

205-D
CIT

CALIFORNIA INSTITUTE OF TECHNOLOGY - RESEARCH IN GENERAL PHYSIOLOGY
AND EXPERIMENTAL BIOLOGY

\$50,000 - RF 33106 July 1, 1934 - June 30, 1937

\$40,000 - RF 35047 July 1, 1935 - June 30, 1937

(Also see "Additional Notes on Grants")

Appraisal: WW inspected the work of Morgan's group on his visit to Pasadena
Jan. 28, 1938

10/23-25/33, previous to his recommendation of RF aid. Since RF aid has been extended to this group, FBH has visited it once and WW twice. The officers have also been in close touch with the work through frequent progress reports, occasional visits by Morgan and Millikan to the RF office, and through correspondence. Morgan reported in his letter 11/6/37 to WW that not only had this contribution enabled them to start a group in animal physiology, but it allowed them to assist in other work along physiological lines, by providing technical assistants for Went, Borsook, Wiersma, and Emerson. The scientific activity has been nearly doubled by the presence of this group of assistants. In their new quarters, which they will occupy in February, 1938, they expect to be in a very much better position to carry on more efficiently what is now under way. Due to a special gift from Mrs. Kerckhoff, they were able to secure Dr. Haagen-Smit, formerly of Harvard University and highly recommended by Professor K"ogl, from whose laboratory at Utrecht he came to this country. He has been working on the chemical side of the plant hormones. They have also had a gift from Dr. Eversole of a greenhouse that will be automatically light, heat, and moisture controlled. This will enable Dr. Went and his group to carry on more efficiently the work on plant hormones. Thus the objectives of the RF appropriations seem to be well on their way toward satisfactory accomplishment.

CALIFORNIA INSTITUTE OF TECHNOLOGY - RESEARCH IN GENERAL PHYSIOLOGY
AND EXPERIMENTAL BIOLOGY (Cont'd)

Objectives: General - To make possible, while the leadership of Professor T. H. Morgan is still available, the development of the biological program at CIT which the Institute anticipated when he was called from Columbia University.

Under the leadership of Millikan, Hale, Noyes, Morgan, and others CIT has developed into one of the outstanding institutions in the country for graduate and postgraduate training and research in the natural sciences. Professor Morgan was called to CIT in 1928 under an agreement whereby he was to have a budget of \$100,000 a year, portions of this budget unexpended during the early years of development to be held for future use of the department. The maximum annually expended was \$80,000; and in 1933-1934 only \$61,000 was expended, the balance being released for the general use of CIT because of pressing needs due to economic conditions.

Specific - In his memorandum to WW 11/9/33, Morgan stated there were aspects of the work in neural physiology that they were anxious to undertake. The theory of the humoral mechanism of nerve activity suggested the possibility of detecting the way in which the nerve current is transmitted over the synapses in the central nervous system, and how it calls into activity, by chemical action, the end-organs, muscles, and glands. More remotely, there is even the possibility that the brain itself may to some extent function in the same way. For plant physiology they had already built a small, well-equipped building for the study of growth hormones. It was thought that the study of photosynthesis here in process might lead to the investigation of other catalytic processes. It was also deemed important to assist the development of biochemistry in the Institute. The primary object of the investigations of this group has been the study of synthetic processes in living matter. In biophysics Dr. Morgan wished to further the work on photosynthesis as measured and analyzed by physical means.

Fulfillment: RF 33106 appropriated \$30,000 to be used during 1934 for re-Jan. 28, 1938 search assistants, apparatus, supplies, and one major staff appointment (a physiologist), and \$20,000 to be reserved by CIT to provide the salary of the physiologist during the years 1935 and 1936. The one-year restriction then operative made it impossible for the RF to grant CIT's three-year request. Therefore, a further appropriation of \$40,000 was made (RF 35047). The net result of the two grants was the provision of \$30,000 annually for 3 years, as originally requested. It was the understanding of the RF that approximately one-third was to be devoted each year to the major appointment in physiology, one-third to equipment and assistance for physiology, and one-third for research assistants in biochemistry and biophysics. In a letter 12/28/33 from Professor Morgan to WW he requested that the RF grant begin on July 1, 1934, instead of January 1, and run until June 30, 1937. This action was taken.

Physiology - C.A.G. Wiersma (Asst. Professor in Biology) was brought from Jordan's laboratory in Utrecht in September, 1934 to fill the position of physiologist at a salary of \$5,000 a year and with a promise of \$5,000 a year for assistance. He brought with him Dr. Anthonie van Harreveld (Instructor in Biology) at a salary of \$3,000 a year. Wiersma has been working mainly on nerve-muscle preparation of Crustacea, with the hope of obtaining a better understanding of the properties of the nervous system. George Marmont and William Berggren were research assistants under the RF appropriations. Further details of the work will be found on sheet "A".

Biochemistry - Henry Borsook (Asst. Professor in Biochemistry) is the strongest of the young group outside genetics. He is rated very high from all points of view by Morgan and others at CIT, including Millikan. C. L. A. Schmidt (U. of California) told WW during his visit 10/16-17/33 that Borsook's laboratory was one of the most important laboratories in this country. Both Professor Terroine (Strasbourg) and S. S. Zilva (Lister Institute) have spoken with particular interest and appreciation of Borsook. The investigations of his group concerning the synthetic processes in living matter have been along three closely connected lines: 1) the measurement of the free energies of the chemical actions involved, by means of the third law of thermodynamics and accurate heats of combustion; 2) the elucidation of the mechanism of coupled enzyme reactions (in which one component is a synthesis); 3) chemical studies of intact, living tissue (tissue slices) and of the whole organism, using information gathered from (1) and (2). Research assistants employed under the RF appropriations were: Mr. S. W. Fox, Mr. Dubnoff, Mr. Emory L. Ellis, and Mr. Cecil E. P. Jeffreys. Details of their work are given on sheet "A".

