—settlement planners, jurists, sociologists, etc.—also participate.

Equally rapid and triumphant was the spread of mathematics in the field of medical science. Here, it is primarily the methods of mathematical statistics that are finding extensive application.

Biometrical methods are employed, for example, in testing new drugs. The use of biometrical methods enables the physician to determine the number of observations to be carried out as well as the necessary experimental groups involved. Reliable data can thus be gained in a comparatively short time. The new pharmaceutics employed in the course of these investigations are, of course, controlled and are in no way detrimental to the recovery of the patients.

Ancient therapies relying mostly on herbs, the home remedies, are still widely employed in many countries. In China,

where many thousand such drugs are known and used, the Hungarian biometrician, Dr. Iréneusz Juvancz, assisted a few years ago in working out the methods by which the real value of these traditional therapies can be most easily assessed.

In addition, Hungarian biometricians are at present participating in a number of experiments which may be of interest even to non-professionals. For instance, in cooperation with the anthropological department of the museum, they are endeavouring to work out more reliable methods than those employed so far for determining the span of human life in earlier ages. For a long time the opinion prevailed that ancient man had an extremely short life span. This assumption was largely based on findings of bones. Although the seams of the skull and the ends of the various bones provide some guidance on the age of death, they cannot be fully relied on. The method worked out now with the aid of biometry and based on the joint evaluation of all signs, enables a more precise determination of age than any one until now employed. Research workers are now inclined to believe that earlier estimates must have been erroneous and that our prehistoric fathers, though rarely attaining the age of a Methuselah, nor indeed the average of present-day man, were longer-lived than formerly assumed.

AMONG "THINKING" MACHINES

Although cybernetics, this young branch of science, is steadily claiming greater independence, it must be dealt with in this context. The electronic machines, recording on their paper tapes with dazzling speed the results of calculations

which otherwise would have probably required the work of several years, have in fact played an important part in spreading the use of mathematical methods.

The elaboration of practical problems very frequently requires their reconversion into numerical expressions which in turn must be subject to a great number of operations, in compliance with the relative mathematical formulae. It is this work—which in many cases never could be performed by the human mind or by the traditional reckoning machines—that it now carried out by means of electronic computers.

An office building in the central part of Budapest houses the electronic computer of the Research Centre of Computation Techniques directed by the Hungarian Academy of Sciences. Covering the floor of an entire great hall, the computer, which works in complete silence and almost unnoticed, is the product of Hungarian industry. Its designers and builders do not claim to have their computer ranked among the most up-to-date ones; in constructing it, they were exclusively led by the wish of providing a means for Hungarian specialists to get thoroughly acquainted with the operation of just such an extremely intricate type of mechanism. The computer has, however, proved capable of considerably more than expected, pouring out as it does columns and columns of figures of the most varied meaning.

More important than factual results is the effect that the very existence of this type of machine has on the way of thinking of Hungarian researchers working in the most diverse fields. It was 10 to 15 years ago that their importance was recognized in Hungary and later on, in the first stage of experimentation, they still gave occasion for controversies and reservations rather than for serious acceptance. A few

years were, however, sufficient to make them the subject of scientific interest.

The machines were first used to solve a set of transportation problems, which involved the expediting to 31 building sites the trucks of a carrier company garaged in seven different places. Then followed the analysis of raw-hide imports. It was found that the use of mathematical methods in determining the composition of raw-hide imports could, under favourable conditions, result in savings of some $ 800,000 annually.

Soon industrial concerns began to put forward their demands. For instance, a big machine-tool factory had serious troubles because of the uneven pace of production. Starting at a low level at the beginning of each month, production would rise steadily to reach a disorderly height towards the end of the monthly period. With the aid of the electronic computer it was possible to work out an exact and detailed working schedule of the factory and to determine the order of the various operations and use of machines for each product.

The Academy's Central Institute of Chemical Research availed itself of the services of the computer when carrying out the analysis of protein structure, and the biology department of a provincial university asked for the cooperation of cybernetic experts in the study of the combinations of the nervous system's reactions to stimuli.

Researchers in the fields of linguistics and literary science also came forward with problems. The linguists attempted the quantitative determination of the Hungarian vocabulary with the aid of the electronic computer. The literary scientists, on the other hand, endeavoured to approach certain problems of aesthetics by mathematical methods. They

tried to work out, for example, the numerical characteristics of the style, terminology, phraseology and poetic technique of various writers and poets. So far the works of two poets have been studied from this angle. In addition, the texts of several authors, comprising 12 to 15 thousand words each, were analysed and tested for the recurrence of individual sounds, syllable types, sound combinations, kinds of words and the distribution of word lengths.

It is a matter of common knowledge that it is considerably more difficult to predict from the foregoing words the next word in the case of a poem than in that of a newspaper article. In the case of the newspaper quotation it was sufficient to give 33 letters out of 100 for the machine to "guess" the text, while 61 letters out of 100 of the poem chosen for the experiment had to be communicated to the computer to enable it to find the missing 39.

MATHEMATICS IN PRACTICE

The Institute of Mathematical Research of the Hungarian Academy of Sciences is one of the main sponsors of the application of mathematical methods in practice. In the Institute, where numerous prominent representatives of Hungarian mathematical science work, over 1,200 practical problems have so far been examined at the request of various industrial works, research institutes and agricultural cooperatives.

At the request of a factory, the ways and means were studied to render the blending procedure employed in bauxite processing more economical. Bauxite, one of Hungary's most important minerals, is the basic material of aluminium. In

the course of processing, an alkaline solution of bauxite powder is fed into a series of autoclaves. In order to bring about the desired chemical reaction, the material must be in continuous agitation in the autoclave for a definite period of time. In practice, however, there was a wide variance in the periods. The problem was referred to the Institute and was set up in the following way. The time spent in the autoclave by an individual particle was designated as a quantity dependent on chance, i.e. as a probability variable. Basing their considerations on the calculus of probability, mathematicians were able to fix the index numbers of autoclave efficiency, whereby a better and more efficient system of coupling could be suggested.

Whole series of similar calculations have been carried out for various industrial works. In a textile mill, for example, a correlation between variations in the revolution per minute of looms and frequency of thread breaks was made the subject of study. Experiments aimed at the determination of the optimum number of revolutions per minute were carried out for some time in the factory, but the empirical data were not reassuring. This question too was answered by the mathematicians on the basis of the calculus of probability.

Let us mention but one more of the series of extremely interesting investigations—the safety test of microwave links.

Telecommunication technicians were set the task of building a microwave system several thousand kilometres long along an oil pipe-line. The system is to carry conversations and telemechanical signals through 24 channels some of which divert to other lines. Relay and branch-off signals are transmitted by means of stations set at definite distances. These stations perform three types of function: the so-called

"terminuses" receive the signals and send the new ones; the relay stations amplify and forward the signals; the branching-off stations are connected to certain other lines. Each station includes a certain number of electron valves, signal receivers, condensers, resistors and other elements. There may be an accidental breakdown of any of these elements, and in the case of certain ones, connection will be completely cut off, while the defect of other elements may result in the partial breakdown of a station. The defects are reported by a signalling device. As long as the defective element is not repaired, the equipment will be completely or partially out of operation.

Every station has a spare set and an automatic device to keep the one in operation which can perform the greater number of functions.

In connection with the foregoing the mathematicians were requested to solve the following problem.

The probability of accidental breakdown varies from element to element and so does the time required for repair. The equipment must, however, function faultlessly, and only a definite yearly number of days—or rather hours—is allowed for shutdowns necessitated by repair work. What qualitative (safety) requirements need to be set for the individual elements so that the operations of the equipment comply with the specifications?

Since the Hungarian telecommunications industry has had orders for several such microwave systems, the solution of this question has formed a part of the preparatory work of production.

As has been said, the primary responsibility of the research institutes of the Academy is fundamental theoretical research. The development of mathematical theory is, accordingly, the backbone of the scientific activities at the Institute of Mathematical Research. Nor is this research work restricted to scientists at the Institute; high-level independent research is carried out by scientific workers and professors in the various universities of Budapest and the provinces.

Especially renowned is the faculty of mathematics in Szeged University, which has given many an excellent mathematician to the country. It was here, in the early 1920's, that the first foreign-language mathematical journal was published in Hungary, edited by Frigyes Riesz and Alfréd Haar, both professors of mathematics of international reputation. Many excellent mathematicians teach in Budapest University too. In prior years, mathematics teachers were trained here; since 1949, however, a separate faculty is devoted to the education of future mathematicians and research workers destined for work in the various sectors of the national economy. Chairs of mathematics were also established in the Technical University as well as in the University of Agriculture and the University of Economics.

Many Hungarian mathematicians are members of scientific societies abroad, and hold degrees and distinctions from foreign universities, where they frequently figure as guest lecturers.

The works of Hungarian mathematicians are for their major part published in foreign languages and are usually favourably received abroad. For instance, Péter Rózsa's

book *Recursive Functions*, which pertains to mathematical logics, appeared in several foreign-language editions. It was reviewed in a number of important journals, which emphasized that the book, the first comprehensive treatise on the subject by a leading expert in the field, is most suitable both for beginners and for reference purposes, and excels for its didactic methods as well as for the clarity of its style.

The collected works of Frigyes Riesz were received with appreciation all over the world. Only one comment (from the *Jahresbericht der Deutschen Mathematiker-Vereinigung*, Stuttgart) need be quoted here: "F. Riesz, the mathematician, who died in 1955 exerted such deep and extensive influence both personally and objectively as few mathematicians of his generation."

The joint work of Frigyes Riesz and Béla Székelyfalvy Nagy, entitled *Leçons d'Analyse Fonctionnelle*, also received wide acclaim. One reviewer called it "sublime", for the definitive form it gives to a comprehensive central part of mathematics. Reviewers attached great importance to the fact that Frigyes Riesz's elaboration of certain parts of the theory of real functions should appear in print. Commenting on the lucid style of the book, they compared its pedagogical merits to those of the French classics. Among many other languages, the work has been translated also into Chinese and Japanese.

Pál Turán's work *A New Method of Analysis and its Applications* has aroused considerable interest in German, and so revised editions of the book have been published in Chinese and English.

The French edition of Béla Kerékjártó's work on the basic principles of geometry, bearing the title *Les fondements*

de la géometrie—I. La construction élémentaire de la géometrie Euclidienne, was also accorded special attention. In the opinion of its reviewers the book brings a needed continuity to the field and may be considered as one of the most comprehensive treatises ever written on the fundamentals of geometry.

