— 1936 —

The Saranac Laboratory
for the
Study of Tuberculosis
OF THE EDWARD L. TRUDEAU FOUNDATION

REPORT OF THE DIRECTOR

AND

FINANCIAL REPORT

FOR THE YEAR ENDING SEPTEMBER 30, 1936

REPRINTS OF SCIENTIFIC PAPERS

The Saranac Lake Academy
of Medicine

THE SARANAC LABORATORY

THE fact that the Saranac Laboratory has always been a separate institution from the Research and Clinical Laboratory of the Trudeau Sanatorium is not generally understood. Both laboratories are sponsored and controlled by the Trudeau Foundation, but the Saranac Laboratory is located at 7 Church Street in the village of Saranac Lake and not at the Sanatorium.

The properties of the Saranac Laboratory consist of the original building, given to Dr. E. L. Trudeau by Mr. George C. Cooper in 1894 as a private research laboratory, together with the John Black Wing, donated by Mr. and Mrs. Frank B. Black in memory of their son. The addition contains the library and lecture room, erected in 1927 and 1928, and private research rooms constructed in 1935. There are also two animal houses.

While the Saranac Laboratory co-operates with the Sanatorium in every possible way, and serves as the headquarters of the Trudeau School of Tuberculosis, it provides diagnostic facilities to the physicians practicing in the village and carries on independent researches in the field of tuberculosis and associated conditions.

To avoid confusion, the Trudeau Foundation publishes separate reports of the Trudeau Sanatorium and the Saranac Laboratory.

THE SARANAC LAKE ACADEMY OF MEDICINE

IN the early part of July, 1931, a group of physicians in Saranac Lake met in the John Black Room to discuss ways and means for supporting the diagnostic and research activities of the Saranac Laboratory during a period of diminishing income. They were of the unanimous opinion that this institution is essential to the continued existence of the village as a center for the scientific treatment and study of tuberculosis. As a concrete expression of this feeling, they constituted themselves the nucleus of a body to be known as the Saranac Lake Academy of Medicine. Its object is "to foster interest in the pursuit of scientific medicine in Saranac Lake" through the agency of the Saranac Laboratory. Its members pledge themselves to support the activities of this institution in every possible way and to seek assistance from others for its operation. The active members are physicians practicing in Saranac Lake, but associate, sustaining, and life memberships are also open to interested laymen. In the financial report for the current year will be found a list of contributors

The formation of the Academy created nothing new. The Laboratory, the Library, the diagnostic service, the scientific lectures and research have always been an integral part of the medical life of the village, but by many they have been freely accepted as a natural heritage from the great founder of this health community. By membership in the Academy of Medicine, or by contributions through it, anyone can feel that he has a part in keeping alive the Trudeau ideals for the furtherance of medical science.

THE SARANAC LABORATORY FOR THE STUDY OF TUBERCULOSIS OF THE EDWARD L. TRUDEAU FOUNDATION

LABORATORY STAFF

Leroy U. Gardner, M.D. ..... *Director and Pathologist*
Arthur J. Vorwald, Ph.D., M.D. ..... *Assistant Pathologist*
Thomas M. Durkan, M.E. ..... *Chemist*
Richard V. Fletcher, M.D. ..... *Clinical Pathologist*
Winfield O. Kelley, B.A. ..... *Clinical Pathologist*
John R. Murphy, M.D. ..... *Clinical Pathologist*
Douglas S. McCrum, B.S., (E.E.) ..... *Photographer and Assistant Chemist*
Morris Dworski, B.S., C.P.H. ..... *Assistant in Experimental Pathology*
Catherine M. Cummings ..... *Librarian and Secretary*
Roy Dayton ..... *Financial Secretary*
James V. Luttrell ..... *Purchasing Agent and Technician*
George C. Hulpiett ..... *Technician*
Anthony B. Delahant ..... *Technician*
Francis T. Creedon ..... *Technician*
Edward L. Gockeler ..... *Technician*
Andrew J. Redlin ..... *Technician*
J. Cloyd Downs ..... *Voluntary Assistant*
John G. Schmidt ..... *Voluntary Assistant*
Leo A. Rabidou ..... *Voluntary Assistant*
Stephen Worthen ..... *Voluntary Assistant*
Roy A. Grinnell ..... *Voluntary Assistant*
William E. Labounty ..... *Assistant*
Henry C. Stout ..... *Assistant*

FIELD AND CONSULTING STAFF

Donald E. Cummings, B.S. ..... *Assistant Director in Charge of Field Work*
Homer L. Sampson, D.Sc. ..... *Consulting Roentgenologist*
John W. Karr, M.D. ..... *Assistant Roentgenologist*
Daniel M. Brumfiel, M.D. ..... *Clinical Consultant*
Robert N. Downs ..... *Roentgenological Supervisor*
Richard Libby ..... *Roentgenological Technician*
Richard Walters ..... *Roentgenological Technician*
Melvin Berg ..... *Bacteriological Technician and Clerk*
William Ficklin ..... *Roentgenological Technician*
Hugo K. Loustan ..... *Bacteriological Technician*
Helen R. Smith ..... *Stenographer*

