ENDOWMENT FOR RESEARCH WORK IN COLLOID CHEMISTRY AT THE UNIVERSITY OF CHICAGO

Such endowment ($300,000) could take either of two forms and should be sufficiently elastic in its terms to be used in the wisest way possible at any given time.

I. In the first place a research professorship (salary $10,000 to $12,000) in colloid chemistry could be endowed with funds for the calling of an eminent leader in the field and for providing him with a high class assistant (of Ph.D. caliber, $2500 to $3000 a year). The assistant would <u>double</u> the productivity of the professor at about <u>one quarter</u> of the cost and would develop promising younger men into potential leaders.

There are only two men in the world whom we would feel worthy of such a professorship and it is not certain that we could secure either. Plan II should then be given careful consideration.

II. The same endowment would provide for the establishing of a highly promising younger man, trained up-to-date in all the resources of chemistry and physics, as an associate professor ($4000) or full professor ($5000) of colloid chemistry, his progress and advance in salary depending on his work. The balance of the income should be used for <u>research</u> fellowships ($2500 to $3000) for men who have their research degree (Ph.D.). The number of these fellows would be greater at first and fewer as the income is used more and more for the professor's salary. Such research fellowships have been found the most productive of all methods for the development

of men and the rapid development of research problems. National research fellowships in Chemistry, Physics and Medicine, the Seymour Coman Fellowships o f the University of Chicago, etc. have fully demonstrated their value.

IT IS THEREFORE RECOMMENDED THAT a "John Brown Fund" of at least $300,000 be secured for the endowment of research in colloid chemistry at the University of Chicago, with these provisions:

1. That every appointee on the basis of the fund, whether Distinguished Service Professor, Professor or Associate Professor be known as "the John Brown Professor (resp. Associate Professor) of Colloid Chemistry".

2. That every assistant or fellow appointed be known as "John Brown Fellow in Colloid Chemistry".

3. That the University provide laboratory space for such work in the new George Herbert Jones Laboratory.

4. That any income from the fund not used in any given year shall revert to the fund itself, either to be used in a subsequent year or to increase the capital fund.

Julius Stieglitz

2 Surface Energy in Colloid Systems

3 The Electrical Relations of Surfaces and Small Partiẽles

4 The Distribution cf the Size of Colloidal Particles as Related to the Stability of Colloid Systems

5a. The Nature of Gels (Jellies)

b. The Phenomenon of Swelling

6 Proteins and their Behavior

7 The Viscosity of Colloidal Systems

8 The Ultimate Structure of Colloidal Particles as revealed:
by work on films and
by examination with x-rays, and
by the microscope and ultra-microscope, and other optical methods.

1 What colloid chemistry studies

COLLOID CHEMISTRY

The most important fact concerning colloid chemistry is that all living organisms are colloidal in structure as distinguished from such crystalline structures as we find in the mineral world. Man himself, and his every organ, tissue or nerve is colloidal in chraacter. Milk is a colloid suspension or emulsion of minute globules of fat in the watery part of the milk. Vegetable structures as well as animal are essentially colloidal. Many industrial processes of prime importance deal with colloid systems, as the tanning of leather, the preparation of rubber articles, the baking of bread, the flotation process of enriching minerals, etc.

The complete scientific mastery of these colloid systems--in biology and medicine and in industry--will be attained only by an exact knowledge of the laws controlling the individual minute particles which form the structure of every colloidal system. We must ground our knowledge on the study of the smallest components to understand the more complex structures.

The greatest general problem is to determine the stability relations. This stability depends upon the existence of surgace films or membranes; upon the electrical charges of the surfaces; upon the sizes and shapes (curvatures) of the particles; upon the crystalline structure of the solids or liquids; and upon such ordinary conditions as temperature, pressure, and viscocity.