Abelian Groups by László Fuchs, treating on a special subject of algebra, was published in English by Pergamon Press, London. It is the consensus of opinion among reviewers that the work is likely to have a great effect on the further development of the subject.

Many other works published in recent years, such as the collected works of Alfréd Haar, the gifted scholar who died so young and János Surányi's monograph on mathematical logic entitled *The Decision Problem of Mathematical Logics* is soon to come out in English. *Convergence Problems of Orthogonal Series* by György Alexits; *Foundations of General Topology* by Ákos Császár; *Decomposition of Superpositions of Distribution Functions* by Pál Medgyessy, have all found general appreciation and interest.

The Hungarian State acknowledges the work of Hungarian mathematicians in many ways.

In 1948, when Hungary celebrated the hundredth anniversary of the War of Independence, a prize, bearing the name of the great statesman Lajos Kossuth, was established to express the highest appreciation of society for its laureates. It is awarded yearly to the most prominent workers in the field of science, culture and the national economy. Since its establishment, fourteen mathematicians have received the award, six of them twice. High government distinctions have also been conferred on several mathematicians.

For every scientist, whatever his specific branch of learning, the greatest satisfaction is to see the fruits of his theoretical work implemented in practice. The history of science, however, knows of a number of instances where the ideas of some man of genius were proved by later generations only. This is a frequent occurrence especially in mathematics, where "experiments" are carried out without control in the human brain, and actual development in technology and other branches of science may not permit the utilization of the mathematician's perception until many decades later. To mention only one of the many obvious examples: It was some thirty years ago that the Hungarian mathematicians Dénes König and Jenő Egerváry were engaged in the matrix theory and the theory of graphs, respectively. Twenty years later the American H. W. Kuhn began to employ their results under the name of "Hungarian method" in his economic calculations concerning problems of transport and management.

Hungarian mathematical researchers are naturally anxious to make practical use of the theoretical achievements of their own as well as of others, and to employ both the old methods which have become the common property of the world and the more recent ones, for the benefit of Hungarian science and the national economy.

THE "BOLYAI JÁNOS" MATHEMATICAL SOCIETY

Our account of the position of mathematics in Hungary would not be complete, should we fail to mention the mathematical society bearing the name of János Bolyai.

The aims of the Society are to encourage interest in mathematics, to promote scientific research and to raise the level

of the teaching of mathematics in secondary schools, and to this end it is divided into three departments.

In the papers read at the fortnightly sessions of the scientific section, research workers report on their recently attained results, making them accessible to their colleagues engaged in any of the numerous sectors of research. Some of the conferences of the department attract foreign participants.

To arouse interest in mathematics, a series of mathematical competitions for students are organized each year by the Society. A national competition with ten problems requiring command of the full armoury of mathematics is held yearly for young mathematicians just graduated from the university. In addition, there are yearly competitions for secondary-school graduates as well as for those still attending secondary school. A special journal is also edited for students interested in mathematics, called the *Secondary-School Journal of Mathematics*. This has appeared now with only minor interruptions for over sixty years and has played an important part in arousing the interest of young people in mathematics.

The primary aim of the educational section is the extension training of mathematics teachers.

It devolves on the educational department to encourage students interested in mathematics and to render them every conceivable assistance. The "Youth Clubs" of the schools sponsored by the section are veritable mathematical societies in miniature, with the students delivering lectures on mathematics, arranging "mathematical afternoons", and inviting lecturers from the universities. No wonder that the young mathematicians of this country have attained excellent results in the mathematical "Olympic Games" organized yearly between the secondary schools of the People's Democracies.

BEFORE DEDICATION

During the twenty years before the turn of the century the Budapest Medical University acquired the necessary funds and land to build a permanent and unified hospital district. At last proper quarters were assured for the work of teaching, practising and research, formerly carried out under modest conditions, in crowded small laboratories set up in private hospitals and dwellings dispersed throughout the city, but nevertheless with a skill and expertise that won widespread recognition for Hungarian medicine. Pettenkofer, the founder of hygiene; Lister, the famous British surgeon; Virchov, the "doctor pontificus" of his day and other distinguished figures in medicine came to Budapest for lectures and visits giving added status to the university.

The work of the University grew and its scope widened, and so the buildings, adequate in 1900, gradually became overcrowded and their facilities outmoded. Recently a magnificent ten-story prism-shaped building, 45 metres tall, was added to the 80-year-old block of buildings of the hospital district. It will house the Research Institute of Experimental Medicine, established in 1954 following the reorganization of the Academy of Sciences. For to study the fundamental mechanisms and laws determining the function of the human organism, large-scale research is demanded and the problems must be examined collectively, with

all available means and facilities of medical science. Hence the new building was a very necessary addition.

The laboratories, operating theatres, and work rooms of the Institute where the modern instruments and complicated electrical apparatus have been installed, are now open to inspection. The large library is yet to be moved to its new quarters and still awaiting completion are the glass-blowing and electrical workshops, where special instruments and equipment will be made to specification. Situated on the sixth floor is a series of specially designed isotope laboratories carefully isolated from one another and from the hallway. The animals used in experimentation are housed in thermostatically controlled rooms ventillated by the modern equipment installed on the tenth floor which also air-conditions the entire building.

An eight-story high, vibration-free building within the complex is one of the most interesting features of the bloc. The rooms on the eight floors are grounded on special foundations so that the vibration and motion of the building will not interfere with the precision of the extremely sensitive measuring instruments.

A permanent staff has been working together since the institute was established in 1954. Until the erection of the new building, its first four departments, those of antibiotics, pharmaceutical research, pathophysiology and experimental morphology, together with the fifth, the microbiological, established in 1960, have been housed on the premises of the universities of Budapest and Debrecen. Two of the departments, those of microbiology and antibiotics, will continue to function on the temporary university premises until a second research building is completed.

Many visitors from all over the world have already come

to see the Institute. Recently, scientists and specialists from Egypt, Czechoslovakia, Bulgaria, Rumania, the German Democratic Republic and the Soviet Union spent weeks and months observing and studying the variety of experiments going on, admiring the hormones made visible on the paper strips of the chromatograph, the wealth of forms appearing under the new microscopes and the new interrelations pointed out by the computers.

What are some of the projects undertaken by the Institute?

The director of the Institute, Professor István Rusznyák (who is also the president of the Hungarian Academy of Sciences), has gained world-wide recognition for his investigations into the nature of lymphatic circulation and has been studying the problem of oedema formation for decades. In the course of this work Professor Rusznyák and his associates succeeded in establishing the fact that an insufficiency of lymphatic circulation is a general phenomenon in the formation of oedema accompanying various diseases. They showed with further experiments the important role the lymphatic system plays in the normal functioning of certain organs.

In addition to his directorship, Professor Rusznyák is in personal charge of the pathophysiological department of the Institute. In a current project of this department, researchers are investigating the question of how hormones are carried through the body and the part played by the lymphatic system in this respect.

Interested laymen are familiar with the decisive part played by the hormones in regulating the complex functioning of the human organism. But even our present-day medical science has not finally established just how the hormones reach the various parts of the body from their place of origin

(from the suprarenal glands, thyroids, etc.). The most accepted conception was and still is that hormones are secreted into the blood stream and then carried to the organ or tissue. As against this, the idea has prevailed for decades that many hormones are carried *via* the lymph vessels.

Hungarian scientists succeeded in proving this assumption in 1962.

Their methods and findings were published in the periodical literature but it is worthwhile to give a simplified summary of their work.

They injected iodine isotope into the thyroid gland. The iodine isotope attached itself to the hormone and the radiation of this small particle made it possible to trace the path of the hormone. The amount of hormones secreted into the blood stream from the thyroid glands was determined with the aid of a Geiger-Müller counter and so was that contained in the lymph vessels. The ticks of the counter made it clear that while the more rapid circulation in the blood vessels contained a lot of hormones, the concentration of the hormones in the slower circulation of the lymphatic vessels was greater. One can use a somewhat free, but rather illustrative simile to this effect: the hormones in the blood vessels could be considered as logs loosely drifting on the surface of a swift stream, while the lymph vessels are like a slow river with a surface practically covered with logs actually touching each other.

This conclusion was reached through painstaking work, involving hundreds of different experiments. The research on this question is by no means over, for it must also be ascertained whether the lymph vessels carry all the hormones or certain types only.

A study of cell multiplication is taking place in the depart-

ment of experimental morphology, under the direction of Dr. Imre Törő, professor of histology and ontobiology. Many component problems of this very complicated subject are being investigated in the Institute. To mention a few: there are the investigations on the function of the thymus, the study of the multiplication, development and morphological characteristics of male spermatozoa, an examination of the physiological functioning, development and multiplication of cardiac muscle cells under the artificial circumstances of *in vitro* tissue and the investigation of the characteristic features of the nucleoprotein, the substance playing the most important role in cell multiplication.

Work is being done with the most up-to-date methods, including special optical instruments. The microchemical examination of the cells and tissues is made with photomicrography and the use of ultra-violet rays. Electron microscopes and isotopes are used in the research, together with films made by micro-cinematography, showing live cells in function.

In this way it was possible to gain insight into several phenomena, disclosing hitherto unknown relationships, important from the point of view of theoretical basic research and of practical medicine. The examination of the thymus gland revealed its major importance in connection with the protective function of the organism and its relation to tumours and other pathological processes. The study of how heart medicines and extracts from the heart effect the heart muscle cell is also interesting from a theoretical and practical point of view. The researchers found that the ability of cultivated cardiac muscles to perform work increases upon the effect of a substance of still not exactly known composition which they isolate.

Research on nucleo-proteins, the vital chemical which plays the major role in cell multiplication, is also closely related to practical problems. During the examination of nucleo-proteins isolated from the healthy and diseased tissues of various species, structural features characteristic of certain species were established. Recognition of these features could lead to an early diagnosis of certain pathological processes.

The pharmaceutical research department which will move into the new building has considerable achievements to its credit.

Sufferers with gastric ailments and duodenal ulcers make extensive use of Gastropin, introduced a few years ago, with highly beneficial effects. This pharmaceutical was developed by the research department of the Institute, together with other preparations, including Spiractin, a respiratory stimulant, effectively used for the respiratory paralysis of newborn infants. The domestic manufacture of Hibernal, a drug used in some surgery cases formerly considered practically inoperable, is also an achievement of the pharmaceutical research department.

The department of antibiotics does not yet have new headquarters, but it is worthwhile to become acquainted with its work. Some of the research physicians of this department could be properly called "cave explorers" because most of their work is connected with a very interesting stalactic cave discovered in northern Hungary a few years ago. The researchers found various microbial strains on the walls of the cave, untouched for thousands of years.