CONTENTS

REPORT OF THE DIRECTOR OF THE SARANAC LABORATORY FOR THE STUDY OF TUBERCULOSIS

— 1936 —

LEROY U. GARDNER, M.D., *Director*

THE policy and general nature of the work in progress at the Saranac Laboratory has remained unchanged during the past year. Problems discovered in field investigations of pneumoconiosis and associated tuberculosis are being studied and elucidated in the laboratory. A close co-ordination between field units, the roentgenological laboratory at Trudeau and the pathological division has insured a very practical trend to much of the research. But other problems of a more theoretical nature are also being attacked, their solutions may ultimately find application in the field of diagnosis and prevention of disease due to dust. Still other questions have been referred to the laboratory by industrial groups who have doubts as to hazards involved in the manufacture and use of their products.

The year has been a very busy one owing to the illness of the field director which has thrown additional responsibilities upon other members of the staff. Their willing co-operation has made it possible to fulfill our obligations, carry on an extensive program of investigation and secure the income necessary to maintain the laboratory.

LABORATORY RESEARCH

Important unsolved problems which are being investigated by experimental methods include: (1) An attempt to determine whether crystalline silica actually dissolves in the body. (2) A comparison of the biological activity of different forms of free silica. (3) A similar comparison of the effects of different forms of combined silica or silicates. (4) The modifying action of other substances inhaled or injected at the same time with silica. (5) The effect of particle size on the rate of tissue reaction. (6) A determination of the degree of retention of inhaled silica particles less than one micron in diameter in the lungs. (7) The effects of mouth breathing on the accumulation of dust in the lungs. (8) Assays of the biological activity of various industrial dusts. (9) A study of immunity in the silicotic host. These experiments, most of which were mentioned in last year's report, are not completed but some have progressed sufficiently to indicate their trend and probable outcome.

The effect of other dusts inhaled with silica. Gypsum, iron oxide, calcium fluoride, and perhaps some of the silicates appear to inhibit the action of silica and cause a delayed and often typical cellular response.

(1) *Gypsum and Silica* A group of guinea pigs exposed to an atmosphere of nearly 172 million particles of pure calcined gypsum dust per cubic foot of air developed no significant changes in 2 years. At the present time, 16 months after concluding the exposure, the survivors still show no ill effects. So it has been concluded that the inhalation of gypsum dust in high concentrations is harmless. This conclusion is substantiated by negative results after the injection of an excessive dose into the peritoneal cavity of guinea pigs. It is also in accord with clinical observation.

Gypsum mixed with equal parts of pure quartz causes a clumping of the dust particles in the atmosphere. Many of the aggregates are too heavy to remain in suspension and too large to be inhaled. As a consequence relatively little of the quartz can enter the lungs and the development of fibrosis is very slow. Observations on animals exposed to such a mixture have now been extended over a period of 2 years and 7 months. They show less fibrosis than guinea pigs inhaling pure quartz for 12 to 15 months. The lesions that develop are modified in character as well as extent; very few of them exhibit the hyalinization that typifies mature silicous fibrosis.

That the protective action of gypsum dust takes place in the atmosphere rather than in the body is indicated by another experiment in which animals have been exposed on alternate weeks to atmospheres containing pure quartz and pure gypsum. In these guinea pigs silicone fibrosis developed in typical form and at a rate comparable to amount of exposure to quartz.

A new experiment in which animals inhale a mixture of 1 part quartz and 3 parts gypsum is now in its 12th month; it is too soon to surmise the result as no specific reaction to silica has yet developed.

Tuberculous infection in association with inhaled gypsum manifests a temporary tendency to progress but this is followed by healing with fibrosis.

(2) *Iron and Silica* For this study there have been three inhalation experiments and two in which the materials were injected into the veins of rabbits. We have worked with iron ore (hematite) containing 6 per cent free silica and with ferruginous chert, the rock in which the ore is found, which averages about 45 per cent of silica.

An 8 hour daily inhalation of approximately 500 million hematite particles per cubic foot of air produced no pulmonary fibrosis in 3½ years. Injection experiments are not yet complete. Guinea pigs infected with attenuated tubercle bacilli and kept in this atmosphere showed a temporary progression of the infection followed by healing with considerable fibrosis.