2 Bearing on overcoming diseases

Thus the virulence of the diphtheria bacillus is

related to its stability as a colloid and this in turn is related to the extent of its negative electrical charge: the higher the charge (potential) the less virulent the organism, while with the organism of pneumonia the virulence increases with the charge (potential). The seemingly opposite relations are due to the fact that the pneumococci are invasive organisms, while the effects of the diphtheria bacillus are indirect, since their injurious action is due to a poison which they excrete. The electrical relations are thus of primary importance in connection with the bacterial diseases.

3 Brane problems

It seems almost certain that the motion of the muscles and the action of the nerves are highly dependent upon these electrical relations, and the electrical relations in turn depend upon the nature of the surface film as well as upon the adjacent media.

These two factors are of prime importance in all colloidal systems, whether of living organisms or of industrial processes. The surest progress, both in biology and medicine and in industrial applications will be made by investigation of the fundamental relations.) Such fundamental relations are:

Problems on Colloids and Their Stability.

1a. The Thickness and Structure of Films and Membranes

b. The Spreading of Liquids on Other Liquids or Solids (Phenomena of Wetting)

c. Adsorption (Surface Catalyses)

Copy given to M57 for Warren Wright

COLLOID CHEMISTRY - SUMMARY

Cost

$300,000 endowment to produce $15,000 annually and to be used on one of the following two plans:

Plan I

Distinguished service professorship @	$10,000	to	$12,000
One or two research assistants @ $2500 to $3,000	5,000	to	3,000
	$15,000		$15,000

Plan II

Young man winning his place	$ 4,000	to	$ 5,000
Three to four research assistants @ $2,500 to $3,000	11,000	to	10,000
	$15,000		$15,000

What Subjects Would be Researched

1a. The Thickness and Structure of Films and Membranes
 b. The Spreading of Liquids on Other Liquids or Solids (Phenomena of Wetting)
 c. Adsorption (Surface Catalyses)
2 Surface Energy in Colloid Systems
3 The Electrical Relations of Surfaces and Small Particles
4 The Distribution of the Size of Colloidal Particles as Related to the Stability of Colloid Systems
5a. The Nature of Gels (Jellies)
 b. The Phenomenon of Swelling
6 Proteins and their Behavior
7 The Viscosity of Colloidal Systems
8 The Ultimate Structure of Colloidal Particles as revealed:
   by work on films and
   by examination with x-rays, and
   by the microscope and ultra-microscope, and other optical methods

What Might be Expected From Such Research

In biology and medicine

Facts on control and cure of pneumonia
Facts on muscle and nerve action and the diseases involved such as muscular rheumatism, certain heart difficulties and the like.

In Industry

Facts of value in tanning
Facts of value in rubber manufacture
Facts of value in flotation process in separating precious metals

November 8, 1927

Dr. Julius Stieglitz
Faculty Exchange

Dear Doctor Stieglitz:

I think the suggestion of you and Doctor Schlesinger that the proceeds from the ednowment of research in colloid chemistry might part of it be used for special research equipment is a sound one. It seems to me that there should be no difficulty in arranging the statement of gift so that such expenditure should be possible.

I saw Mr. MacDowell last Thursday and gave him your memorandum. I found out from him the man whom he thinks might give the money. He has promised to take it up with him and I have the matter on my calendar to foll to follow through with Mr. MacDowell from time to time.

Sincerely yours,

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Sincerely yours,

The University of Chicago

Department of Chemistry

November 4, 1927

Mr. Rowland Haynes
Secretary
Faculty Exchange

Dear Mr. Haynes:

Dr. Schlesinger suggests that one of the conditions in the plan for a fund of $300,000. for the endowment of research in colloid chemistry be that at any time when the needs of the research demand, the income from part of the fund or any income not used may be used for special research equipment instead of for a research fellowship or research assistantship.

Such an item would provide for the installation of special apparatus at the beginning of the work and the fund could be so administered that there would be no difficulty in providing equipment from time to time.