Research began on the ability of these strains to produce antibiotics. Several hundred strains were examined; several were productive. But this does not mean that they can be

immediately put to therapeutic use. So far they have succeeded in isolating Primycin, and it has been tested in several hospitals. It was found to be quite effective in the treatment of T. B. fistulae which would not heal nor respond to other medicines. Another antibiotic was tried successfully on a particular kind of fungus infection.

The Research Institute of Experimental Medicine will shortly move into its new centre. It was given a fine home; the glass and aluminium structure is an imposing sight in the midst of smaller buildings. It was erected in the area where several generations of Hungarian physicians were trained and where so many outstanding achievements, properly recognized throughout the world, were made during the last decades. The balance sheet of the eight years prior to dedication justifies the expectation that it will measure up to its famous predecessors.

COMBATING AN ENDEMIC DISEASE

Tuberculosis was one of the most widespread and destructive diseases in Europe, Japan and the United States during the first decades of the 20th century. Although the T.B. bacillus was discovered by Koch as early as 1882 and tuberculin, which was thought to be its remedy, a few years later, medicine stood helpless in the face of the surreptitious and subtle spread of the disease.

Fresh air, bed-rest and proper nourishment proved to be the most effective remedy and all stricken people, if they could afford it, went to sanatoria. Splendid sanatoria built throughout Europe were filled with wealthy patients.

Dwellers of the factory districts and tenements, however, did not get into the famous sanatoria—their path led to the cemetery. The ratio of T.B. deaths rose frightfully throughout the world and most of the coffins were taken from the miserable flats of the crowded, unsanitary working-class quarters.

Hungary stood in the forefront of this ghastly record of deaths. The T.B. death rate at the turn of the century was 20 out of 10 thousand per annum on an international scale; the figure in Hungary was 40. In this period every second death in the 20 to 40 year age category was caused by T.B. T.B. did not only take its death toll in the cities but also from the countryside; the undernourished and often starving peasantry living in unsanitary and, in wintertime, unheated homes, could not offer any resistance to the disease.

Since the end of the Second World War T. B. mortality has gone down considerably. Hungary is still not among the best countries in this respect but it no longer occupies the bottom of the ladder.

The change is primarily due to effective medicines which were introduced some twenty years ago, primarily streptomycin discovered by S. A. Waksman in 1944, then PAS (para-amino salicylic acid) and INH (isonicotinic acid hydrazide). The disease became curable.

It must be stated that the incidence of fatal T.B. cases gradually became lower even in the decades preceding the introduction of the medicines; this improvement had, of course, its temporary setbacks. The state offered little assistance in fighting the disease. The achievement was primarily due to the physicians.

WITHOUT MEDICINES

The beginnings of the fight against tuberculosis go back to the years preceding the turn of the century.

A congress on public health was held in 1894 in Budapest, where Professor Frigyes Korányi, a specialist in internal medicine passionately devoted to the people, made the announcement that an "anonymous donor" pledged a large sum for the building of the first tuberculosis sanatorium in Hungary. Many enthusiastic people rallied behind Korányi; a popular writer appealed to the public for donations, a famous painter designed the posters, the mayor donated a lot, the architect made the plans free of charge . . .

This is how the first Hungarian T.B. sanatorium was opened—amidst total governmental indifference—in 1901 with 116 beds. It expanded slowly and was followed by the first centre for patients suffering in T.B.

The physicians actually fought with empty hands, and without medicines for the recovery and life of the patients.

Following the death of Frigyes Korányi, the leadership of the struggle against T.B. was assumed by his son, Sándor Korányi, also an outstanding physician. The centre of healing was the sanatorium where, along with the generally accepted cure of rest, fresh air and good food, they tried to introduce all the new treatments which would benefit the patients. Thus artificial pneumo-thorax was applied in Hungary first in 1912, and up-to-date surgical methods were also introduced quite early.

The selfless and thorough efforts of the physicians brought results: there were fewer fatal cases and many patients recovered in the sanatorium. Yet this was a defensive struggle. Tuberculosis had powerful allies; mass-poverty, malnutrition and unbearable housing conditions all contributed to the spread of infection. It was not even possible to determine the number of people who had T.B. since most of them did not get to see a physician. Many fathers and mothers fending for their families, even if they knew about their ailment, could not think of going to the hospital for fear of making the family's lot even more miserable. The social insurance institutions allowed three months of treatment for their members, but the peasantry, which made up the bulk of the country's population, did not get even this assistance. The desperate peasant had to choose, in case of affliction, from two possibilities: to go to the hospital and sacrifice the small plot from which his family eked out a livelihood, or to remain

at home and sacrifice his life. There were about 15 thousand deaths from tuberculosis each year in a land where hospital beds stayed empty because neither those with limited insurance, nor the uninsured masses could afford the expenses of hospital treatment.

GENERAL OFFENSIVE AGAINST T.B.

Following the country's liberation the people's state allied itself with medical science, supporting the struggle against T.B. with its material means and legislative might. One of the first actions of the new state power in 1945 was to procure the available anti-tubercular medicines from abroad, however expensive, and to work out, together with the physicians, the strategy of an all-out offensive against T.B.

Besides the problems involved in the general improvement of the people's living conditions and the establishment of a free public health system, a host of special tasks had to be solved.

The new and effective medicines made cure possible, but the spread of the infection also had to be checked. Compulsory vaccination of infants was decreed. (At present all children obtain the B.C.G. vaccination and several booster vaccinations.) Immunization was thus assured and now it is estimated that the sanatoria maintained for children could be gradually closed within the next decade. Screening examinations involving the entire population were introduced throughout the country. Mobile health units reached the most distant hamlets to disclose cases of infection and ensure medical treatment for all.

To augment the struggle against T.B. a law was passed

in 1960 having as its ultimate aim the complete eradication of what used to be an endemic disease in Hungary. It insured to the entire population, free of charge, all facilities of modern medicine, including all known methods of T.B. prevention, diagnosis and treatment. It also decreed that those people whose family situation warranted should receive their full sickness allowance even during hospitalization.

In Hungary the struggle against tuberculosis is waged according to a national standard through a scientifically organized plan. T.B. patients can only be treated by specially trained physicians, who belong to the national tuberculosis network. Physicians engaged in T.B. treatment obtain systematic information on the latest foreign and domestic scientific achievements related to the work and participate every year in three-week post-graduate courses.

Practical medical activity for the prevention and cure of T.B. continues to increase each year, thanks to the considerable assistance from the State. The pivotal institution of this struggle is the National Korányi T.B. Institute, named for the two great Hungarian pioneers, the father and son.

SANATORIUM IN THE HILLS

Budapest, two cities in the last century, is divided in two by the Danube: the Pest side stretches out to the plain on the left, and on the right, built on the slopes of the western hills, is old Buda.

The National Korányi T.B. Institute, once a 116-bed sanatorium, now a huge "healing complex" lies on a slope of a Buda hill, in a wooded area, far above the fog zone and well protected from the wind. New pavilions were erected

amidst the trees of the 80-acre park, while on the clearings there are many shelters built on the English pattern, small forest cottages for two patients each.

The Institute has 11 sections of internal medicine, and one each of bronchology and surgery. A section for research is also housed there and forms an organic part of the Institute.

The majority of the physicians engaged in medical practice in the sanatorium also carry on research work, mostly in cooperation with the staff members of the scientific sections. Let us enumerate a few research projects conducted by physicians in charge of the hospital section: control of the effect of medicines through animal tests, problems of rehabilitation (rehabilitation has become, particularly since the Second World War, an integral part of the treatments), relations of pregnancy and tuberculosis, and the evolution of strains of bacteria which resist antibiotics.

The sputum test is the most positive method for identifying T.B. The presence of the pathogene can be proven in most cases, especially at the initial stage of infection if the bacteria are bred in a culture medium. This method was used in Hungary for a long time but only in research work. However, when it was recognized that early detection of the disease was a cardinal question in the protection against T.B., this diagnostic method was adopted. An effective culture medium was developed through very painstaking work in the Institute and is being shipped now regularly, in concentrated form, to the diagnostic laboratories functioning in the various parts of the country. About 600 thousand sputum specimens are examined a year and this figure is expected to reach one million within a couple of years. Such mass-scale diagnostic screening is a remarkable achievement.

The pulmonary surgery of the Institute achieved international recognition. Artificial pneumothorax and simple surgical remedies which had been applied for a long time are often replaced by large-scale thoracic operations. Every year approximately four hundred such operations take place in the Institute's surgical department. The great advance of surgery called for finer and more precise methods of chest function and cardiac examinations. All advances of technique are utilized; for instance, taking coloured photos of the bronchial mucous membrane has become one of the routine tests.

The Institute's research work carries over into many other directions. One team in the pathophysiological section has done pioneering work in studying the effect of anti-tubercular medicines on the functioning of the patient's higher nervous system. A most significant investigation of the microbiological section has been on the danger inherent for humans in the tubercular diseases of some animals, especially milk cattle.

CURED CASES

There are more registered T.B. cases in Hungary now that in the past, because systematic screenings have disclosed them. Data of the last two years, however, show a considerable drop in the number of new cases; out of every 10,000 people there were 38 newly registered T. B. patients, this went down to 29 in 1959, 26 in 1960, while in 1961 only 24 were registered for treatment.

The reduction in mortality is likewise due to the fact that every case is hospitalized and obtains proper care. Rehabilitation and health education also play an important role in

the fight. Patients can learn a new trade in the sanatorium, if necessary. Young women can learn dress-making or other light physical or mental work, while men may obtain retraining in various crafts. After recovery they'll be in a position to accept jobs which are not detrimental to their health.

Cured patients can return to their homes in a healthy frame of mind, and with proper living conditions and regular medical check-ups, become an asset to the community.

The mobile health service continues to tour the country, to the most remote corners, tracking down tuberculosis until the disease is no longer there to find.

PHARMACEUTICAL RESEARCH

French papers carried a news item in October 1962 about a Hungarian medicine, secured through the cooperation of amateur radio-operators, which saved a French patient's life.

This is the gist of the newspaper stories:

A patient at the Grenoble hospital was in a critical state. The attending physician advised that the illness could be checked with a Hungarian medicine, Degranol, not available in France.

An amateur radio-operator who was a friend of the patient appealed for help. An operator from Amiens got the message and transmitted it with his more powerful set. A Hungarian radio-amateur heard the S.O.S. call, contacted the Hungarian Red Cross and within a few hours the medicine arrived by air in Brussels and was then forwarded to Grenoble.

Dr. Lacomte, head physician of the Grenoble hospital, stated that the Hungarian medicine was effective and the

patient's life was saved. The hospital management and the patient wrote letters of acknowledgement for the prompt help.