A similar exposure to inhaled chert with 45 per cent silica caused only slightly more reaction in 2½ years than the hematite with 6 per cent silica. In animals kept in a normal atmosphere for 15 months after stopping the exposure, the reaction already initiated has manifested little tendency to progress. Chemical examination of their lungs revealed that only 6 or 7 per cent of the ash was composed of silica. The figure is low; in human silicosis it generally exceeds 15 per cent. A check-up revealed that while most of the dust particles used for experiment were of inhalable dimensions those of the silica component were in the upper size limits while those in the iron were in the smaller range. This caused the silica particles to settle out of the air more rapidly than the iron. Accordingly a new lot of chert

was secured in which both the silica and the iron particles had been ground to the desired size. On suspending this dust in the atmosphere a dust cloud was produced that averaged over 800 million particles per cubic foot of air, 95 per cent of which were less than 3 microns in diameter. On analysing the atmospheric dust inside the animal cages only 33 per cent of the material was found to be silica. In other words, there was still some selective settling of the quartz particles in the air before it floated into the cages. But even so, the animals would be subjected to over 260 million particles of free silica in every cubic foot of air, which is far in excess of that necessary to produce siliceous reaction in a period of 12 months. The new experiment is now in the 15th month but no nodular fibrosis has yet developed. One is therefore compelled to seek some other explanation for the failure of the silica to produce its usual effect.

There is a definite tendency for particles of iron to adhere to the surface of silica particles suspended in the atmosphere. Theoretically the protective coating might interfere with the interaction between the silica and tissue; if the coating is applied chemically there is definite experimental proof that it does. If the suspension is made in water instead of air no evidence of protection is detected. The injection of an aqueous suspension of the same chert into the ear veins of rabbits causes silicotic fibrosis within a year. After the two dusts enter the body there is nothing to indicate that the iron is attracted to the silica and neutralizes its action although it does modify the character of the tissue response. Guinea pigs exposed on alternate weeks to pure quartz and to hematite dusts develop silicotic fibrosis of the lungs whose severity is directly proportional to the amount and duration of the silica exposure. The final solution of this problem will require time and extended observation involving animal experimentation and a study of the physical relationship of air suspensions of silica and non-siliceous particles.

Infection of guinea pigs exposed to ferruginous chert with attenuated tubercle bacilli produced a result like that in the hematite series but there was a tendency for the spread of the infection to occur more frequently and the scar tissue that followed healing involved larger areas of the lungs.

(3) *Granite dust* is recognized as one of the common causes of silicosis but its behavior is peculiar. The rock consists of a natural mixture containing about one-third quartz and two-thirds silicates in the form of feldspar and mica. Only the quartz component is thought to be harmful. Early inhalation experiments with granite dust in this laboratory failed to produce silicosis in guinea pigs although the same material causes numerous cases of the disease in the workmen at Barre, Vermont. At the time, the failure of the laboratory experiment was attributed to insufficient exposure. However the lungs of the animals contained quantities of dust which should have initiated at least the early stages of a silicotic response. Furthermore, guinea pigs exposed to granite inhalation and infected with attenuated tubercle bacilli developed a fibrosis which had some of the characteristics of silicosis although typical nodules did not form. In the human cases the reaction to granite dust has also been unusual. The roentgenograms of many of the Barre cutters show a linear type of reaction instead of the usual nodulation. Others have a nodulation but it is frequently associated with definite evidence

of infection. A few autopsies on granite cutters with histories of long exposures have revealed no nodules, the lungs of other men whose exposures were similar but in which there was evidence of tuberculosis showed typical silicotic nodulation. The number of such cases has been too small to warrant any conclusions but the findings cannot be disregarded.

The various observations have suggested the following hypothesis: The silicates in granite dust prevent the free silica component from exerting its usual effect in the normal tissues; in the presence of a complicating tuberculous infection the inhibition is released and the silica is free to act.

To test this hypothesis a number of experiments have been devised and some of them are already finished. First it is necessary to be certain that an excessive dose of granite dust will not produce silicosis in the body of a normal animal. Previous experience has adequately demonstrated the reliability of the intravenous method of injection to produce a characteristic tissue response in the case of pure silica. Such response is elicited within a year after the injection of 1 gram and even 0.1 gram of quartz particles all less than 5 microns in diameter. The results have been verified too many times to question the method. Granite dust was ground to the same degree of fineness and four series of rabbits were injected with the following doses: 3.33, 1.67, 1.0 and 0.5 grams. The largest dose contains approximately 1 gram of free silica in the form of quartz which theoretically is ten times the amount necessary to cause reaction. During the 14 months which have elapsed since completing the injections most of the animals have been killed. At autopsy none has shown even microscopic evidence of a silicotic type of reaction, the response is of the type produced by inactive silicates. This result has been encouraging but the animals that are still alive might possibly develop changes later so they will be kept as long as possible. To be absolutely certain that there has been no error the observation is being repeated with a duplicate series of injections using a dust that has been checked both chemically and petrographically before and after grinding. (In the first series only chemical checks were made on the composition of the dust.)

