29. M. Cohn, *J. Biol. Chem.* **201**, 735 (1953).
30. P. C. Chan, A. L. Lehninger, T. Enns, *ibid.* **235**, 1790 (1960).
31. P. D. Boyer, A. B. Falcone, W. H. Harrison, *Nature* **174**, 401 (1954).
32. H. A. Lardy and C. A. Elvehjem, *Ann. Rev. Biochem.* **14**, 1 (1945).
33. C. L. Wadkins and A. L. Lehninger, *J. Biol. Chem.* **234**, 681 (1959).
34. W. Chefurka, *Can. J. Biochem. Physiol.* **38**, 1195 (1960).
35. M. DeLuca, Ph.D. thesis, University of Minnesota, 1963.
36. A. Fujimoto and R. A. Smith, *Biochim. Biophys. Acta* **56**, 501 (1962).
37. Development of the concepts presented has been made possible only through the able participation of graduate students and postdoctorate fellows. At work now are J. B. Peter, M. DeLuca, Donald Hultquist, Jimmy Hinkson, Gunther Kreil, Larry Butler, and Richard Moyer. Past contributions were made by Clarence Suelter, Kurt Ebner, Arthur Schulz, and Mary Dempsey. The researches have been supported by grants from the U.S. Public Health Service, U.S. Atomic Energy Commission, and Hill Family Foundation.

Oriental Renaissance in Education and Medicine

A Canadian physician sees a sudden renaissance of Western learning on the Chinese mainland.

Wilder Penfield

This is a new China, after thousands of years as an empire—a new nation. Politically the Republic of 700 million people is young, but it is conscious of new power and great ambition. For a month in the autumn of 1962 my wife and I were guests of the Chinese Medical Association, traveling thousands of miles by rail and road to visit the colleges and hospitals of the larger cities and to see all that the time would allow in that vast country. Physicians welcomed us. Lectures, hospital rounds, university visits and discussions, and social events were arranged. I was made a member of the Chinese Medical Association.

The fact that we are not Communists was taken for granted, and we heard no political discussion except when we asked to have broadcasts or speeches translated. This article is made up of random observations which are as objective and critical as I can make them. It is in no sense a complete study, and I can only hope that my colleagues in China will forgive any possible errors or misconceptions. I know that my colleagues in the English-speaking world who may read the article will welcome an introduction, however inadequate, to the scientists, doctors, and educators of a very young country which is, at the same time, old and proud (*1*).

To understand what is happening in the People's Republic of China one must realize that there are practically no foreigners there now, except from the Orient. But, in spite of that, a remarkable renaissance of Western learning is going on. This is important to us as well as to the Chinese. There is a general expectation among them that science and higher education will solve the unsolved problems, that mechanization will banish hunger and bring plenty, the afforestation and the construction of more dams will control the floods and the droughts of the past. The people are temperate, frugal, puritanical, and remarkably law-abiding. It is the nature of these people, as I discovered in 1943 on a visit to western China, then under Chiang Kai-shek, to be fastidiously clean, to work hard, and to find something to laugh about.

An Interview

To give you the perspective of the Chinese on education and medicine, I can do no better than to report one interview literally. At my request, the more or less official atitude toward medical education was expressed to me by the Vice Minister of Health, Tsui Yi-tien (a physician who is in charge of medical education and is one of the vice presidents of the Chinese Medical Association). In such an interview note-taking is made easy by the delays during which the interpreter must listen to Chinese in one direction and speak Chinese in the other.

"The problem of medical education is inseparable," he began, "from that of education in general in China." Backwardness in China was due to "colonialism and to our feudalism and capitalism." For a hundred years after invasion by foreign powers, new culture, modern science, and modern industry made their start. But the work was not in the hands of Chinese. There was no overall plan for higher education, and there could not be, until independence came. "For medicine," Tsui said, "there were colleges run by the British, Americans, Germans, Japanese, and others. They trained personnel and research workers, but," he added, "the purpose was to serve their own interests.

"China has a long tradition of her own in culture and art. Now China has been liberated, thanks to the Communist Party under Mao Tse-tung. When we say 'liberation,' we refer to the feudalists inside, imperialists outside, and capitalists both sides." When he mentioned the capitalists both sides, the minister laughed. "Starting in 1949 to 1950 or 1952," he continued, "restoration of the economy was our major concern. But during this period, culture and education were also reorganized.

"Economically speaking, foreign capital was confiscated. The same was true in the field of culture and education. We took over the schools of the British, French, Japanese, the United States, and others. Personnel was used as long as the members of the staff would follow the law and the spirit. Since China is socialist in nature, there must be a unified plan.

"In the first five-year plan of 1953," he said, "education was included. In Old China, there were medical colleges

The author is a Guggenheim fellow in education at the Montreal Neurological Institute, Montreal, Canada.

and universities in large centers such as Shanghai, Tientsin, and Peking. It was now considered that the country would be best served if medical colleges were more widely distributed. Today, except for Tibet, every province in China has its medical college."

Next he gave some surprising statistics, which I also heard from other educators. "During the 40 to 50 years before 1949 (that means the whole history of modern Chinese medicine!), only 18,000 qualified doctors had been trained in China. During the past 13 years, 102,000 additional physicians have been graduated from modern schools (not including the traditional herb doctors of whom there are 500,000 in active practice today). In addition to the senior-grade modern medical men," he pointed out, "there are the middle-grade personnel to be considered. We have qualified 450,000 nurses, technicians, midwives, pharmacists, and others during the same period.

"Based on our practical needs, the organization of medical teaching at present," he said, "is this: One college calls for a curriculum of 8 years—the Chinese Medical College in Peking. It is planned to train teachers and research workers. Each physician should have mastered two foreign languages before graduation from this College. Of the other medical colleges, one third now provide a 6-year curriculum and less than two thirds, a 5-year curriculum. A very few schools have a 3-year course, which is intended to prepare men for the practical needs of factories, mines, and farms."