Degranol, known as one of the most effective drugs against some malignant diseases of the blood, is only one of the Hungarian pharmaceuticals internationally known and recognized. According to non-official data Hungary was among the ten leading exporters of pharmaceuticals between the two world wars and has continued to maintain this position. Hungary exports medicines to approximately 60 countries, including some with a highly advanced pharmaceutical industry, like Great Britain, Switzerland, the U. S., the Soviet Union and the German Federal Republic. The Hungarian pharmaceutical industry has a long list of drugs and medicinal preparations as its contribution to world medicine.

The pharmaceutical industry originated less than a century ago and although Hungary was not among the pioneers, by the turn of the century, her first factories of this kind were operating. The industry started as small manufacturing units in primitively equipped shops, but the products soon became well known. It is worthwhile mentioning, as a historical curiosity, that Gedeon Richter, the first Hungarian manufacturing pharmacist, began to prepare adrenaline one year after its discovery by the Japanese Takamine, scientist, who extracted 4 grams from the suprarenal glands of 8 thousand animals. A few years later, in 1907, Richter produced sufficient amounts of the hormone to satisfy the entire adrenaline requirement of the Austro-Hungarian Monarchy. Twenty years later, another factory, Chinoin, introduced, as one of its hundreds of products, an original veterinary medicine, Distol, for sheep and cattle rot, which secured international fame for the factory.

LARGE-SCALE OUTPUT OF VITAMIN C AND PAPAVERINE

The Hungarian pharmaceutical industry developed a number of outstanding products during the thirties. Albert Szent-Györgyi, the well-known biochemist and Nobel Prize-winner, was responsible for many of these discoveries. Vitamin C extracted from paprika was first produced on a large scale in Hungary using Szent-Györgyi's process. Vitamin P, one of the factors necessary to prevent capillary bleeding, was isolated by Szent-Györgyi and Professor Rusznyák. Szent-Györgyi and his collaborators also established the vasodilator effect of a natural constituent of human muscles known in the pharmaceutical trade as ATP.

It was also during the thirties that two researchers of the Chinoin factory, Dr. Zoltán Földi and Rezső König, succeeded in synthesizing papaverine, the well-known antispasmodic for the treatment of cramps of various internal organs, the muscles and blood vessels. Papaverin had been used for a long time in medicine, but could only be extracted from opium derivatives in minute amounts. Synthetic papaverine, made in Hungary for the first time, continues to be a major export item. Following the synthesis of papaverine, a derivative of it, also a very efficaceous antispasmodic, was manufactured for the first time by Chinoin and is marketed under the trade name of Perparin. Novurit, which proved to be superior to the other diuretics, was also developed by Chinoin. The pharmacology of both medicines was presented first by Béla Issekutz, Sr., well-known Hungarian scientist. Ultraseptyl, a highly effective sulphonylamide used against wound infections, also originated from the Chinoin laboratories.

The pharmaceutical industry throughout the world made tremendous progress during the 10 to 20 years preceding the Second World War; huge plants based upon mass production were set up. There was some progress in Hungary but even the largest plants were rather primitive; production went on in narrow barrack-like buildings, jumbled together, and the chemicals were stored in the yard, around the buildings. The ability of the Hungarian pharmaceutical industry to be competitive with big international concerns was largely due to its staff of outstanding specialists.

The ravages of the Second World War, the persecution and deportation of many scientists and the interminable intellectual blockade were all calamitous to Hungarian pharmaceutical industry. Ruined and paralysed factories were awaiting reconstruction at the end of the war. This was at a time when penicillin began its triumphant march and the hitherto unknown world of the antibiotics was opened up by researchers.

How many years would it take for the Hungarians to catch up with the trail-blazers? Looking at the ravaged country at that time one would not even have ventured a guess.

Hardly fifteen years had passed when the penicillin plant, one of Chinoin's new sections, started operations, and the Biogal factory, the new centre of antibiotic research and manufacture, was opened in the city of Debrecen. In the meantime the reorganization of pharmaceutical production and research was completed. Factories of various size which in the past competed with one another were nationalized and a sensible reorganization of their activity took place. Pharmaceutical research became coordinated and planned, mostly carried out in special institutions instead of factories.

CENTRE OF PHARMACEUTICAL RESEARCH

The Pharmaceutical Research Institute is the country's leading institution of its kind. Its modern buildings were erected in the neighbourhood of the Chinoin factory. The relation is not only close because of location, Chinoin is a partner, one could call it a "large-scale pilot plant" of the Institute; many new medicines developed there are manufactured by Chinoin. This research institute, which is hardly ten years old, keeps the factory quite occupied. In addition to Degranol (which was placed on the list of approved preparations by the International Health Organization), Trioxazin and Frenolon were also developed by the researchers of the Institute.

Both pharmaceuticals are new, about 2 or 3 years old. Both Trioxazin and Frenolon belong to the list of the newly developed tranquilizers which differ from the "classic" sedatives in that they do not lessen the functioning of the central nervous system (they do not make one sleepy, for instance), but normalize the non-desirable nervous symptoms in a more subtle and motivated manner.

The programme of pharmaceutical research in the Institute is determined on the basis of the mortality and sickness statistics. The major objective is to combat illnesses that claim the greatest number of victims. Statistics vary, of course, in different countries but generally speaking, most

of the fatalities of those under 40 years are due to accidents on the road, while over 40 the circulatory diseases and cancer predominate. Pharmaceutical researchers are helpless in the face of road accidents, but the Institute, just as research all over the world, is trying to find effective remedies for the ailments characterizing those over 40. The Institute is also engaged in research covering all modern chemotherapeutic trends, for instance steroid hormones, preparation of antibiotics and the elaboration of agents acting on the nervous system.

Requirements for the approval of new medicines are exacting. The new pharmaceuticals, just like the heroes of the fairy tales, must undergo many tests.

The new compounds are tested, their effects being ascertained first in guinea-pigs, mice, rats, dogs and cats.

Once the compound has proved effective and safe, clinical try-outs begin, carried out, as a rule simultaneously, in a foreign hospital as well. The new compound is alternatively given to the patient with tablets of identical appearance, but without the patent agent. To avoid the possible hypotheses of the physician from interfering with the system of tests, a double control is resorted to, when only the man in charge of the experiments knows what kind of medicine was administered. Data provided by such tests are fully reliable.

Once the new compound has successfully stood all the clinical tests, the evaluated data are submitted to the Scientific Health Council for approval. In case of a favourable decision, production in the pilot plant begins. Large-scale production of the new medicine follows the successful pilot plant try-out.

NUTRITION AND SCIENCE

Budapest, with its close to two million population, has, like other large cities, its own peculiar districts or quarters. Around Üllői Avenue is a concentration of university hospitals. The boulevard leads into a large square opening onto a number of health institutions. The Food and Nutrition Institute is one of them.

The major object of the Institute's research is food and man, the latter not only as a consumer, but also as a producer of food.

At present the Institute is studying one of the most interesting and most primitive foods, mother's milk and the female organism producing it. The investigation aims to find a remedy for infant diseases due to a shortage of vitamins in the mother's milk. To establish the relationship between the deficiencies in the mother's milk and the nutrition of the mothers, the researchers have been carrying on systematic observations and guidance of the mother's nourishment before and during the lactation period. The mothers under study had to adhere to the prescribed diet for several months.

Some interesting and quite unexpected findings were made at the very beginning of the experiments. For instance, a few mothers under observation were given oranges and liver *sauté* as sources of Vitamins C and A to determine the extent and duration of absorption of these vitamins. It was

found that Vitamin C had a comparatively slow absorption, being present in the organism 24 hours after eating and much longer in the mother's milk even when afterwards the mothers received nourishment devoid of Vitamin C. On the other hand Vitamin A which as a rule is stored by the organism, was turned over to the mother's milk rapidly and almost at once, and was then present in the milk for a short time only. Also studied was the effect on the mother's milk of food cooked with lard, oil and milk. A nutritious and balanced diet for nursing mothers will be prepared and recommended on the basis of this series of examinations.

The health department of the Institute studies the diet of people engaged in agriculture and transportation, of children and sportsmen, moreover the effect of a one-sided compared to a varied diet on the health, growth, resistance and ability to work of certain age-groups. The relationship between road accident and diet, between condition and ability to work, and the fitness of the aged and their food, all are examined by the Institute. A special study was made of the diets of university students during their examination period. The practical problem of how to provide low-cost balanced meals to university canteens is also a part of the Institute's programme.

Another project of the Institute is the interesting and important problem of selecting high-yielding wheat strains most suitable for Hungarian conditions. In this connection the Institute is also keeping an eye on the acclimatization of the wheat species introduced in Hungary.

Agrarian experts submit many plants which they think are worth introducing and ask the Institute's opinion on the proposition. The Institute decides on the basis of experiments whether these plants develop favourably in Hungary

and whether their introduction and improvement is practicable.

Samples of all food shipments from abroad are regularly submitted to the microbiological department, where examinations are made for bacteria, parasites, or other impurities. A report is given to the Ministry of Health which then decides whether the foodstuffs can be marketed.

A department on toxicology carries on investigation connected with the use of chemicals in agriculture, in particular those having a toxic effect. Recently there have been many chemical factories built in Hungary to manufacture pesticides and weed-killers. These protective agents are sprayed from low-flying airplanes or by tractors over large areas. It is therefore important to determine how much poisonous chemical remains on the food crops, and the maximum amount which can be used before becoming a health hazard.

This same department also determines to what extent food colours can be used. Colouring is a necessary additive in some industries, especially those manufacturing sweets. There are 20 to 200 legally permitted food colours used in various countries, but only six colouring agents to be used in foodstuffs have been authorized by the Institute.

The name and address of the Institute is well known throughout the country. The institutions of industry, agriculture, trade and health service consult the Institute with the same confidence that one has in going to his family doctor.

The Institute has a scientific staff of 125, mostly physicians, who are well assisted by the complement of biologists, chemists, pharmacists and veterinarians. The Institute has an excellent library and some 120 scientific periodicals keep the staff abreast of progress in nutrition throughout the world.

SAFEGUARDING THE HEALTH OF WORKERS

The National Institute of Labour Hygiene occupies a large building in the same area. The visitor enters a modern, glass-walled *foyer* bright with potted plants.