To test the action of the other components of granite individually, the same method is being employed. One gram of feldspar particles has caused no significant reaction in one year's time. The micas have not yet been investigated as there have been technical difficulties in grinding them to the required size.

There still remains the testing of granite and its individual components in tuberculous animals. These experiments are now in progress. Granite is being injected into rabbits with systemic tuberculosis, into others with a localized infection in the liver and into a third group whose livers are sensitized by the injection of heat-killed tubercle bacilli. This should demonstrate whether the tubercle bacillus, its products or their interaction with the tissues will free the quartz in granite from the inhibitory action of the silicates.

(4) Calcium fluoride and silica. The inhalation of fluorspar dust which contained 1[illegible] per cent of quartz produced only a very early silicotic reaction in the lymph nodes but not the lungs of rats exposed for a period of 10

months. After 15 months there was still nothing in the lungs. Injection of 1 gram of this dust, ground so that all particles were less than 3 microns in diameter, caused an early silicotic cirrhosis of the liver after 15½ months although almost no change was seen at 12 months. It is probable that in this instance the spar was merely diluting the silica as the dose of the latter was relatively small. In the inhalation experiments it averaged only 68 million particles per cubic foot of air and in the injection experiments the gram of dust contained only 0.1 gram of silica. As this study was undertaken merely to test the activity of a particular type of rock the possibilities were not so thoroughly explored.

The data of this first group of experiments form the basis for our belief that other types of dust inhaled at the same time with silica modify its action. Thus far only retarding influences have been investigated. There may be substances, possibly the alkalies, which accelerate the action of silica. When opportunity permits they will be investigated although this problem presents many technical difficulties.

(5) *The different forms of free silica.* Free silica exists in crystalline and amorphous forms. As pointed out a year ago, there is evidence to indicate that one of the common types of crystalline silica known as chalcedony may be more active than normal quartz. In chalcedony the crystals are exceedingly minute and are cemented together with amorphous silica whereas normal quartz occurs in the familiar large crystal. The tests on these two substances have not progressed sufficiently to permit definite conclusions as to their relative irritating properties. There are also other forms of crystalline silica produced by heating normal quartz to different temperatures. These former are known as chrystobalite, tridymite and vitreous silica. For some unexplained reason tridymite seems to be more active in the tissues than the others, but all are capable of causing fibrosis.

Of the amorphous forms of silica it was stated last year that opal was active and this observation has been verified. It has now been demonstrated that another mineralogical form of opal known as diatomite or diatomaceous earth is also capable of producing silicosis in animals. (The mineral, diatomite, is composed of masses of microscopic plants known as diatomes which have "skeletons" of silica.

It is thus becoming apparent that silica in the free state, whether crystalline or amorphous, is capable of setting up progressive fibrosis in the body. Whether all forms are equally capable of penetrating the lungs from the air remains to be demonstrated. When this phase of the work is completed it may become possible to correlate the degree of biological activity with the physical properties which are somewhat different in the various forms of silica. This should be helpful in determining the mode of action of silica upon the tissues.

The silicates or combinations of silica with various bases. Clinically the only silicate which is generally accepted as a cause of disease in the lungs is asbestos. Technically asbestos is not a single species of mineral, the term includes a variety of more or less complicated hydrated silicates of magnesium which have the common property of a *fibrous structure*. Among

the other silicates that have been reported to cause nodular fibrosis are talc and slate. However, the possible part played by co-existant latent or active infection has not yet been given due consideration in these cases.

A systematic examination of representative silicates is now in progress, making use of the intravenous and intraperitoneal injection methods to determine whether excessive dosages are capable of producing reaction in living tissues. The behavior of most of them has been followed for at least a year and it seems quite obvious that they will prove to be practically inert in uninfected animals. The reaction in all cases is one of phagocytosis at the site where the injected particles happen to be carried by the blood stream. Most of the phagocytes are immobile and they do not tend to collect into localized masses as is the case with uncombined silica. It is of course possible that more reaction will develop later but since there has been no change in a year in the animals injected intravenously it is improbable that any will ever occur. The following silicates have already been studied: zeolite (from two sources), feldspar, garnet, sillimanite, talc and zeolite (both synthetic and natural.) The injection of asbestos minerals has just been started, but they present technical difficulties which will have to be overcome before they can be injected into the blood vessels of animals. The final step will be the testing of the same substances upon animals with healed and active tuberculosis. It is quite conceivable that in such hosts some of the silicates may produce a different response.

Alterations of immunity in the silicotic subject. The explanation for the high frequency of infection, and particularly tuberculous infection, in the silicotic individual has not yet been discovered. This subject is still under investigation and is being attacked from several aspects.