At the close of the 2-hour interview I made some inquiry in regard to international scientific conferences. It was apparent at once that I had approached a sensitive area. Tsui said China favors such conferences since they "help the work throughout the world." However, the general principle adopted is this (and I quote): "Since China has been deprived of her rightful seat in the United Nations by the puppet government of Chiang Kai-shek, we are unwilling to join any conference in which representatives of that government take part."

Peking Union Medical College

Tsui had referred to the Chinese Medical College with the 8-year curriculum. It is housed in the beautiful buildings of the former Peking Union Medical College, which was established in 1915 through the generosity of John D. Rockefeller. Those who are familiar with the history of medical education in China know the story of this institution, commonly called P.U.M.C. The original buildings are intact, and a tall additional structure is now being completed within the compound (Figs. 1 and 2). The headquarters of the Chinese Academy of Medical Sciences is located there, as well as the Chinese Medical College. Huang Chi-hsu (*2*) is titular head of both organizations.

Soon after the P.U.M.C. was founded it became an institution for medical treatment, teaching, and research—an institution that, of its kind, was second to none in all the world. As originally organized, it disappeared during the Japanese occupation, but the buildings and the magnificent library were preserved. The influence of its intellectual ideals and the initiative of the small, select band of Chinese doctors who had been trained there is far-reaching and important still.

Beginning this year, an annual alternating exchange lectureship will be inaugurated between the Chinese Medical College and McGill University in Montreal. It is called the Bethune lectureship after Norman Bethune (*3*), who lost his life in 1939 while serving as a surgeon in the Communist Army when that army was fighting against the Japanese.

Peking University

There are many new institutions of higher learning in Peking. As we drove out of the city toward Peking University we passed along a broad tree-lined boulevard called the "Street of Science." Nine colleges and two universities were pointed out to me: colleges of Agricultural Machinery, Medicine, Geology, Iron and Steel, Aviation, Petroleum, Mechanical Engineering, Agriculture, and Socialism. The universities were Ching Hua (chiefly for science) and Peking (formerly Yenching).

Peking University, where I spent one morning, has an extensive campus that includes hills and pleasant lakes and tall trees. Three companions went with me. Indeed, they rarely left me on any expedition during my whole month in China, and we had many discussions that led in the end to understanding and friendship. The companions were Wu, the interpreter, Huang Ting-chen, vice president of the Chinese Medical Association, and Y. C. Chao, a neurosurgeon of Tientsin and Peking (*4*).

A government car took us to the former residence of Layton Stewart, once president of Yenching University. We were received by a tall, smooth-faced Chinese, apparently not yet 40 years old, dressed in a blue high-necked jacket and brown trousers. He spoke only in Chinese and deferred frequently, at first, to an "executive," who sat silent at his side. Our host delivered the "party line" preamble and then, with greater assurance, turned to educational matters.

It is general practice in all institutions that a visitor is ushered into a reception room where tea is served. (We would call it green tea, very good, hot, and served with no additions.) A responsible officer then gives a preliminary historical review. The nonprofessional executive is always present. In medical institutions, informality, direct discussion, and laughter soon break through. But here it was not until the close of a long formal morning that this young professor of biochemistry, who is also director of scientific research in the university, spoke in English. He smiled, as we started on a tour of the university grounds, and said he had spent 2 years studying protein chemistry in Toronto and had obtained his Ph.D. at Yale a year later.

Now, to return to his initial pronouncement: "This institution," he said, "became a university of the people in 1949." Previously (from its founding in 1898) its "purpose as a whole was to train personnel for the ruling class, the Kuomintang, banks, and foreigners." During the first 3 years, "a time of land reform and economic restoration," the curriculum was altered so that "patriotic intellectuals" could serve the people. "During the first five-year plan," he continued, "1953–57, we set out to train personnel for reconstruction and to introduce Soviet learning. There had originally been six colleges within the university—Arts, Science, Law, Engineering, Agriculture, and Medicine. Now there is only one —Arts and Science. Other colleges were moved out and housed nearby. In this way each institution could be greatly expanded.

"Every student, before graduation, must present a thesis including original work. Reviews are rarely acceptable. Only two subjects are required of all students: foreign language and the theory of political science." All students must spend some time each year

laboring with workers. Junior members of the faculty must do this also.

The university has 17 subdepartments. The list throws a good deal of light on university orientation. Seven departments come under the heading of *science*: mathematics and mechanics, physics, radio electronics, geophysics, chemistry, biology, and geography and geology. Ten are put under the heading of *humanities*: Chinese language and literature, western language and literature (there are subsections of English, French, and German), Oriental language (Japanese, Burmese, Hindi, Korean, Pakistani, and so on), Russian language and literature, philosophy, history, economics, political science, law, and library science.

All of the science departments offer 6-year courses. The humanities departments offer 5-year courses, except for library science, which offers a 4-year course. The university enrollment is 11,000, with about 260 additional postgraduate students. (There are 160 "foreign students," undergraduate and postgraduate.) There are 2000 faculty members, more than 200 of whom are professors and associate professors. Postgraduate courses are of 3 years duration and there are set course and thesis requirements. Eleven thousand students live within the precincts of the university; two thirds of them are men. As in the colleges, the parents provide food, clothes, and books, but some financial aid is given to 60 percent of the students through a university committee.

The student rooms that I visited were small, with two sets of double-decked beds, one small table, and one or two chairs. Each student is required to spend 2 hours a week in outdoor exercise and setting-up routines during the first 2 years. The most popular sports are basketball and soccer.