The Institute's rather small staff is faced with a large programme of research, concrete prevention and cure. From a total personnel of 130 a staff of 40 physicians, chemists, engineers, physicists, biologists and psychologists direct the activities of the Institute assisted by laboratory and health technicians and other auxiliaries. This group is engaged in manifold research, embracing labour physiology (determining the optimum conditions of work for a person of normal health, according to age, sex and constitution), study of occupational diseases and their cures, problems of labour energetics (correlation between intensity and energy requirement) and problems of occupational psychology (effect of monotonous work on the nervous system, investigation of the noise factor). The Institute made an exhaustive study of conditions in industries where workers such as moulders, smiths and rolling mill operators were constantly exposed to excessive heat. For those workers dehydration and loss of salt from the organism are a health hazard. The Institute formulated a protective drink to compensate both for the loss of water and salt.

Up until 1945 there was only one official precautionary

measure against lead poisoning and even this had not been carried out. For instance, every third or fourth worker in one of the Budapest battery factories contracted lead poisoning and most of them never recovered. The Institute developed a process using a metal other than lead and also found a treatment for the afflicted; this resulted in the virtual elimination of this occupational disease.

The National Institute of Labour Hygiene enjoys a considerable authority in the country. The rapid pace of industrial development calls for the reconstruction and expansion of many old factories and building of new ones. This can only be done with the approval of the Institute and its superior organ, the Ministry of Health. The plans are approved only if there is provision for the necessary safety and health installations.

This is by no means a smooth and easy job. Those in charge of the investment are inclined to be "thrifty" with health and labour safety expenditures. In such cases the Institute never approves the project, no matter how pressing it may be, until the necessary health protection investments are ensured.

The Institute has undertaken several projects which are significant for occupational psychology and industrial management alike.

The occupational analysis is made up from a questionnaire asking the following information: branch of industry, brief outline of the process of work and of the occupation, physical involvement, position of the body, psychological character of the job, physical environment of the job, occupational hazards, incidence of accident. On the basis of the questionnaire data the Ministry of Health determines an occupational analysis for each branch of industry, also stating what

physical and psychological characteristics are required for each kind of job in the industry. This means that not only the personal inclination of the individual is considered when assigning work but also his or her physical and psychological make-up.

A worker who could only perform a certain job with reduced capacity such as a physically disabled person—may be able to meet the full requirements of a job, if it is properly analysed from a health point of view. This is not only a gesture of social welfare but one of great economic significance in a country where the main problem is not one of unemployment but rather one of a labour shortage.

The preparation of these analyses entails a tremendous burden on the Institute, since some 3,000 to 4,000 types of jobs have to be covered in all branches of industry, and with the constant emergence of new industries, it is almost a never ending task. For instance, the health regulations of the young Hungarian plastics industry were made up on the basis of these analyses as were those for work done with radio-active isotopes and for the chemical industry in general.

A special group is engaged in the study of preventing silicosis, one of the most dangerous industrial diseases. Experiments with animals have been conducted on the effects of various types of dust inhalation. Mobile health units cover the country and the staff selects through screening tests the workers affected by silicosis. Moreover, the Institute submits recommendations for the installation and use of safety devices which reduce or eliminate the danger of silicosis.

The great problem of curing silicosis and its perfect prevention by biological means has not been solved yet by the Institute, but there are a number of partial achievements to

its credit. Before 1950 it was taken for granted that grinders (an important section of the metal workers) would be incapacitated from silicosis after 5 or 10 years' work. In these industries the grinding wheels were made out of quarry stone. Since 1950, thanks to the investigation done by the Institute, synthetic stones which do not contain any silica are used. Thus silicosis is no longer an occupational sickness among the grinders. Water spraying in the mines during drilling has also proved to be effective, as has the installation of special ventilating equipment.

This difficult job is not done by the staff of the Institute alone, they have a large auxiliary to assist them, including the network of factory physicians. This is something new in Hungary. There are as many as 700 doctors with regular consulting hours permanently assigned to the larger factories. This arrangement takes some of the burden off the still overcrowded district medical centres, but more important than that, the factory physician is becoming a specialist in the various industrial diseases, he diagnoses and assigns those patients who need special medical care to the Institute for observation and treatment.

The labour safety agents in the shops, and the labour safety committees in the larger factories are also auxiliaries of the Institute. They are primarily trade union activists whose main job is to see that labour safety regulations are carried out by the management and the workers, thereby eliminating accidents. They submit all problems of labour health in their factory or shop, together with their proposals to the Institute. The Institute sees to it that any new means of labour safety and hygiene developed in certain factories, if fully satisfactory, are made mandatory for the entire industry.

A number of minor ailments such as skin diseases are under study by the Institute. Eight out of ten skin diseases are due to occupational causes. The incidence is aggravated by the rapid growth of the chemical industry. Research is directed to find the causes of skin disease and to develop ointments and lotions which protect the workers from infection and facilitate the cure.

The work of the National Institute of Labour Hygiene is a testimony to the fact that in Hungary the health of workers has become a public trust.

SPECIALISTS OF INDUSTRIAL APPRENTICE TRAINING

A group of young teenagers are busily engaged in very serious activity in a Budapest schoolyard. Two boys are laying rows of bricks, two girls are spreading sand on each row. Other pairs are building "walls" out of wooden planks and spreading make-believe mortar over them. They are working in full earnest, using the tools of the trade, if not the actual materials. It all looks like play. But, of course, it isn't. This is a scene in a Budapest apprentice training school and the participants are apprentices, future building trades workers. The adult standing by is a teacher of the school.

This is an example of the new system of training skilled workers in Hungary. Before the Second World War the entire productive apparatus was in private hands and most apprentice training was done by small artisans. Today industry is nationalized and the training of artisans and skilled workers is the responsibility of the State. Apprentice training institutes have been set up for this purpose; they provide theoretical training in the classrooms, practical training in the school-shops, and the hostels furnish room and board to the students.

The schoolyard described above is actually a special school-shop for the training of building trades workers, in this case masons. Schools for industrial trades train skilled shop-workers, turners, grinders, machinists, toolmakers,

etc. These school-shops introduce them to the rudiments of their trade and the use of the machines waiting them in the factories. Real shop practice follows one year later, in the factories. Building trades apprentices, however, need no inside shops for practice, for it can be done on construction sites.

Practical training of future miners entails special difficulties. According to Hungarian health regulations youth under 16 cannot work in the mines. But after completing the compulsory eight grades of grammar school, most of the boys have already chosen another occupation. Working conditions in the mines are so special that they cannot be reproduced with the aid of models or other auxiliaries. Miners' training had to be placed therefore on more realistic foundations. At present boys under 16 are accepted as apprentices, but during the first year their practical work is conducted above-ground, with a weekly tour in the mine led by their instructor. They visit the hewing and extraction fronts and observe the work of the skilled miners. During this time they become acccustomed to underground work, which is quite an adjustment in itself.

Practical training of automobile mechanics was directed in such a manner that they were divided into groups and each group had an instructor who explained them the functioning of all the parts of the car. It became evident, however, during examinations that one group was best acquainted with the chassis, the other with the engine, the third group with the differentials, according to what part their instructor was an expert on. At present the individual instructors do not teach the group of apprentices the working of the entire automobile but only of that part they are specialized in. Thus the boys become equally familiar with the entire automobile, and become all-round mechanics.

The development, registration, comparison and perfection of the methods of teaching, training and demonstration are the responsibility of the Institute of Methodology operating under the Ministry of Labour. The researchers of the Institute are now working on three major themes: the methodology of actual instruction; education; and the stimulation of interest in new techniques. Pedagogical material concerning the various crafts and also documentation for the instructors' use are available at the Institute. The Institute makes, in collaboration with specialists, documentary films and slides which are distributed on a rental basis to the apprentice training institutions.

The Institute has a permanent staff of 21, and 80 to 90 permanent outside co-workers handling the work covering the entire country and all the crafts. Whenever there is a large-scale project, groups of up to 150 instructors are drawn in.

Practical work is conducted, of course, in the apprentice schools. New methods elaborated there and tested in practice are generalized by the Institute and developed into a pedagogical method, which will again be put to practical use by the instructors of future skilled workers.

The teachers are especially concerned with the problems of re-orientation of education. This job has many facets, especially because present-day's youth differs, both physically and intellectually, from those of the past. A most outstanding difference is that they are, thanks to advanced medical science and public health, healthier and better developed, moreover that they acquire their fundamental knowledge not through mechanical discipline or cramming.

Requirements for training in the various forms have to be elaborated by taking all the above into consideration. The principles and practical instructions to this end were elabo-

rated by the Institute; they serve as a basis for all apprentice schools to prepare their own plans according to their special conditions.

The Institute of Methodology is also charged with the theoretical and practical post-graduate training of the instructors. Lectures and demonstrations on education and training are arranged for the dissemination of the best-proven pedagogical methods. Books are published by the Institute on the methodology of the teaching of the various crafts. Assistance is also given for the illustration of the subject-matter, the Institute sends out collections of models and drawings to the schools, which they can utilize in making their own demonstrative material. Stimulated by the Institute's initiative, many schools prepare their own auxiliary means for demonstrative training.

The Institute of Methodology cooperates with other scientific institutions. Making use of the research work done by the Research Institute of Mining, the Institute of Building-science and others, it is constantly improving the methods of industrial training, thus helping to satisfy a major requirement of the national economy.

SCIENTIFIC DEGREES

Two or three times every week a group gathers before a meeting-room of the Hungarian Academy of Sciences; they are getting ready for a debate on a dissertation. The prospective candidate, encouraged by the sympathetic glance of interested specialists, colleagues, friends and relatives, takes his seat at a small table, next to the platform. Facing him are the "opponents" and a jury consisting of outstanding representatives of his field of specialization.

The discussion begins. The opponents state their opinion, the candidate answers them and the audience anxiously awaits the outcome of the session—will the aspirant obtain the degree of candidate?

Opponent, *aspirant*, *candidate* are commonly used terms relevant to training scientists in Hungary. The meaning of the terms have changed somewhat and therefore should be explained.

Aspirant in this case means aspirant for a scientific degree. This is the title of a person who is trying to obtain the lowest post-graduate scientific degree awarded by the Academy. To do so, he has to defend a scientific dissertation in an original research project in an open discussion.

The *opponent* is a scientist entrusted by the Academy to submit a criticism of the aspirant's dissertation.

A *candidate* in ancient Rome was a person aspiring for

public office and his white toga denoted his status. This is the term given in Hungary to a scientist, a researcher who successfully defended his thesis in an open discussion with the opponents, the jury or other persons present; his dissertation was accepted and he obtained the scientific degree.