Very truly yours,

JS:GB

Julius Stieglitz

CHEMISTRY IN MEDICINE*

William J. Mayo
Rochester, Minnesota

Man may be considered a chemical machine for the production of energy. So far as I know, no engine has ever been devised which, with the same amount of fuel, produces as wonderful results. Of the power produced in the human body, only 25 per cent is under voluntary control. Seventy-five per cent is used in heating the body and maintaining the great vegetative functions, circulation of the blood by the heart, respiration by the lungs, and digestion by the gastro-intestinal tract, and the metabolic functions. All of the vegetative functions are in existence in those animals which have no nervous system, control being exercised through various chemical internal secretions and the primitive sense of touch of the entire cutaneous surface of the body.

With the development in man of the central nervous system, there came four special senses in addition to the sense of touch. First came the sense of smell, that the mouth might be turned toward food; second, the sense of taste, that the primitive mouth might distinguish good from bad food; third, the sense of hearing, with the ears in the middle of the head on either side, that danger from all directions might be detected; fourth, the sense of sight, with which came the great development of the thinking and coordinating part of the brain, with the result that there exist direct pathways from visual centers to the higher cerebral centers. Edison

* Talk given at a luncheon at the University of Chicago, Chicago, December 5, 1925

well says that 90 per cent of human knowledge comes through the eye.

Among the lower animals there are other expressions of primitive control through the special senses. For instance, in the bloodhound the sense of smell is so extraordinarily augmented by the system of nerve endings in the nasal cavity that it largely controls the cerebral functions. The eyes of the bloodhound are so defective that they scarcely permit the animal to recognize its master across the street, and merely prevent the dog from running into obstacles as he follows a scent. The eyes of man, so far as mechanics are concerned, have neither the acuteness nor the length of vision of those of many of the lower animals. It is not the eye mechanics but the eye brain of man which is triumphant.

The mechanism of the central nervous system acts as an electrical control of voluntary energy. The sympathetic nervous system, acting with the so-called internal secretions, which are chemical, controls to a large extent the vegetative functions. It seems probable that an attempt on the part of the central nervous system to gain power over these primitive functions has much to do with the various types of nervous exhaustion and mental and bodily fatigue, which our modern social life seems to have so greatly increased.

When we study the combustion of the fuel used by the human body, we find that the process is really quite simple. The most important substance in the world is chlorophyl, the green coloring matter of plants, which acts to convert the energy of the sun's rays into a mechanism to change inorganic material into organic material. The substance in which we are most

interested as fuel for man is carbon. There is really no fundamental difference between the heat produced by coal on a fire and carbon oxidized in the body of man, except in the rate of combustion, which is determined by the molecular arrangement of the fuel. In either case, heat and energy are the result of combustion by the union of oxygen with carbon. All life is the result of the oxidation of carbon.

Man is what he eats. (Moleschott, 1850)

The simplest foods are the carbohydrates, which consist of carbon, hydrogen, and nitrogen. Carbohydrate in burning leaves no ash; the residue is eliminated through the lungs as carbon dioxide. A certain amount of excess carbohydrate is stored in the liver as glycogen, but much of an excess may be stored in various parts of the body as fat.

Fat contains very little oxygen, the molecule of stearic acid of beef, for instance, containing only one part of oxygen in eighteen of carbon. Fat therefore burns slowly and may leave a poisonous ash, especially in persons with diabetes. Owing to precise methods of regulating the diabetic metabolism applied by Wilder and Adams, the surgeon is today able to perform major operations on the properly rehabilitated patient with diabetes with a mortality not exceeding that of the average. After 141 recent major operations on patients with severe diabetes, prepared by these methods, only four deaths occurred, as reported by Wilder and Adams. Insulin, the chemical substance discovered by Banting, Collip, and McLeod, has brought diabetes under control.

It is interesting that fat requires an enormous amount of oxygen for combustion. Consequently for proper matabolism of fats fresh air and much exercise out of doors are necessary, since much of the fat is oxidized in the lungs. Besides heat and energy, fat produces water. When the hibernating animal goes into winter retreat, his temperature drops to around 50 F., the normal temperature of a cold-blooded animal, and from his autumnal fat drives the little heat, energy, and water required to sustain life.