Fig. 1. Entrance to the Chinese Medical College, Peking. These buildings, which once housed the Peking Union Medical College, now house the Chinese Medical College and the Chinese Academy of Sciences.

Medical Colleges

In general, the so-called colleges (like the "institutes" in the U.S.S.R.) have an academic standing equal to that of the universities, which have larger enrollments. Up to the present time, neither the colleges nor the universities have awarded any degrees, but this matter is "under advisement by the government." The graduate receives some sort of certificate, and his scholastic record follows him wherever he goes in later life. There is no national system of scholarships. Tuition and lodging on the campus of the college or university are free, but the student must pay for food, books, and clothing if he can, as mentioned earlier.

Members of the faculty are, in general, provided with houses or apartments on the college grounds at low rentals. The professor or teaching assistant lives on his salary and has a rice or wheat ration card, like other people. He pays a small fee for each visit to the health clinic. He may own a bicycle. There are practically no privately owned automobiles in China, but the buses are numerous and fast. (An automobile called the Phoenix, suitable for private use, is in an early stage of manufacture. We saw one example. Chinese-made trucks are numerous. The government uses cars of foreign make.)

The calendar of the Chung Shan (*5*) Medical College in Canton is typical

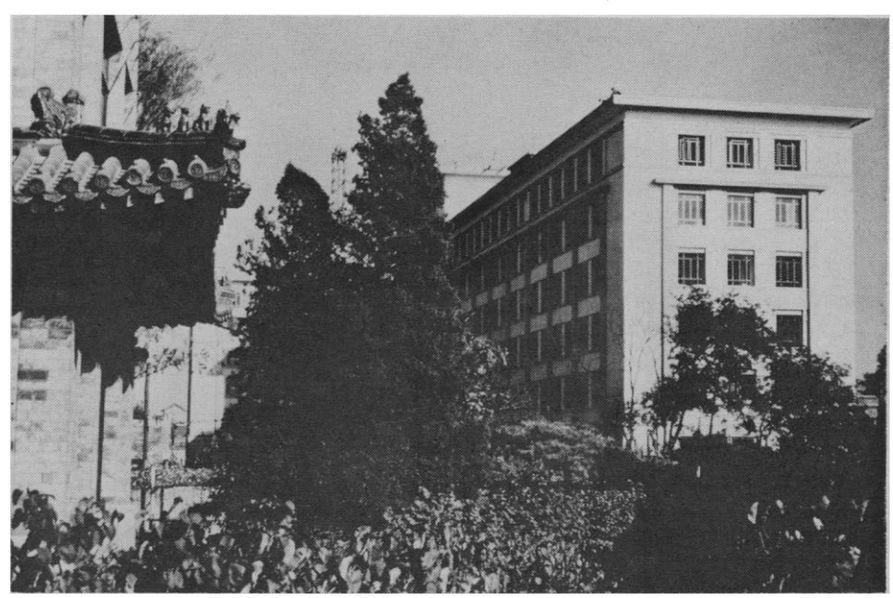

Fig. 2. Chinese Medical College, Peking. The modern building on the right was nearing completion when this picture was taken, in the autumn of 1962. Its simplicity is in striking contrast to the style of the other buildings in the compound, with their tile roofs in the style of the Ming Dynasty as shown in Fig. 1.

of the calendars for the medical colleges in general. The academic year opens in September. There is a statutory 4-week vacation in January and one of 6 to 8 weeks in July and August. In the spring the student usually makes a brief visit to the tombs of his ancestors. A student is expected to devote 8 weeks each year to manual labor. He does this usually in vacation periods, as many Western students do. During the year of internship, the undergraduates are required to spend 2 months in a village hospital to become familiar with that type of practice. One or two instructors accompany each group of a dozen students during this period.

"Chung Shan College," Dean Liang said, "has 2200 medical students in a total course of 6 years. The first year is for premedical study and the last year for internship. A considerable proportion of students in Canton are Chinese from neighboring foreign countries. This year the College could admit only one student out of 30 applicants from China. Graduates from middle school must present knowledge of one secondary language. It is either Russian or English here in Canton. In Shanghai, there is more tendency to present French. Texts are all in Mandarin. [Cantonese as a spoken language is incomprehensible to one who speaks Mandarin, but the written languages are the same.] Reference books are in other languages. In the early years following Liberation, the College accepted 600 students in each class and the course was shorter. But this was far too many for thorough teaching.

"There are 400 instructors in the medical faculty," the dean continued, "including 70 professors and a small number of traditional doctors." The Committee of College Control consists of one director, or dean, and four vice directors (all members of the faculty). The dean is nominated by the Ministry of Health and the Minister of Education, but he is finally appointed by the National State Council.

When I asked about local freedom, the dean said: "There is local freedom for organization, but all the directors are called together to Peking periodically for conference, and to decide on general policy."

I found, during visits to the other large cities, that there was less standardization of college organization than I had expected. For example, the First Medical College of Shanghai "is under the direct control of the joint Ministries of Medicine and Education." The second Shanghai Medical School, on the other hand, is under the Shanghai Municipal Board. The First College receives support from municipal sources as well, since it gives some service to the city.

Teaching Hospitals and Medical Colleges

Let us consider the teaching hospitals and medical colleges of Shanghai as examples of institutions of these types. Shanghai is the largest city of the People's Republic (probably more than 7 million). Once famed for romance and for uncontrolled vice, it is now a smoky metropolis, a rather drab place of factories and ships and traffic. The formerly lurid center for night clubs has been transformed into a recreation center, with reading rooms and facilities for meetings, table tennis, and other indoor games. The race track has become a park. Christian churches are kept open in each district of the city for those who wish to worship there.