The aspirant system, this organized form of training scientists, was established by government decree in 1950. The Academy was entrusted with directing the training for scientific degrees. To this end the Academy established a Committee on Scientific Qualification made up of prominent scientists and academicians representing all branches of science. The members proposed by the Academy were appointed by the Council of Ministers. This Committee selects each year, on the basis of previous degrees, knowledge, publication and achievements, 300 to 400 aspirants out of about 1,500 applicants; a scientific tutor, the "aspirant guide" is appointed for each prospective candidate. Once the aspirant has written his dissertation he submits it to the Committee on Scientific Qualification. Following this a special jury is appointed by the Academy consisting of outstanding representatives of the particular branch of science. This jury hears the open discussion on the candidature, and on this basis and the merits of the dissertation, submits a proposal regarding the award of the highly coveted degree of candidate.

This is the first important stage for a young researcher in his scientific career; by upholding his dissertation he gives proof of his ability to advance his branch of science through independent creative work. Some of the older generation, primarily those in research, but also some specialists engaged in applied science, sit for the examination and carry on research work for the degree.

To date over 1,300 people have acquired the degree of candidate. About 500 more people were given this degree at the time of the introduction of this system in recognition of their previous scientific achievements.

With eighteen hundred specialists holding the degree of candidate in a country of ten million, the question might arise as to the standard set for a scientific degree.

The requirements are very high even for the selection of the aspirants; their scientific record, their work and ability is strictly scrutinized, because these factors are an indication of the potential level of their theses.

Another requirement is that the subject chosen by aspirants must fit the long-range plan of Hungary's scientific research. There is no question as to the correctness of this requirement. The State gives special consideration to the aspirants in the form of time off from work and financial aid. They are allowed one day off a week for research, 38 days of paid holidays per annum for study, and additional time off for the writing of the dissertation. The fees of the aspirant tutors are also paid by the State.

Holders of the candidate's degree receive special supplementary pay from the Academy every month, corresponding to about 15 per cent of the average salary of scientific workers. This supplement is, however, dependent on a requirement. The Academy regularly reviews the scientific activities of candidates who have held their degrees for more than five years. Those who cannot account for additional scientific contributions during the five years may keep their title of candidate, but do not receive the monthly allowance.

The title of candidate is only the first scientific degree. Candidates can apply, on the basis of scientific achievement, for the title of Doctor of Sciences. Only three hundred people

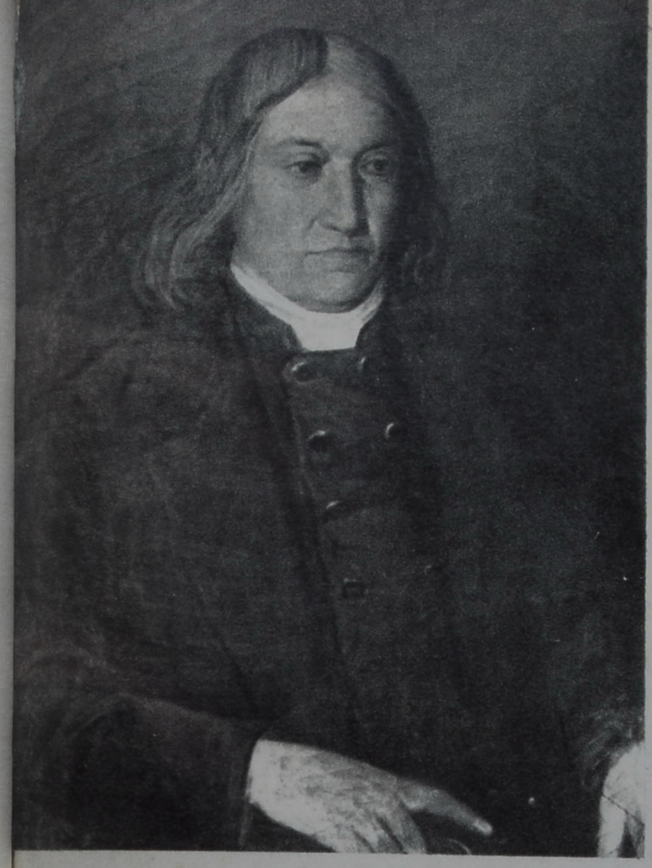
possess this degree in Hungary; it can only be obtained through outstanding scientific work. The dissertation submitted for the doctor's degree is reviewed by senior scientists in the field.

The Corresponding Members of the Academy are elected from among the doctors of science, and the full Members from the Corresponding Members. The Hungarian Academy of Sciences has at present 69 Corresponding Members and 89 Members; they are all internationally outstanding in their fields. Scientists elected to either rank must submit an inaugural paper within a year. The inaugural lecture of the new academician is always an outstanding event, it often presents the findings of decades of research.

The discussion in one of the meeting halls of the Academy has just been ended. The jury retires to pass judgement. The aspirant is surrounded by his friends and colleagues, they are all anxiously awaiting the reappearance of the committee.

It is possible that within a few minutes a new candidate will be installed amidst the old walls of the Academy.

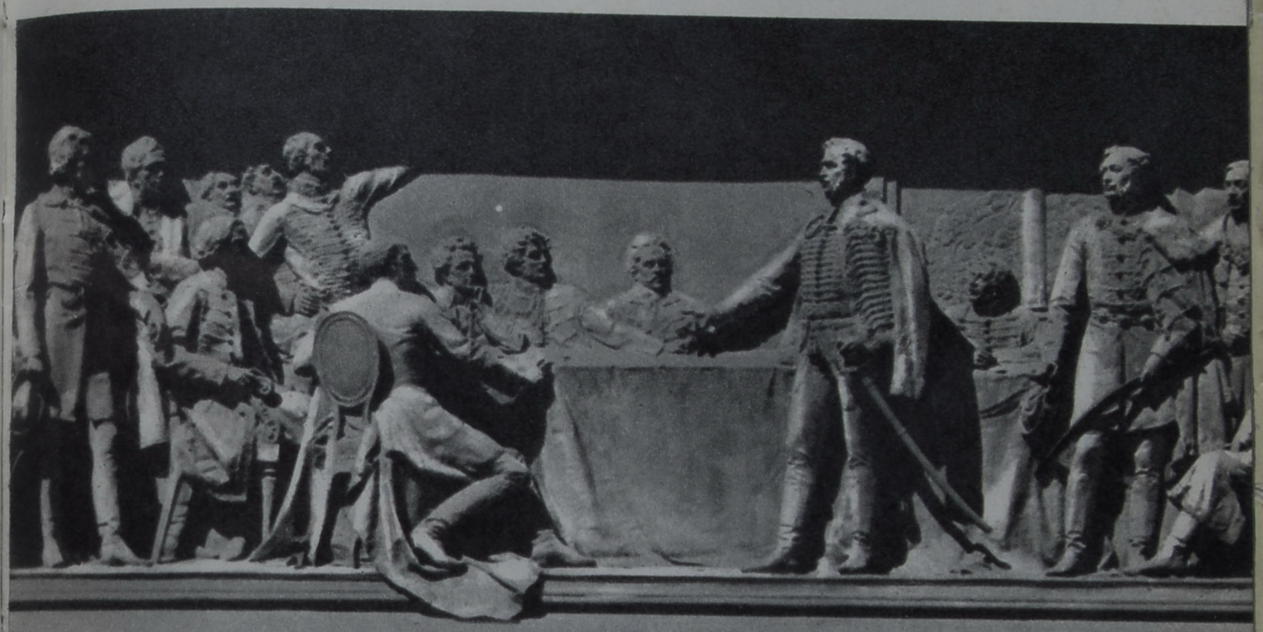
PHOTOGRAPHIES



Farkas Bolyai (1775-1856), mathematician and experimental physicist, author of textbooks and belletristic works

János Bolyai (1802-1860), one of the greatest mathematicians of his times and one of the inventors of non-Euclidean geometry

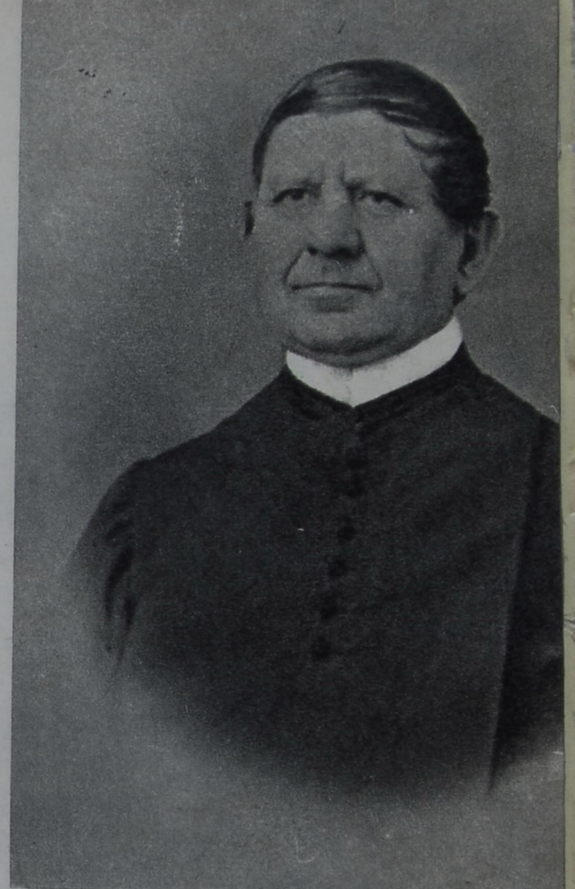
István Széchenyi (1791-1860) sponsored the reform movement of the 1820's. He was an outstanding statesman and writer. His initiative gave the impetus for the building of the Chain Bridge, the first permanent bridge of Budapest . . .