It is known that tubercle bacilli grow very rapidly in a young silicotic focus produced artificially in experimental animals, in the old lesions of human silicosis the organisms are usually very few and hard to find. The question arises as to whether the tubercle bacillus is stimulated by the silica itself or by some of the products formed from the interaction between it and the tissues. (1) *Effects upon bacteria in vitro.* Previous experience in the laboratory had shown that the addition of silica particles to artificial culture media accelerated the rate of growth of tubercle bacilli but the amount of culture obtained after a given period of time was no greater than without the silica. Recently some exceedingly fine crystalline silica was sent to the laboratory that has had a very marked accelerating influence on cultured bacilli. The old experiment is being repeated on a quantitative basis. (2) *Effects upon bacteria in vivo.* An attempt is being made to determine on a quantitative basis the number of tubercle bacilli in silico-tuberculous lesions of various ages.

The effects of silicosis upon the host are manifested by the development of the obvious fibrous nodules in the lungs but there may also be more subtle changes in the body fluids that explain the peculiar susceptibility to tuberculosis. The immunity mechanisms of the body fluids are now the subject of intensive study.

Natural immunity. Among certain other species the white rat manifests a natural immunity to infection with the tubercle bacillus. If the organisms are injected into the animal's veins real tubercles do not develop; the bacteria merely circulate in the blood for an indefinite period of time. It has now been shown that tubercles will form in a silicotic rat. Whether this means an increase or a lowering of resistance is debatable, but at least it has been demonstrated that there is an alteration of natural immunity. A similar experience was demonstrated some years ago in rabbits, which are naturally resistant to human type tubercle bacilli. Thus it appears that it is possible to alter natural immunity with silica.

Acquired immunity. It is well recognized that a certain degree of artificial immunity can be induced in animals by vaccinating them with tubercle bacilli of low virulence. This procedure is very simple and the effects of the primary infection, which remains localized, can easily be differentiated from those of the reinfecting test inoculation with virulent tubercle bacilli. In the silicotic host this is not so simple as the silica causes the vaccinating infection to spread. It is possible, however, to induce immunity with heat-killed bacilli. This method is under investigation and although the results are not yet complete it seems probable that the usual protective action will not be destroyed. It may prove to be somewhat impaired. The sensitivity to tuberculin of animals in the acute and subacute stages of silico-tuberculosis is comparable to that in animals with simple tuberculosis. Unfortunately the extremely chronic forms of silico-tuberculosis found in man are not reproduced in animals.

As soon as silicosis has developed in a group of rabbits now being dusted their immune responses to pneumococcus infection will be tested. This experiment has a practical as well as theoretical bearing for it has never been proven whether the silicotic individual is actually more susceptible to pneumonia than the normal. There is considerable evidence for believing that he is not. The work on the possible alteration of immunity is not sufficiently advanced to draw inferences as to its outcome.

The effect of mouth breathing is being investigated by exposing animals whose nasal passages have been more or less completely stenosed with caustics to the inhalation of dusts in the same room with normal controls. The weight of inhaled dust will be the criterion of the effect of this procedure.

The solubility of silica in the body is being approached from the angle of excretion in the urine as suggested by King. The urinary output of silica in groups of normal, tuberculous, and silicotic subjects is being followed over a long period of time. While it is not possible to analyse all of their food for its silica content, an attempt is in progress to discover how much of the excreted silica may be derived from food and how much from inhalation.

Retention of extremely fine silica in the lungs. A request was received to test the biological activity of a silica powder composed of particles not greater than 20 Angstrom units in diameter. This material seemed to offer the opportunity of proving whether, as some observers claim, the lung treats very fine particles like a gas and eliminates them with the expired air or

whether they are retained and cause disease. Unfortunately there is no way to prevent particles of this magnitude from clumping and it is impossible to determine the size of minute clumps by ordinary methods of measurement. Nevertheless an inhalation experiment with an imperceptible suspension of atmospheric dust is being started to learn whether any reaction will occur.

Testing of industrial dusts suspected of disease-producing capacities. A study has been completed on the action of glass wool and it has been demonstrated that this substance is incapable of causing fibrosis in the animal body. Injected intravenously it has no more effect than the inert silicates described above. Large quantities can be ingested either with food or by the fasting stomach without producing demonstrable reaction in any part of the alimentary tract.

Tests upon the action of dolomite, silica jell and several other substances have been started.

FIELD STUDIES

The third annual survey of the iron ore miners in the Lake Superior district has now been completed. The results of examinations made by the various company physicians and of the roentgenograms of the chest totalling well over 5000 have not yet been tabulated but new cases of siderosilicosis or progression to more advanced stages of this condition have been rare. Likewise the production rate of new tuberculosis has not been as great as was anticipated. Particular interest attaches to the group of cases, rather rare in this industry, which exhibit massive conglomerate shadows in the roentgenogram. A few of them have apparently been observed in the process of evolution. Sometimes they develop rapidly in men still at work who have no symptoms of infection. Most of these shadows persist but a few have disappeared as rapidly as they come. Their ultimate outcome is still a matter of conjecture but with the opportunity to follow their course year after year it should be possible to establish their clinical significance. The dust concentrations in all the mines have been maintained at levels which can hardly produce new cases of silicosis. In all rock work involving exposures even to low concentrations of silica dust the wearing of respirators is enforced. Future observations on the men will therefore be largely concerned with the evolution of such disease as may have already started.