Shanghai's leading teaching hospital was also named Chung Shan (or Chung San) after Sun Yat-sen (*5*). It is placed near the First Medical College and is allied to it. Opened in 1937, this hospital, like other Chinese institutions, passed through changes that followed the changing fortunes of war. It was occupied in 1938 by the "Japanese Imperialists," in 1945 by United States military forces, in 1946 by the Kuomintang, and in 1949 by the Communists. There are five other separate teaching hospitals in the vicinity. They specialize, respectively in pediatrics, otolaryngology, tumors, women's diseases, and neurology and neurosurgery (*6*). After "Liberation" (in 1949), the hospital beds of Chung Shan were increased from 350 to 600. There are, at present, 128 modern doctors and six traditional doctors on the staff. Staff quarters and a school for the children of staff members have been built adjacent to the hospital.

The hospital serves two large factories directly, and accepts their workers for treatment. It has supervisory responsibility for eight factories and responsibility for health propaganda and sanitation in the local district (25,000 people). It cooperates with certain other hospitals, sends interns to country hospitals, and conducts refresher courses for outside physicians. All this is in addition to the teaching of medical students.

Heart Surgery

Here is the exciting story of the initiation of open-heart surgery in Chung Shan Hospital, as it was told to me.

A special laboratory for heart-lung physiology was created, and the necessary complicated equipment was ordered from the United States, where the new operations had been recently devised (too recently for the apparatus to be available in the U.S.S.R.). The major piece of equipment, without which this form of surgery is impossible, is an "artificial heart and lung." It is used to maintain the patient's circulation while the heart is opened by the surgeon. The surgeons waited 18 months. Nothing arrived. Then they concluded that such things were subject to the general American embargo.

"Why not make our own?" they said. Shih, the thoracic surgeon (*2*), read the literature and turned hopefully to the instrument repair shop of the hospital. Months later, an elaborate "extracorporeal blood circulation apparatus" had been built. It was thought that two dogs would require an amount of blood equal to the blood supply of a man.

Blood was obtained, the dogs were anesthetized, and the operation was carried out. But alas, the dog patients died of air embolism. So the instrumentation was scrapped and they started again. Finally, 18 months after the beginning of the work on the apparatus, the experiment was repeated. The dog lived. Then the "open heart operation" was performed on a man, who had been waiting for it. Hypothermia was used to decrease the body's metabolic requirements. The man's blood was recirculated through the newly built heart-lung apparatus and returned in a circuit, freshly oxygenated, to the patient. The operation was successful. The "Mayor of Shanghai" came to see the equipment. Since then, the apparatus has been successfully used in operations on 80 patients.

The day I visited the hospital I was shown a group of Shih's patients recovering from heart operations. They were in a special ward of the hospital, and they seemed as enthusiastic as the young thoracic surgeon with whom I "made the rounds." He and I went to the operating room. There open-heart surgery was in progress. As I entered the room I saw that there were five doctors and two nurses, all gloved

and gowned, carrying out the procedure. Three thousand cubic centimeters of blood had been obtained from donors and added to the patient's blood circulating through the machine. There were 15 other individuals in the room in masks and gowns, some of them graduate students. At the operating table, Shih was helping his assistant, teaching him to carry out the procedure. Shih looked up and spoke to us quietly in English: "Mitral stenosis and insufficiency, due to rheumatic heart disease." Then the work went on.

The exposure was good, the thorax and heart were open, and the blood was moving in and out between the body of the sleeping patient and the home-made heart-and-lung machine. (There has been a similar adaptation in the field of heart surgery in Tientsin. If there are errors in this over-simplified description of the work at Chung Shan, I can only hope that thoracic experts, West and East, will be indulgent).

Traditional Medicine

In the Chung Shan Hospital, a well-trained, young woman surgeon, Li, was carrying out a controlled study on a series of patients who were suffering from acute appendicitis. It was planned to include 300 such patients in the study and to treat them by the ancient classical technique of acupuncture.

I examined a young man who had been admitted to the hospital the day before. He had acute appendicitis, without question. His blood count and temperature indicated it, and he still had true spasm of the abdominal muscles on the right side. The attack was clearly subsiding.

I turned to Tsui Shi-yi (professor of surgery, vice chairman of the First Medical College, and president of the local branch of the Chinese Medical Association). "What would you do," I asked him, "if this young man lived at a distance from hospitals, where a second or third attack might be fatal?"

"Oh, we would have operated when he came in," he replied, "and, in any case, if a patient seems to be in danger we operate at any time, of course."

"Are you going to compare this series of patients treated with acupuncture with a series of patients to whom no treatment is given?"

"No, our patients would not accept that." His reply was a rebuke which was fair enough. I had asked for it. Then he added, "We will have a similar series of patients treated with antibiotics to serve as a control."

I was invited to carry out the acupuncture procedure. The sterile acupuncture needles, which are slender and very sharp, cause little or no pain. For the treatment of acute appendicitis, they are inserted deeply at two points in the right lower leg. I carried out the maneuver under Li's watchful eye. The needles entered intermuscular fascial planes which I could tell from the resistance of the tissue to the needle. The young man felt a sensation in the second toe of the right foot, as my instructor said he should. The needles are kept in place for an hour, during which time they are moved in and out at intervals. The treatment is given twice daily.

To explain the apparent benefit of these treatments, Li suggested, in reply to my questions, that there may be a reflex effect upon the peristalsis of the intestine adjacent to the appendix. This, I suppose, could do so. Be that as it may, vast numbers of patients, outside teaching hospitals, are being treated by traditional doctors in China today in this manner, and the best approach to balanced control is an unprejudiced scientific evaluation such as this one. If the procedure has no value, a clear statement to that effect will then carry weight among medical men, ancient and modern. The so-called traditional doctors are physicians of an ancient school. They are not witch doctors, nor are they charlatans. They have textbooks and records of experience. They do not operate, unless penetrating the skin with a needle may be called that. They do administer herbs. They counsel and reassure, and they are remarkably skilled in the treatment of fractures.