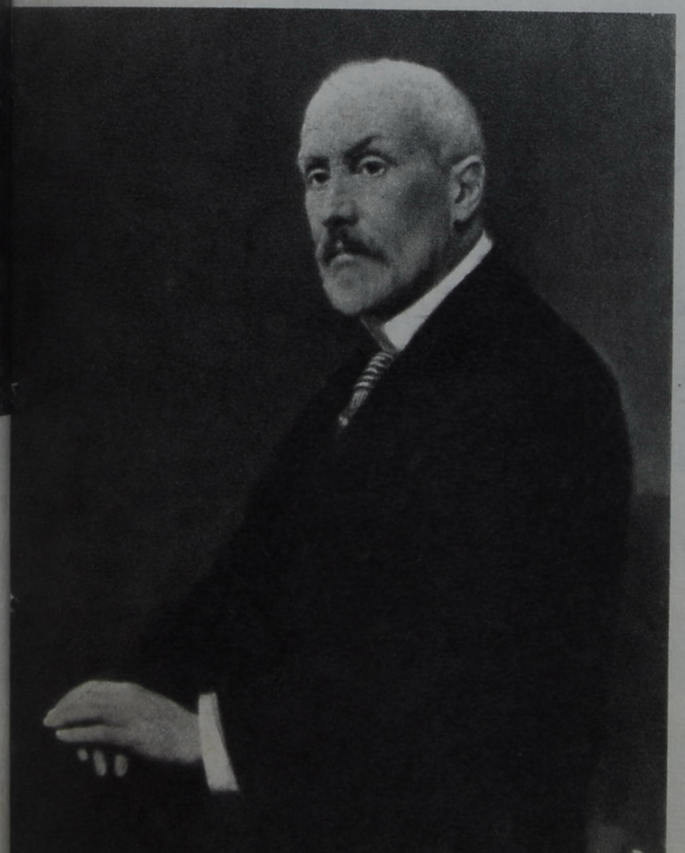


. . . and the Hungarian Academy of Sciences. The relief on the wall of the building depicts Széchenyi offering one year's income for the foundation of the Academy

The palace of the Hungarian Academy of Sciences in Budapest

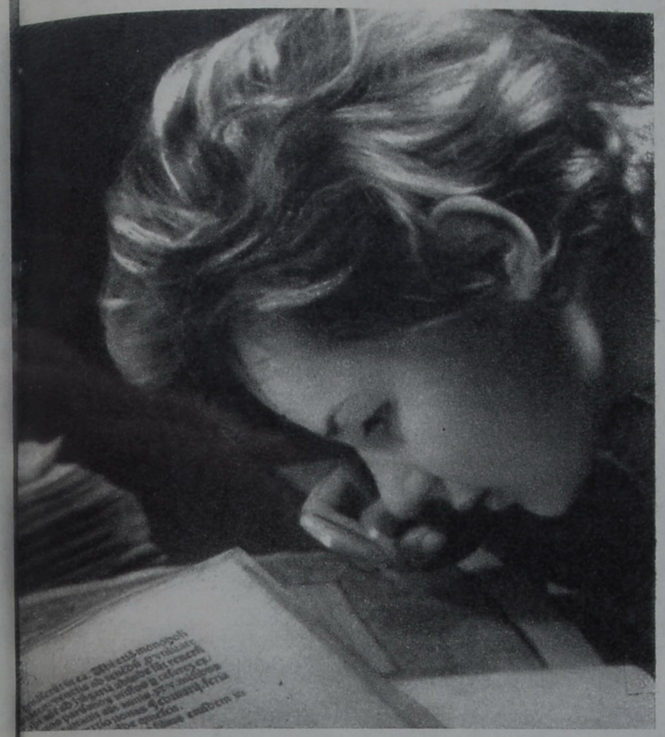
Ányos Jedlik (1800-1895), a physicist, one of the first to discover the principle underlying the operation of the dynamo, made the first dynamo in the world



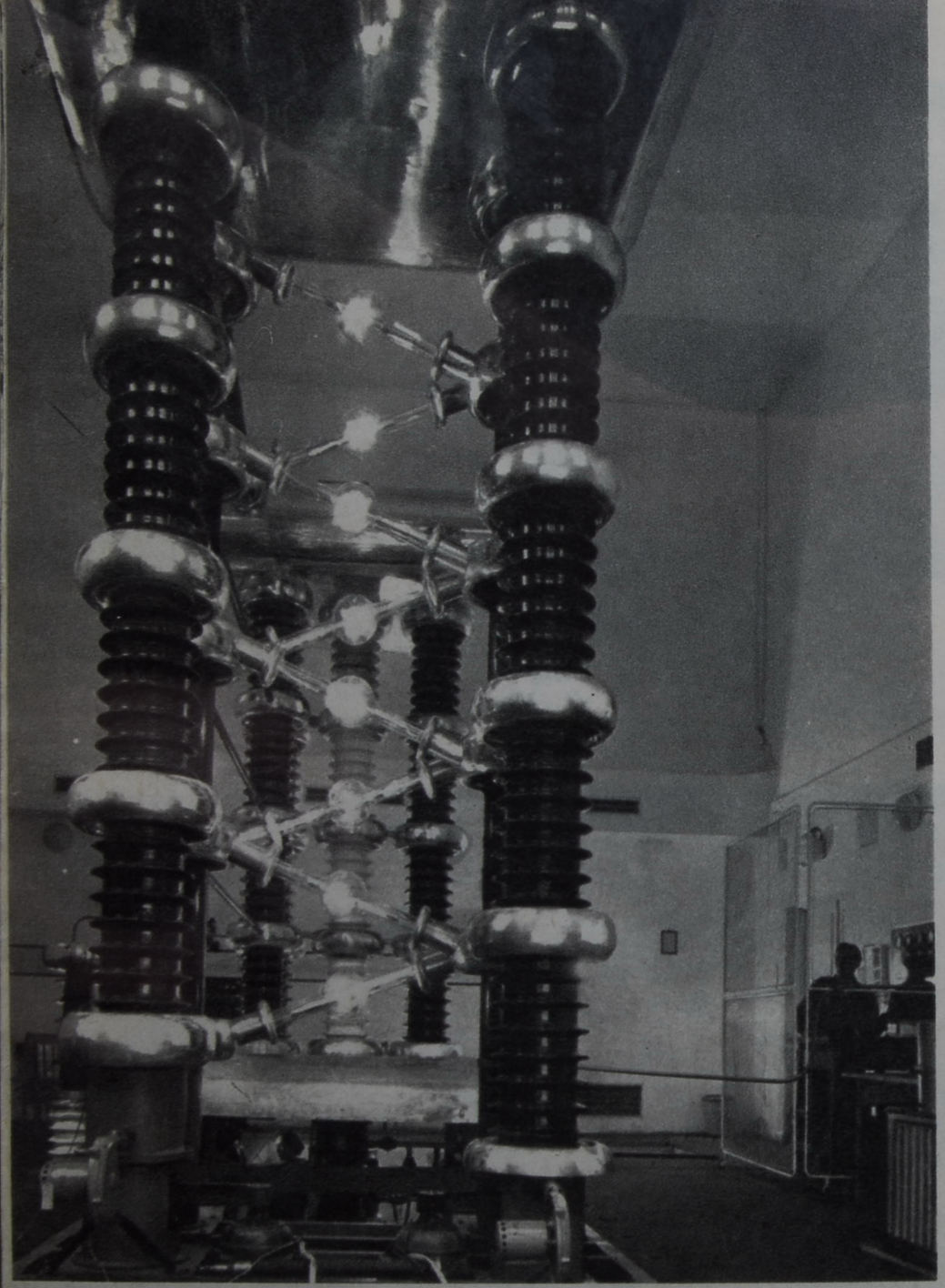


Loránd Eötvös (1848-1919), the greatest Hungarian physicist constructed the torsion balance named after him