The third class of food is protein, which, like carbohydrate and fat, is composed of carbon, hydrogen, oxygen, and, in addition, nitrogen with a little sulphur. The nitrogen is essential to give form and substance to the body and makes possible the deposition of other elements. When body protein is used as a fuel, the nitrogen is separated and must be excreted largely through the kidneys. Retention of nitrogen is a causative factor in affections of the kidney, for instance, what is ordinarily called Bright's disease.

The application of fundamental and easily understood facts in physico-chemistry have led to the most extraordinary improvement in the prevention or cure of a vast number of diseases not heretofore well understood. With all due respect to the late Mr. Bryan, kindly and sincere, but unscientific, and to the good intentions of the Tennessee legislature, certain facts can be explained only on the basis of evolution. For instance, our taste for salt and iodine. It has long been known that if cattle are fed modern purified

salt they grow thin, but if they are given old-fashioned brown rock salt they at once grow fat. The discolorations in the salt are due to iodine. Farmers close to the sea have always recognized the value of marsh grass as stock feed. At intervals the marsh grass is covered by the tides which leave a deposit of salt and iodine, necessary for proper chemical reactions in the body. The discovery by Kendall of the chemical, thyroxin, the active principle of the thyroid gland, has been of epochal importance. Today a host of diseases formerly little understood but called after some prominent feature, as heart disease, oxophthalmic goiter, have, through the use of thyroxin, been brought under control by Plummer and others.

Owing to means of preoperative chemical rehabilitation of patients, there has been great reduction in the mortality rate of operations for goiter. Pemberton has, within one year, performed a thousand consecutive operations with a mortality rate of less than one-third of 1 per cent.

As Bayliss said, there is no dividing line between physics and chemistry, sice it is only under certain physical conditions that chemical changes can take place. With the best microscope, particles 1/10 micron or 1/250,000 inch in diameter can be seen. Beyond the limits of the microscopic field lies the physicochemical field of the colloids which contains particles between 1/10 micron or 1/250,000 in diamter and 1/1,000 micron or 1/25,000,000 inch in diameter. The great body of the colloids, in the ultramicroscopic field, come more or less under the range of the eye because they are salt they grow thin, but if they are given old-fashioned brown rock salt they at once grow fat. The discolorations in the salt are due to iodine. Farmers close to the sea have always recognized the value of marsh grass as stock feed. At intervals the marsh grass is covered by the tides which leave a deposit of salt and iodine, necessary for proper chemical reactions in the body. The discovery by Kendall of the chemical, thyroxin, the active principle of the thyroid gland, has been of epochal importance. Today a host of diseases formerly little understood but called after some prominent feature, as heart disease, exophthalmic goiter, have, through the use of thyroxin, been brought under control by Plummer and others.

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Light travels 186,000 miles a second. When a ray of light strikes a substance, it is refracted and its electromagnetic vibrations are changed. There are visible to the human eye those ultramicroscopic vibrations known as colors, which are relative rates of speed, ranging in length from 770 millimicrons to 390 millimicrons, the longest and slowest being red, and the others in order of length and speed, orange, yellow, green, blue, and violet. It is interesting that the eye is able to distinguish only eight shades of each color while today there is an electrical eye which will pick out rapidly no less than thirty shades of each color.

It has been largely through colors produced en masse by dyes that many tests, all of which are physicochemical, have been developed as to the conditions in the body. By the use of the Rowntree-Rosenthal test with the intravenous injection of the dye, tetrasulphonephthalein, we are able accurately to gauge the functional capacity of the liver, thereby avoiding many deaths from toxemia due to failure of hepatic function.

The surgical mortality in cases of jaundice in which patients have been properly prepared for operation by restoring the blood calcium content has been reduced from above 25 per cent to 3 per cent, as shown by Walters.