A medical clinic was established in a plant of the Inland Steel Company at the beginning of the year. Physical examinations are being made by a physician in their employ, stereoscopic films of every chest are taken by a member of Dr. Sampson's technical staff and a complete laboratory examination including blood count, Kahn test, urine examination and anything else indicated is made in the clinical laboratory. An engineering survey is being carried on in the plant to discover and correct any hazard that may exist.

The program includes both pre-employment and periodic examinations of all employees. Out of more than 3000 examinations this year only 2 or 3 cases of tuberculosis have been discovered. These men were informed of their conditions and arrangements were made for their treatment. Other conditions were likewise brought to the attention of the men and after a

thorough explanation they were referred to their own physicians for treatment. The plan is working well as the employees have confidence in the clinic physician and they appreciate the company's interest in their health. From the scientific standpoint the opportunity to re-examine from time to time a very large industrial group that is exposed to no particular hazard is unique. The material accumulated will furnish a basis of comparison for mining and other groups constantly exposed to high concentrations of silica.

A third study is being made in the cement industry. Although there is no theoretical hazard from silica in the manufacture of this product, a good deal of dust is produced. In spite of the negative chest findings in the survey made by the United States Public Health Service, the Cement Association, which has high ideals for the health and safety of men employed by its member companies, asked the Saranac Laboratory to survey more of its plants. Three of them, located in Pennsylvania, Alabama and Kansas, have now been studied. The men were examined either by local physicians or by the clinical consultant to the Laboratory. Stereoscopic roentgenograms of the chest were made and interpreted by the department at Trudeau. Laboratory engineers made surveys of the concentration and character of the dust in the plants. The data from the last plant have not yet been compiled; the positive findings at the others were surprisingly meager.

No pulmonary changes are visible after prolonged inhalation of finished cement dust. A few of the men show an increase in the linear markings of the lungs but the incidence of this change cannot be correlated with the intensity or duration of the exposure. With one exception, where a man had run a drill in sandstone, the same can be said of the inhalation of the raw materials, limestone and clay, of which cement is made. Tuberculosis is not influenced by the inhalation of cement dust; the frequence of healed lesions has been the same as that in the general population. Complaints referable to infection of the upper respiratory tract have been relatively uncommon in the men thus far examined. Final conclusions as to the influence of cement dust will only be drawn after analysing the findings from widely scattered plants; at the present time it hardly appears that evidence of serious injury will be discovered.

A similar study was made of the men and the possible industrial hazards in another gypsum plant. The findings confirmed the conclusions previously reached, that the long-continued inhalation of gypsum dust is not dangerous.

TEACHING, ADDRESSES, AND PUBLICATIONS

Various members of the staff gave their usual courses in the Trudeau School of Tuberculosis. The Silicosis Symposium, which had been held during the two preceding years, was omitted because it was felt that not enough new material was available for discussion. Dr. Vorwald, the assistant pathologist, has given a series of lectures on the anatomy, physiology and pathology of the lungs to the nurses at Trudeau. Clinical-pathological conferences were held from time to time as part of the program of the Saranac Lake Medical Society. Papers were presented by the director, the assistant pathologist, and the chemist, before the American College of Physicians, the American Society of Safety Engineers, the New York State Medical Society, the American Association of Pathologists and Bacteri-

ologists, the Koniside Club, the National Tuberculosis Association, the Fourth District Branch of the New York State Medical Society, and the Franklin County Medical Society. Membership on federal, state, industrial and insurance committees dealing with silicosis has also required considerable time and thought. Five papers have been either published or are in press. Reprints of three are bound as part of this report

CLINICAL LABORATORY WORK

The diagnostic service to the clinicians and hospitals of the community has been maintained with a physician and three part-time technicians available to perform any tests that may be required. The work is financed by fees from patients, contributions to the Saranac Lake Academy of Medicine, an appropriation from the Trudeau Foundation and the proceeds of contracts with the General Hospital and Northwoods Sanatorium. The maintenance of this department is always difficult because many of the physicians elect to have only the more elaborate tests performed by the laboratory. Routine examinations, which constitute the bulk of the work and which would bring in more income are done elsewhere. Nevertheless it has been felt that the institution has an obligation to the community and every effort is being made to maintain the service. The remuneration is not sufficiently attractive to hold a qualified diagnostician very long and hence the personnel is constantly changing. However it has been possible to find competent physicians to perform this service during the period while they are obtaining their cases. Dr. Vorwald, the assistant pathologist, has assumed the responsibility for this department and has not only improved the general quality of the service rendered but has personally given pathological diagnoses on over 200 surgical specimens without charge to the patients. During the year a total of 5036 examinations have been made in this department.