Traditional and Modern Surgery

In Tientsin I was shown a valid contribution from the ancient art of Chinese medicine to the modern art of the Hippocratic school. The Hospital of Traumatology and Orthopedics (*7*) is under the able direction of Fang, a professor of orthopedics. He had prepared for me a follow-up demonstration of the treatment of fractures of both bones of the forearm, calling back to the hospital a succession of recent patients in which the standardized light willow splints of the traditional doctors had been used where Western practice would have called for plaster. A pencil of brown Chinese paper rolled on a steel core is placed under each splint and over the space between the bones of the forearm. Thus, through the pressure of splints, the pencil stretches the interosseous ligaments.

Shang, an orthopedist and an associate of Fang's demonstrated the case of a boy of 12 who had had simple fractures of both bones of the forearm 2 days previously. When the patient was admitted, Shang had anesthetized the area with a brachial novocaine block and had used "traction and finger reduction" to correct, under fluoroscopy, overriding and angulation of the bone fragments. The paper rolls had been placed on the skin over the interocceous space on both sides. Three willow splints of the standard lengths had been applied, and three cords had been tied about them. The palmer splint was shorter than the others. Exercise of the joints had been started. On questioning, the boy said the exercise had caused him a little discomfort at first. The relief of pain by novocaine and investigation of the position of the bone by means of x-ray were the only departures from the traditional method of treatment. The standard herb medicines traditionally given in cases of fracture had been prescribed.

It was planned that the splints would be removed at the end of 4 weeks. In the case of adults, splints are applied for 7 to 8 weeks. Fractures of both bones of the lower leg are treated with similar techniques.

Fang summed up: in 280 cases of simple fracture of both bones of the forearm which he and his associates had reviewed, there had been no example of nonunion, and there was no atrophy of disuse. In an earlier, similar series, in which only modern techniques had been used, there was nonunion in 4 percent of the cases and delayed union in 12 percent.

Near Shanghai we visited the headquarters of a farmer's commune. There was a central clinic staffed by two traditional doctors, a dentist, a pharmacist, and a modern physician (Fig. 3), who cooperated as a team, each in his own office. Workers pay a small fee for admission to the treatment clinic. At present, the country could hardly get along without the herb doctors. According to the "request of Chairman Mao Tse-tung," the plan is to test and to preserve what is of value and to produce, in the end, a fusion: "only one Chinese Medicine."

Neurosurgery

The hospitals that I visited were teaching hospitals of the major cities and the Bethune International Peace Hospital at Cze Chia Chuang. The general level of medical and surgical practice in all of these city hospitals was first class. Being a neurosurgeon, I was expected to "make rounds" on the neurosurgical wards. At the Bethune Hospital, a smiling young neurosurgeon in a very well run ward, was introduced as "your grandson," amid general laughter. He was a pupil of Y. C. Chao, once a graduate student in the Montreal Neurological Institute.

I shall limit myself to a few words about the development of this specialty. It may show what must have happened in other specialties. No help from the traditional doctors can be expected in neurosurgery (in their literature there is not even a word for brain tumor!)

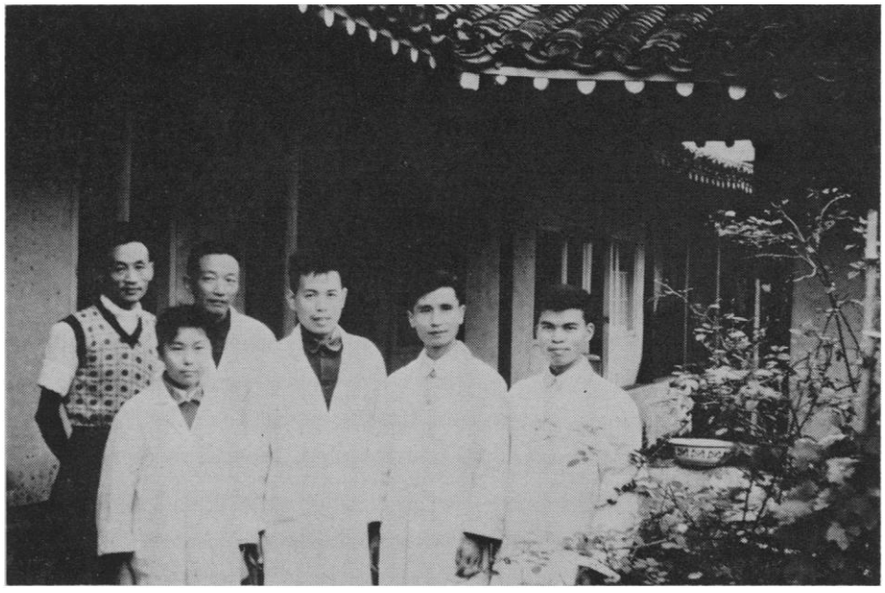

Fig. 3. The staff of the clinic at headquarters of the Tang Wang Rural Commune, Shanghai area. At extreme right, the dentist; next, a modern physician; next, two traditional Chinese physicians. The man in the sweater and the woman are, I think, pharmacists. The commune includes 4229 families (18,000 people, 9600 of them able to work) and 26,800 mu (about 1800 hectares) of tillable land.

Fig. 4. Medical staff of the Peking Neurosurgical Institute in the Hsuan Wu Hospital, seen in the background. Dr. Y. C. Chao, director, in a white coat and without a cap, stands to right of center. On his right are my wife and myself, Dr. Hwang Ting-chen, and Mrs. (Dr.) Y. C. Chao.