The Academy in session



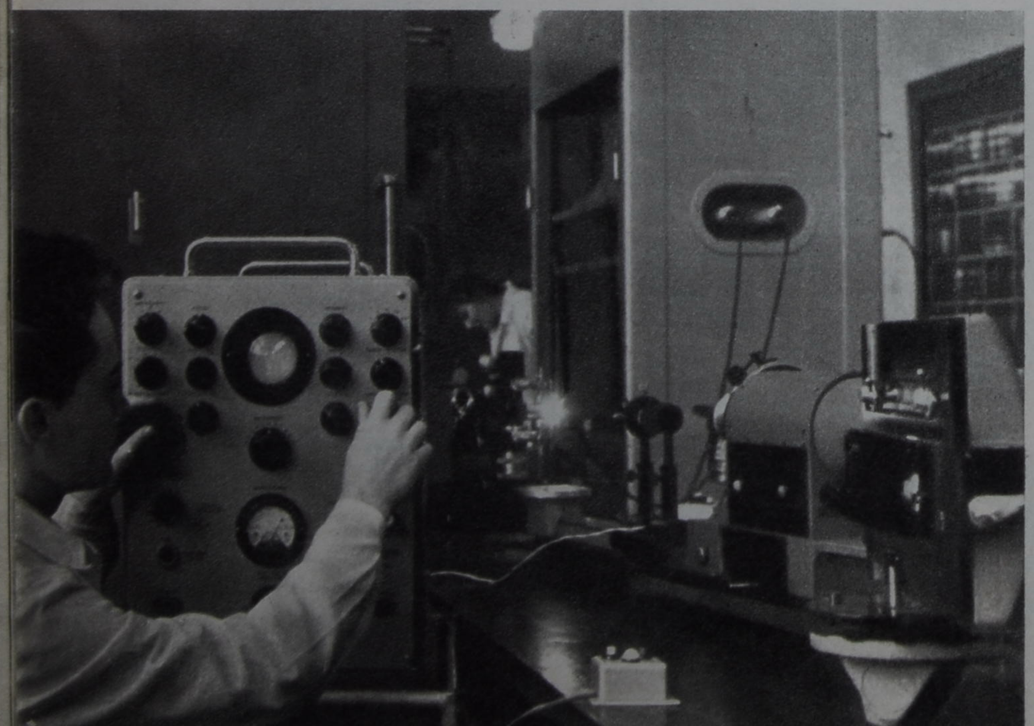
Scientists of the future

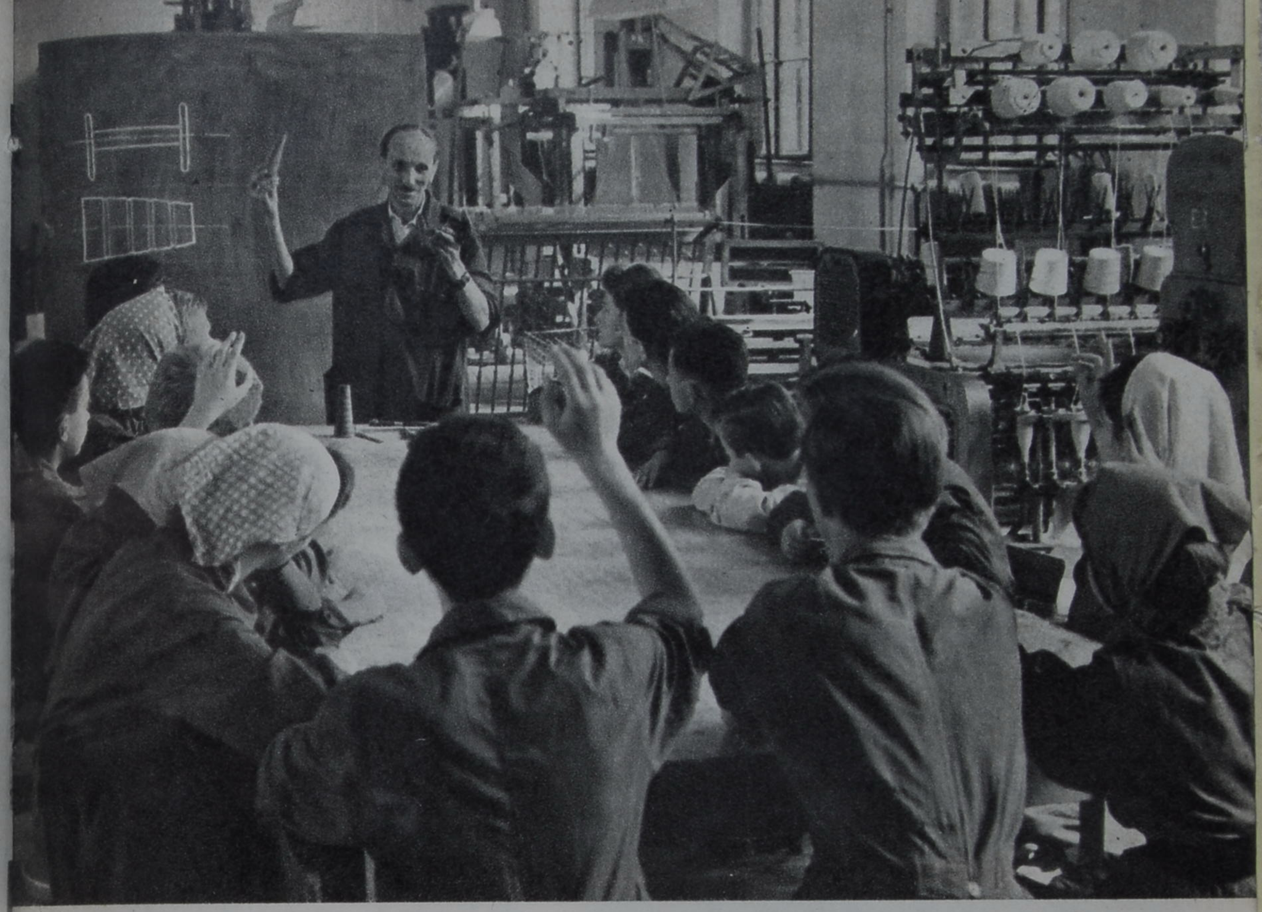


Department of nuclear physics at the Central Institute of Physics Research

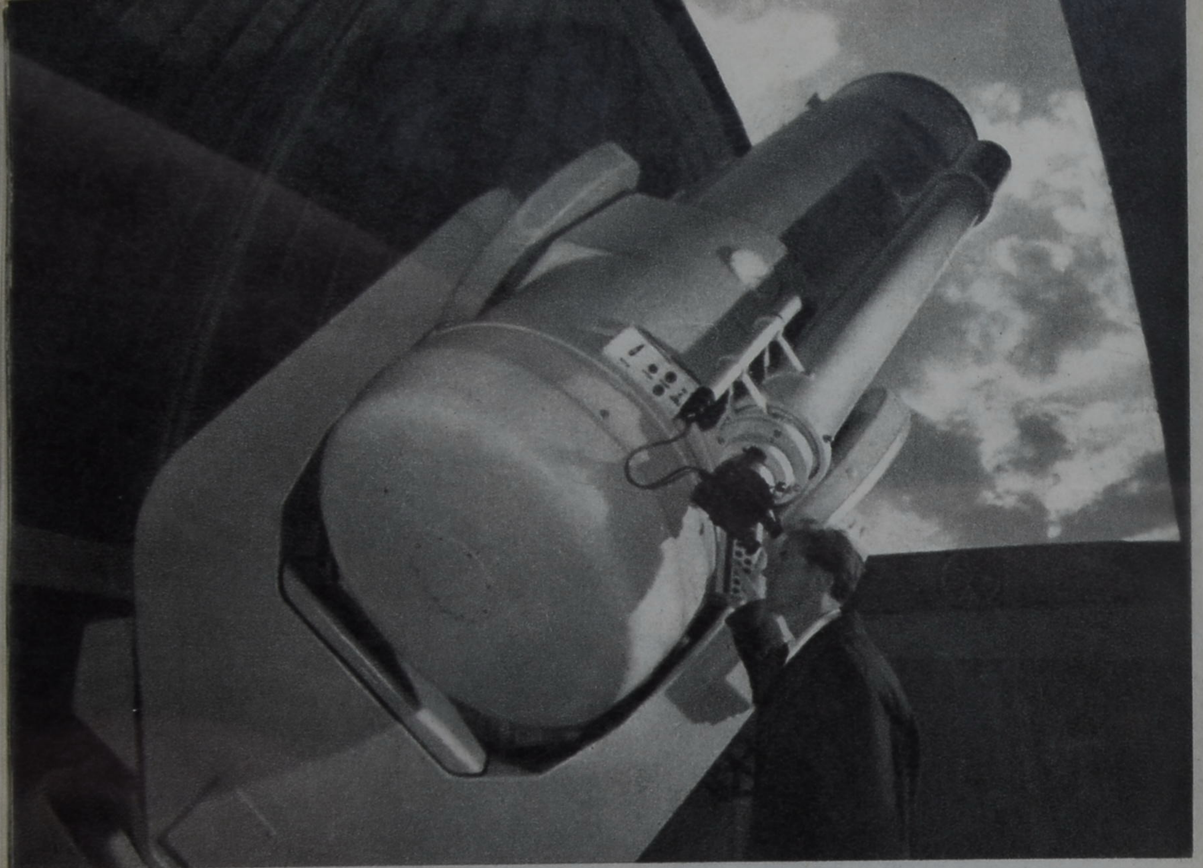
Quality inspection at the Chinoin Pharmaceutical Factory

Spectograph at the Precision Mechanical Department in the University of Technology in Budapest





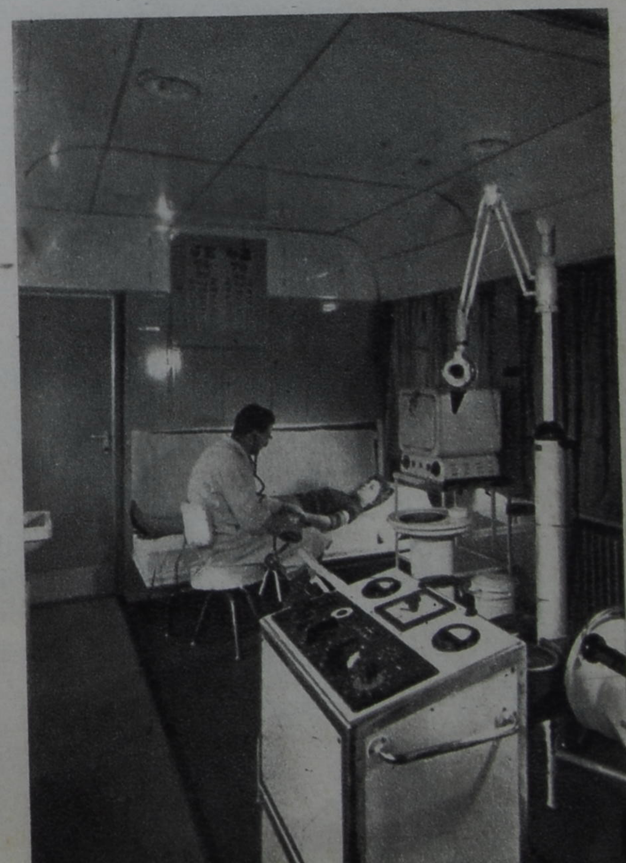
Apprentices getting practical instruction in a textile mill



The new reflecting telescope at the Observatory of the Hungarian Academy of Sciences

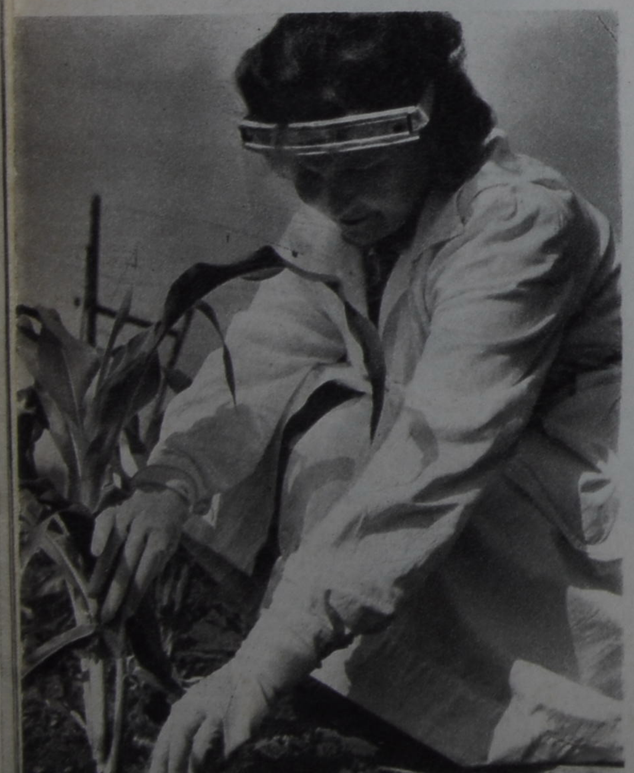
A sputnik tracking station is set up on the roof of a house in Miskolc

The laboratory of the T.B. Sanatorium in Budapest



Modern surgery in a railway coach to provide for rural areas

The Institute of Soil Science and Agrochemistry at Gödöllő



Experiment with radio-active isotopes at the Agricultural Research Station at Szarvas

Experimental irrigation on the rice fields of the Great Plain

The Institute of Biological Research on the shores of Lake Balaton

A new experiment

IN THE SAME SERIES

I. GARAMVÖLGYI – M. HORVÁTH

ACHIEVEMENTS
AND THE MEN BEHIND THEM

Why is it that travellers meet so many Hungarian-made buses on the highways of the world?

Why are Hungarian multiple-unit trains running on the vast plains of Argentina?

Why do the major sea ports order Hungarian ships and cranes, and the plants and towns in distant countries purchase the machine tools and telephone exchanges of this small Central European country?

This book provides an answer to these questions and takes you to the centres of some characteristic products of Hungarian industry and agriculture. It introduces the scientists, the inventors and specialists whose work contributes to the further exploration of the secrets of nature and serves human progress. It also conveys an idea of the extent to which Hungary after scarcely more than fifteen years of freedom is using its creative powers to assist the former colonial countries which wish to avail themselves of this help.

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