The unfortunate illness of Mr. Cummings, the field director, has kept him away since February, but the other members of the staff have loyally assumed extra responsibilities. Dr. Vorwald, assistant pathologist, has carried most of the load of supervising the experimental work in the laboratory, thereby relieving the director. Mr. Downs, field supervisor of roentgenology, has taken over the administrative details for the study in the iron ore industry and the supervision of the clinic in the Inland Steel Company. Mr. Durkan, the chief chemist, and Mr. McCrum have made the engineering surveys in the cement and gypsum studies. Miss Cummings, the secretary, has spent many extra hours with the extra correspondence and voluminous reports that would ordinarily have emanated from the field director's office. The director takes this opportunity to express to them and to all the other members of the staff his appreciation for their support.

At the roentgen laboratory at Trudeau the laboratory budget provides the salary for an assistant to Dr. Sampson. Dr. John W. Karr, a graduate of the University of Rochester, joined the staff in this capacity in August. It is hoped that he will be able to relieve Dr. Sampson, who is now hard pushed to review the many thousands of films from our own and other industrial surveys

Mr. J. Cloyd Downs, voluntary assistant chemical engineer, has not been able to spend much time in the laboratory but he still serves us as a valuable consultant. Mr. Edward Goeckler, who was a volunteer histological technician last year, has made his services so valuable that he is being taken on to the regular staff. Four more volunteers have served more or less time in the laboratory this year. Mr. L. A. Rabidou, Mr. John Schmidt and Mr. R. A. Grinnell have been assisting in the preparation of dust suspensions for animal injections and in various other ways. Mr. Stephen Worthen spent the summer in the chemical department, analyzing lung tissues. Our appreciation of their services is gratefully acknowledged.

In the diagnostic department the change in personnel has been unusually rapid. Dr. Robert Major left for his home in February and Dr. Richard V. Fletcher relieved him for three or four months until Mr. W. O. Kelley, who was formerly in charge of this work, returned for the summer. On October first Dr. John R. Murphy took over the responsibilities. All of them deserve the gratitude of the institution and the community for their able services.

FINANCES

The statement which follows indicates a balance of $15,031.06 at the end of the fiscal year. This sum is not surplus earnings but is made up of advance appropriations for research already in progress. Receipts during the year amounted to $62,608.43, which with the balance of $11,385.82 carried over from last year makes a total of $73,994.25. Of the current receipts $42,037.28 was in payment for consulting field and laboratory services and $10,000 was an appropriation by two associations of stock and mutual insurance companies for basic research. The balance consisted of earnings from income and miscellaneous gifts. The anonymous gift of $1,000 for equipping the new John Black Wing was acknowledged in last year's report, but was not credited to income as it was received after the expiration of the fiscal year. The sum of $1,278.15 was received from the sale of copies of the "Silicosis Symposium" published by the Employers Mutuals Insurance Company under the direction of Mr. B. E. Keuchle.

The director expresses his grateful appreciation for the support received from all who have contributed to the work in the laboratory. Special mention is made of the large contributions from the National Bureau of Casualty and Surety Underwriters, the American Mutual Alliance, the Employers Mutuals, and Mr. Samuel Eckert. The director acknowledges his debt to all the members of the staff who have rendered such faithful service and to Dr. Baldwin, the director of the Trudeau Foundation, for his unfailing sympathy and advice.

al engineer, has not been
he still serves us as a
s a volunteer histological
le that he is being taken
served more or less time
Mr. John Schmidt and
ation of dust suspensions
Mr. Stephen Worthen
ying lung tissues. Our
ged.
onnel has been unusually
bruary and Dr Richard
until Mr. W. O. Kelley,
d for the summer. On
onsibilities. All of them
ommunity for their able

ce of $15,031.06 at the
rungs but is made up of
ogress. Receipts during
e balance of $11,355.82
,994.25. Of the current
ing field and laboratory
associations of stock and
The balance consisted of
anonymous gift of $1,00
nowledged in last year's
eived after the expiration
ceived from the sale of
the Employers Mutuals
E. Keuchle.
for the support received
the laboratory. Special
the National Bureau of
n Mutual Alliance, the
he director acknowledges
e rendered such faithful
Trudeau Foundation, for