In 1940, after 2 years of work in Montreal, Y. C. Chao (Yi-cheng) returned to China and went back to the Peking Union Medical School, where he had qualified in medicine. But the Japanese invasion forces closed that school and hospital in 1942. From then until sometime after the Communist regime took over in 1949, there was chaos as far as medical practice was concerned. During the confusion, Chu Hsien-yi (now professor of medicine and director of the Tientsin Medical College) gradually gathered a group of bright young Chinese doctors around him in Tientsin. In 1952 Chao joined them and immediately inaugurated a program of residency-training in neurosurgery.

About 1954, in conformity with national policy, a neurosurgeon, Arytienoff, director of the Kiev Neurosurgical Institute, was brought from the U.S.S.R. to plan the development of the specialty. After 6 months in China, Arytienoff returned to Kiev, recommending that a Neurosurgical Institute be created in Peking, and that Y. C. Chao be brought back from Tientsin to direct it. This was done. Today, the Peking Neurosurgical Institute in the new Hsuan Wu Hospital has 120 beds devoted to the specialty and a remarkably skilled medical staff (Fig. 4). This institute and the department of neurology and neurosurgery in the Tientsin Medical College have trained neurosurgeons who are now scattered across China. In all, there are 336 beds for neurosurgical cases, in various hospitals. In addition, partial training in neurosurgery is given general surgeons, who come to Peking or Tientsin for 6-month courses and who then return to their own hospitals. These surgeons are prepared to carry out the simpler procedures, and they knew where to send patients with more complicated problems. It is fair to say that clinical brain surgery in China's best medical centers is as good as it is anywhere in the world.

The same cannot be said of neurology and the sciences that are basic to it. In general, "applied" medicine (if clinical work may be called that) in China seems to be first class, as was shown by the heart surgery initiated by men trained in China who had merely read of the work in medical journals. But basic medical science and new approaches to research lag behind, waiting, no doubt, for scholarly scientists to appear who can be freed from the full weight of medical practice.

I lectured under the auspices of the Chinese Medical Association in Peking, Shanghai, and Tientsin, and in each instance was asked to provide the manuscript in advance. The text of four different addresses on neurological subjects was translated in Chinese (Mandarin); these texts have since been published in that language in the Chinese Medical Association *Journal*. Most of the articles also appear in that journal in English.

After each lecture the interpreter, a neurosurgeon, delivered my address in Chinese (Fig. 5). I was called upon to give the introduction and later the conclusion and to comment on the lantern slides. Y. C. Chao then translated and explained my observations on the slides. In every case the lecture was well delivered in Chinese. A day or two later a seminar of senior men from the local medical school was held, for questions and discussion of the lecture. The interest and understanding shown in these seminars were excellent.

Some general notes may be added here, drawn from my discussions with various physicians and from my observations of the people.

Common Diseases

Among the most serious medical problems are schistosomiasis; wading in rice fields and the agricultural use of manure from the cities are factors in the spread of this disease. Special laboratories have been created to study the causative liver fluke and its effects on its hosts, man and the snail. Infectious hepatitis, measles, poliomyelitis, and encephalitis are problems in China, as they are elsewhere. Trachoma is under attack. Tuberculosis and leprosy are treated with drugs and isolation. Bovine tuberculosis, which produces bone and joint disease, is common, but drug therapy is effective. Malaria, typhus, and the typhoids are decreasing, and cholera is practically gone. Syphilis and addiction to opium and heroin are gone. Alcoholism never was a very important problem in China. Now, I am told, it has almost disappeared as a cause of commitment to asylums, in contrast with the situation in some countries, such as Australia. Influenza, coronary disease, and multiple sclerosis are less prevalent than they are in the West. Cancer of the nose and throat is particularly prevalent, although there is no obvious reason why it should be.

Population and Birth Control

From conversations with well-informed medical men I concluded that improvement in general health conditions has produced a lowering of the death rate. This is true, of course, all over the world. Better medicine is the cause of the so-called population explosion. A more descriptive phrase would be population overflow, or perhaps birth-death disparity. In China, I was told, families are already small, averaging two children each. From watching thousands of families in parks and public places, I would say that the statement is accurate.

At present, birth control, late marriage, and small families are all being recommended by a nation-wide propaganda program and by the organized policy of the members of the medical profession. After marriage, even after late marriage, a delay of at least 2 years before having children is recommended. The argument presented to those who marry is this: A small family makes it possible to give the children a better education and results in better health for the mothers. Family-planning units are established in all hospitals. In areas where no hospitals exist, such units are set up in clinics or offices. This campaign is the special responsibility of obstetricians and gynecologists.

If the leaders of the nation can persuade the people to accept this program, as they have so successfully persuaded them to accept others, I can see no reason why the increase in population may not be reduced from the present 2 percent to zero. The great obstacle is, of course, the continuing improvement in medical practice that may result in continued lowering of the death rate.

Many people have asked me, since my return, whether the family unit in China has been destroyed. My answer is that the traditional multiple-family groups under one roof are no more. The affection between parents, children, and grandparents is quite obviously unbroken. The small unit seems to be

Fig. 5. The close of a lecture-by-proxy at the First Medical College, Shanghai. Facing forward at extreme left is Mr. Wu, our interpreter. Beyond, in the garden, the faces of medical undergraduates may be seen through the open windows. This lecture, entitled "Speech and perception," had been translated into Mandarin by a young Shanghai neurosurgeon, Dr. Chi, who then committed the first half to memory. He delivered it so well that I found myself enjoying and applauding my own lecture although I can not speak Chinese!