Through studies of the chemistry of the blood has come remarkable improvement in the results of operations on patients with reduced renal function. Rowntree's phenolsulphonephthalein test of kidney function has been of immeasurable value. Braasch, Bumpus, Hunt, and Walters, by rehabilitation, careful preparation for operation, and proper after care, based on these considerations, of patients with prostatic hypertrophy, were able to perform prostatectomy in a series of 213 consecutive cases with but two deaths. The mortality rate in years gone by varied from 7 to 30 per cent.

Balfour, by physicochemical rehabilitation of patients before operation and proper care afterward, was able to perform operations on the stomach and duodenum in 589 consecutive cases, with only six deaths. When one considers that 120 of these operations were massive gastrectomies performed largely for cancer, with but two deaths, one is impressed by the enormous drop from the old mortality rate of from 10 to 25 per cent.

The application of pure science, as exemplified in the physicochemistry of man, is sufficient, from the standpoint of surgery, to give point to the discussion. While I have quoted largely the mortality of surgical operations for various conditions in which the benefits of these researches have

been especially marked, these investigations have given results fully as important, if not more so, in medicine. The new knowledge not only has given the medical man ability to prepare many patients for successful operations who formerly were beyond help, but also, of even greater importance, makes possible preventive medicine, the detection and cure of disease in the early stages, so that surgery will no longer be necessary.

The new knowledge which has made possible these results is all owing to a better understanding of the biochemistry of the human body. A survey of the 10,000 years of Egyptian history shows that there were no less than eight complete relapses of Egyptian culture into barbarism. Evidences unearthed of medical science have been confined largely to a few things of historical interest rather than of scientific value. Apparently there was little understanding of physical diseases. Emotions were played upon by prayers and incantations to various gods, a procedure different only in degree from that of present day cults and "pathies".

It was Aristotle, physician to Alexander the Great, who, 400 years before the Christian era, gave the beginnings of science. It was no wonder that the Aristotelian methods of deductive logic ruled for two thousand years until in the great sixteenth century, the century of Shakespears, Bacon developed inductive logic, and Harvey laid sound foundations of physiology. It was the time, too, of the chemist physician, Mayow, whose investigations led to the discovery of oxygen.

The investigations of Harvey, Mayow, Sydenham, the clinician, and their contemporaries were made with the aid of magnifying glasses, which could hardly be called microscopes. In the succeding 200 years there were no outstanding names in medicine. In the latter part of the eighteenth century John and William Hunter did much to put medicine on a sound foundation. John Hunter, the surgical pathologist, working with inferior microscopes, related general pathology to clinical medicine, and through his achievements England remained the center of the medical sciences until, in the nineteenth century, the development of better microscopes in France gave to France the scientific field in which worked that greatest benefactor of all time, Pasteur, the chemist physician.

The work of Pasteur marks the greatest epoch in history. It gave control of all the diseases of microbic origin whose characteristic germ could be recognized by the microscope. Mass diseases, typhoid fever, yellow fever, and malaria were wiped out, and by sanitary measures the dangers of contaminated milk and impure water were removed. The original work of this one man as it was extended in Europe and in the United States increased the average lifetime of man from forty-two years to fifty-eight years.

We stand before the ultramicroscopic field of chemistry today much as our forebears stood before the microscopic field in the day of Pasteur. So far as the science of medicine is concerned, a new epoch dawns.

The extension of life from the average age of forty-three to fifty-eight has brought an enormous number of persons into middle life, and later, with the result that there are naturally more deaths from the characteristics diseases of middle and later life, affections of the heart, kidneys, liver, and from cancer, but fortunately, through chemical means, now channels open for the cure or prevention of these diseases.

Through studies of the biochemistry of man it is evident that the age of three score and ten promised in Holy Writ is to be brought about. I would that I were a student again, a freshman, with all the wonders which medical science will work out, before me, that I might see in the next generation the continuation of the researches of my day and time, the marvels which will rid man to a large extent of disease and add so greatly to human happiness.