SUMMARY OF DIAGNOSTIC EXAMINATIONS

January 1, 1936 — December 31, 1936

Diphtheria cultures	12	Stomach contents	4
Smears for Vincent's Angina	19	Milk, bacteriological counts	31
Blood		Water, bacterial examination	42
Agglutination for typhoid	14	Water, chemical examination	361
Differential counts	221	Smears for gonococcus	9
Red and white counts	393	Urine	1151
Hemoglobin determinations	178	Autogenous vaccines and filtrates prepared	31
Coagulation time	4	Pathological specimens	207
Matching and typing	225	Referred autopsy specimens	34
Cultures	15	Autopsies, human	45
Chemistry	124	Animals inoculated for diagnosis	55
Sedimentation	101	Miscellaneous examinations	725
Spinal fluid, urine and other material for tubercle bacilli	142		
Sputum for tubercle bacilli	909	Total	5035

SARANAC LABORATORY FOR THE STUDY OF TUBERCULOSIS

RECEIPTS AND EXPENDITURES

Year ending September 30, 1936

Balance on hand October 1, 1935			$11,385.82
Receipts:			
From endowment:			
Interest	1,875.00		
Dividends	1,000.00		
		2,875.00	
*Gifts and other receipts for maintenance of plant and work		55,633.43	
*Gifts for building and equipment		1,000.00	
Transferred from Elizabeth Milbank Fund		2,500.00	
Sale of old equipment		350.00	
Repayment of advance to worker		250.00	
Total receipts for year			62,608.43
Total of balance and receipts			73,994.25
Expenditures:			
Salaries, for research and field surveys		47,704.95	
Travel and other expenses of workers		2,421.90	
Fuel, light, supplies, animals, feed and other running expenses		7,964.54	
Permanent improvements of plant		871.80	
Total expenditures for year			58,963.19
Balance on hand September 30, 1936			15,031.06
Cash on hand:			
Bankers Trust Company (Saranac Laboratory Fund)		14,535.42	
Saranac Lake National Bank (Trudeau Foundation account)		495.64	
		15,031.06	

*See following pages for list of contributors

Y OF TUBERCULOSIS

URES

936

$11,385.82

00
00
2,875.00

55,633.43
1,000.00
2,500.00
350.00
250.00

62,608.43

73,994.25

47,704.95
2,421.90

7,964.54
871.80

58,963.19

15,031.06

14,535.42

495.64

15,031.06

CONTRIBUTIONS

TO THE

SARANAC LABORATORY

From October 1, 1935, to September 30, 1936

(Note Items received after October 1, 1936, in second column, to be credited in 1937 report)

Adirondack Fund for the Tuberculous	999.96	249.99
American Mutual Alliance (Casualty Companies)	5,000.00	
Mrs. Bigelow Crocker	5.00	5.00
Mrs. Charles L. Crocker	50.00	50.00
Mrs. Francke G. Darte	50.00	
Agnes Musser Eckert Fellowship	1,000.00	1,000.00
Dr. Leroy U. Gardner	407.00	50.00
Dr. Albert H. Garvin.		7.00
Gulf Rock Oil Corporation	50.00	
Hillside Fluorspar Mining Company	1,250.00	
Inland Steel Company	12,899.95	4,299.99
Johns-Manville Corporation		1,250.00
Lake Superior Iron Ore Association	20,262.34	3,607.45
Mr. Lawrence MacFarlane	100.00	
National Bureau of Casualty and Surety Underwriters	5,000.00	
New Jersey Manufacturers Casualty Insurance Company	200.00	
Owens-Illinois Glass Company	600.00	
Pennsylvania Glass Sand Corporation		5.00
Portland Cement Association	2,400.00	2,400.00
Mr. Arthur B. Purvis	250.00	
Rosiclaire Lead & Fluorspar Mining Company	1,250.00	
Sales of Book "Silicosis Symposium" (thru Mr. B. E. Kuechle and Associates)	1,278.15	163.00
Carried forward	53,052.43	13,087.46

Brought forward	53,052.43	13,087.46
Saranac Lake Academy of Medicine:		
Mrs. John F. Archbold		50.00
Dr. Edward R. Baldwin	50.00	
Boyce & Roberson	25.00	
Mr. A. W. Currier	10.00	
Dr. Joseph T. Eagan	50.00	
Mrs. A. C. Erkander	50.00	
General Hospital of Saranac Lake	51.00	
Miss Anna L. Gilbert		10.00
Mrs. Henry Hudson	25.00	
Dr. David T. Smith	10.00	
Mr. R. B. Smith	100.00	
Dr. George E. Wilson	15.00	
Mr. Frank J. Tone		100.00
United States Gypsum Company	2,125.00	625.00
In Memory of Sydney Lunt Wood:		
Miss Sarah C. Armistead	5.00	
Mrs. S. L. Wood and Mr. John Wood	15.00	15.00
Miss Susan Wood	50.00	
	55,633.43	13,857.46

FOR NEW BUILDING AND EQUIPMENT

Anonymous, thru Dr. Henry B. Doust	1,000.00

FOR ENDOWMENT

(Held in trust by Trudeau Foundation)

Milbank Memorial Fund, completing pledge	50,000.00	
Mr. Frank J. Tone		5,000.00