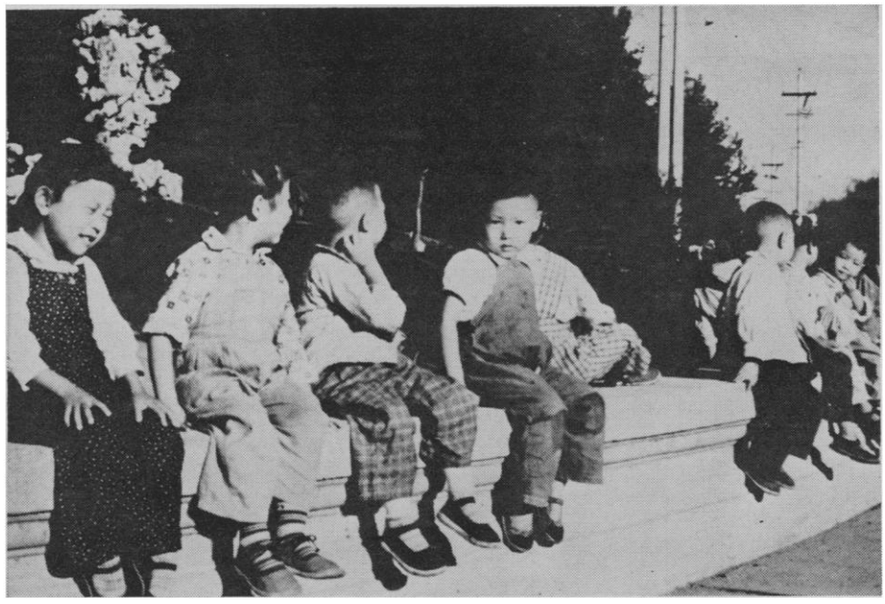

Fig. 6. Chinese children in Lotus Park, Nanking. The variety of clothes and patches tell the home story.

held together by strong ties, although many mothers work outside the home.

Midwives are forbidden to perform abortion. Abortion is permitted if carried out by doctors, but only under certain conditions. If a pregnant woman applies to the hospital, the request for abortion may be granted for one of two reasons: (i) because the health of the prospective mother demands it (the husband must agree to the abortion); or (ii) because there are already too many children in the family.

In the case of an unmarried girl, I was told, abortion may be performed only if her health requires it. An effort is made to call in the father and urge him to marry her. A doctor who performs an abortion illegally is "criticized" on the first occasion. On the second, his action is published. On the third, his license to practice may be suspended or he may be sentenced to jail or forced labor. If a woman dies as a result of illegal abortion, the physician must "go to the death court."

Nutrition

We saw no evidence of dietary deficiency in mainland China. This discovery came as a surprise to us because of the press reports of malnutrition and the misleading pictures that were current in the West. We traveled by train throughout the length and breadth of the land, watching the people at every station stop, and in the cities and hospitals. I am familiar with the signs of malnutrition. I have seen it in other countries, resulting from famine and poverty, and as a physician I have seen it in hospitals. My opinion is that there had been no food shortage sufficient to interfere with health and energy during the 6 to 12 months before our visit. Even in the North, where we could see that there had been a partial crop failure due to drought, the people did not show signs of undernourishment. The workers in general show great vigor; the children are well and happy (Fig. 6).

Discussion

In a physical sense, the people of the People's Republic of China are isolated from the rest of the world. No doubt that isolation serves various purposes. In spite of it (or is it perhaps because of it?), a remarkable renaissance of Western learning is going on. It has been said that, at the beginning of this Communist regime, pressure was brought to bear on scientists to accept certain ideas and principles in the field of science, with a disappointing result. Whether or not that is true, it is obvious that in the broad field of science and medicine today, and in most of the "arts and sciences," there is no isolation. There is freedom of thought and debate in those fields—freedom to seek the truth independently.

In Peking this year, each of the principal groups in the nation sent a delegation to march in the "Liberation Day" parade on 1 October. The delegations came from farm and factory, from military unit, school, youth club, and art group. Apparently, each unit prepares its exhibit as a sort of surprise. It was perhaps significant that a platoon of members of the Academy of Sciences (Academia Sinica), dressed in white, marched in the parade, bearing aloft in gold characters the first line of the famous quotation from Chairman Mao's 1956 speech:

"Let a hundred flowers bloom.
Let a hundred schools of thought contend."

In general, during the 13 years since the Communist government came to power, there has been a far-reaching reorganization and expansion of institutions of higher learning in mainland China and, with it, a rapidly rising demand, on the part of students, for advanced teaching. The students come from all categories, but, as one would expect, the sons and daughters of well-educated parents are proportionally the most numerous. Curriculum standards were lowered at first, and courses were shortened. The qualified teachers were few indeed. Now the emergency seems to be passing, and attention in the institutions has been turned to the need of raising academic standards.

In the field of medicine, the application of modern methods in hospital treatment is satisfactory, sometimes brilliant. Basic science is less well developed. Progress, here, awaits better equipment in some cases, but most of all, it awaits the availability of trained postgraduate students who are not completely occupied with clinical work.

There is as yet no system of scholarships for young men and women of superior talent. In this regard mainland China lags behind the U.S.S.R., as do many Western countries. The enthusiastic upsurge of Chinese students, their willingness to work, and the peculiar capacities of the Oriental brain may offset this lack, at least temporarily.

In 1943 I visited the U.S.S.R. for the first time. The isolation of the Russian people was similarly complete. As in mainland China today, the inflow of scientific information was never cut off. We in other countries have watched the remarkable evolution of Soviet education since that time. Even though the historical background of the two peoples is not the same, it is still reasonable to predict that the development of higher education in China will

be no less brilliant in a relatively short time.

The isolation of the people of mainland China is disappearing on the scientific and intellectual level. We can now make contact with our colleagues in the East. They use the language of our professions, and they are beginning to make their own contributions. Perhaps it is in science that the brotherhood of man is most clearly established. Scientists have always preferred to take the view that there are no national boundaries.

References and Notes

1. Two recent and informative books on life in China are *The Wall Has Two Sides, A Portrait of China Today* (Cape, London, 1962), by Felix Greene, an Englishman resident in the United States, and *The Other Side of the River* (Random House, New York, 1962), by Edgar Snow, an American reporter with a unique entrée into the People's Republic of China.
2. Huang Chia-hsu, now head of the Chinese Medical College, is a thoracic surgeon who once spent 3 years working at that specialty with Professor Alexander at the University of Michigan. Shih, now Professor of Surgery in Chung Shan College, Shanghai, received his medical training in that institution but took his graduate specialization in thoracic surgery under Huang at Peking Union Medical College.
3. Norman Bethune was a thoracic surgeon from the Royal Victoria Hospital of Montreal, trained by Professor Edward Archibald of McGill University. His biography has been written by Allan and Gordon [*The Scalpel and the Sword* (Little, Brown, Boston, 1952)]. Today, even the Chinese school children know the story of this Canadian, who was a martyr to their cause. His ashes are buried in a special Chinese Heroes Cemetery, in Cze Chia Chuang. Not far off is his memorial, the Bethune International Peace Hospital, now an excellent civil and military institution with 800 beds.
4. Mr. Wu is a graduate of Nanking University, where he learned his excellent English, with some assistance from a Linguaphone. Dr. Huang was a graduate from Tibet and gained his medical training in Japan. Dr. Chao was graduated from Peking Union Medical College. He then studied at the Montreal Neurological Institute as a Rockefeller Travelling Fellow, in 1939 and 1940.
5. Chung Shan was, according to Professor Liang, dean of Chung Shan College in Canton, the real name of Dr. Sun Yat-sen, "the great liberator of China, the man who overthrew the Ch'ing Dynasty and freed us from the Emperors. He was born here in Kwantung Province and he studied medicine at Hong Kong, marrying a young woman by the name of Soong Ching-ling. Her sister, Mei-ling, later became Madame Chiang Kai-shek. . . . Because of his revolutionary activity, Dr. Chung Shan was forced to escape to Japan. But he returned, calling himself Dr. Sun Yat-sen to avoid recognition by the Emperor's police. He established the first Republic of China on October 10, 1911. We call that the 'old democratic revolution.' But when we refer to 'Liberation' we mean the beginning of the present government under Mao Tse-tung, October 1, 1949. Dr. Sun died of cancer, but his wife lives on now, outside Peking. She is Vice-President of the Republic." I might add that the last Emperor of China, Fu Yi, was deposed at the age of 3. The Japanese later made him the puppet Emperor during their occupation. He is now living without restriction in Peking. He has written two books that have to do with the last days of the Empire.
6. The Red Cross Hospital is used for neurological patients. It is a gloomy place of 120 beds, in an ancient park. It was founded sometime before 1920 as a hospital of 43 beds, called Harvard in China.
7. The Hospital of Traumatology and Orthopaedics, in Tientsin, was built with the support of British missionaries and was opened as the McKenzie Memorial in 1860. The centenary of the opening was celebrated in 1960. It is one of the teaching hospitals of the Tientsin Medical College and has 280 beds. There are five sections: pediatrics, traumatology, bone and joint tuberculosis, hand injuries, and "mixed" (arthritis, nerve injuries, and protruded intervertebral disks). A 1-year postgraduate course is given to surgeons who have previously had 5 years or more in general surgery. Up to the present, 250 surgeons have taken the advanced course in orthopedics. Dr. Fang has published a study (in Chinese) of this method of treating fractures, in the *Chinese Medical Journal*, published by the Chinese Medical Association, Chu Shih Ta Chieh, Peking. He calls the method the "integrated method" and has promised to publish an English version of the article, also in the *Chinese Medical Journal*.

News and Comment

Investigation: House Unanimously Approves Comprehensive Inquiry into Federal Support of Research

The House of Representatives voted unanimously last week to appoint nine of its members to conduct a comprehensive investigation of federal support for research. The action is a manifestation of increasing congressional unease over the phenomenal growth of federal support for science and engineering, and it was inevitable that sooner or later this unease would receive formal recognition.

Ideally, the outcome could be beneficial for Congress and research, since the expansion and pervasiveness of federal support have produced conflicts, imbalances, and congressional hostilities, all of which could be favorably affected by a detailed survey of the whole picture. Such a survey is now lacking—something that is lamented not only by congressmen but also by growing numbers of scientists and science administrators who are dissatisfied with, or mystified by, the decision-making process for allocating national resources for research. Thus, an inquiry—especially one that would command congressional respect—is a welcome and overdue development on both sides of the politics-research relationship.

However, a disturbing difficulty is that the investigation ordered last week is an oddly shaped offspring of some very strange political bedfellows, and before and after it was voted, informed predictions were made that it would turn out to be a shallow, meaningless affair. Significantly, this view is shared by several members of the investigating committee.

On the other hand, the very existence of the committee is a decisive indication of congressional concern, and even if this particular investigation should fizzle, the movement for closer congressional scrutiny of research will nevertheless have been strengthened. Longstanding committees with scientific jurisdictions regard the investigation as an adverse reflection on their performance, and they can be expected to reappraise, and intensify, their own roles as legislative watchdogs over scientific matters.

The pessimistic view of the investigation's potential is realistically based on (i) the immensity of the subject, (ii) the difficulty of obtaining a competent and respected technical staff, (iii) the short time allotted for producing a report (a little over 15 months), and, most important of all, (iv) the remarkably heterogeneous cast selected for committee membership.

Federal support for research, development, and education associated with these activities is generally said to exceed $15 billion a year, although it is easy to get a good argument that a lot of the bookkeeping is nonsensical and that a great deal charged to R&D