Plant Physiology - F. W. Went (Asst. Professor of Biology), from Utrecht University, and his group have as their main research problem the formation, action, and chemical identity of the internal growth and developmental factors in plants. In the past the work has mainly been restricted to one substance or group of substances, the auxins or growth hormones. Support from the RF has been instrumental in enlarging this field of activity. Dr. Jan van Overbeek and Dr. James Bonner were the research assistants employed under the RF appropriations, and Mr. C. L. Schneider was the technical assistant. Details of their research will be found on sheet "A".

Biophysics - Robert Emerson (Asst. Professor of Biology) concentrated his interest in physical measurements of photosynthesis. His research assistants under the RF appropriations were Mr. Lowell Green and Mr. Marston Sargent. Dr. Emerson, according to a letter from Professor Morgan to WW dated November 6, 1937, is now in the Carnegie Institution at Stanford University, where he will remain for three years and then return to CIT. Details of the work of this group are given on sheet "A".

Financial statements show that the entire amount of the appropriations has been expended in accordance with the original understanding of the grants, and that small additional amounts were contributed by CIT.

Additional
Notes on
Grants:

In addition to the appropriations listed, four research aid grants, totaling \$2,980, have been made for work at CIT in the field of genetics. Also, on December 10, 1930, the RF appropriated \$500,000 for the development of natural sciences at CIT, on condition that the Institute should secure for the same purpose, in cash and/or legally valid pledges from other contribution sources, not including legacies, the sum of \$3,500,000. On December 18, 1930 the GEB authorized its officers to enter into an agreement in a similar amount for the same purpose. In 1934, 1937, and 1938 the time for completion of pledges was extended and now continues to August 1, 1938, with one year additional for collections. Under funds collected to match these appropriations a new building is being erected to provide enlarged quarters for those aspects of Morgan's work which connect most closely with research in the basic sciences.

On December 1, 1937 the Executive Committee of the RF was authorized to appropriate to CIT sums not to exceed a total amount of \$300,000 during the six-year period beginning July 1, 1938, toward support of developments of chemistry in its relationship to biological problems, the amount to be available in any one year of the period not to exceed \$70,000, it being understood that an adjustment of the amount payable shall be made as income is received by CIT from the endowment provided under RF 30080 and GEB pledge No. 426. Under this new appropriation approximately \$10,000 a year will go to Morgan's group for technical assistance in biochemistry, biophysics, and plant and animal physiology.

Sheet "A"

Details of Research under RF Appropriations

Physiology - Wiersma found that the muscles of the legs of crustaceans have a very typical innervation, each muscle fiber being usually innervated by three different axons. In the crayfish single axons were isolated in the central nervous system, which produce distinct effects in the periphery when stimulated. Studies were also made on galvanotaxis in fish, and on the intoxication with the alkaloid bulbocapnine, using cats as the experimental animals. The study of this intoxication is important for knowledge of the normal posture. George Marmont helped with the course in physiology and with the demonstrations. He has developed great skill in making single nerve fiber preparations of crustaceans. The work of William Berggren was confined to the chemical analyses of the lactic acid and phosphagen content of crustacean muscles under different conditions.

Biochemistry - Mr. S. W. Fox has worked mainly in the preparation of a number of compounds of interest to biochemists and physiologists, in a state sufficiently pure for the determination of their entropy, heat of combustion, and free energy. Borsook states that the skill which Fox brings to this work is that of the "instinctive" organic chemist, and that men of his ability are at present rare in the United States. Mr. Dubnoff has taken part in a continuation of the studies of intermediary nitrogen metabolism of isolated animal tissues. The object of the experiments was to obtain some information on the factors influencing the autolysis of proteins and amino acids in isolated animal tissues. Mr. Emory L. Ellis was engaged in obtaining thermodynamic data of compounds of physiological importance (free energies and heats of combustion). This is the only place in the world at present where these data, fundamental for the whole field of physiological energetics, are being obtained. Mr. Cecil E. P. Jeffreys has taken part in the study of nitrogen metabolism of mammalian tissues, specifically the formation of protein, uric acid, and creatine. He has been engaged in working out a quick, micro method for the determination of total purines.

Plant Physiology - Dr. Jan van Overbeek (from Holland) set out to approach the action of the growth genes from the physiological side and was able to show that in a number of hereditary dwarf races of corn, each caused by a different recessive gene, the dwarfishness was due to an excessive destruction of auxin by oxidative processes. Dr. James Bonner laid the foundation of successful tissue cultures of plants. With certain extracts he was able to make the parenchyma cells of bean pods grow in an otherwise synthetic medium, and he could sub-culture these growing cells four to five times. The importance of this work lies in the fact that so far no one has been able to cultivate plant parenchyma cells in vitro. In "Science" 2/12/37 there is an article by Bonner on "Vitamin B₁ a Growth Factor for Higher Plants." FBH suggested Bonner to Dean Taliaferro (Chicago) 2/15/37 in regard to an opening for a botanist. Mr. C. L. Schneider has been subjecting the Avena tests to a closer analysis, which has already led to some improvements in the testing for auxins.

Sheet "A" (Cont'd)

Biophysics - Mr. Lowell Green, besides making physical measurements of photosynthesis, has collaborated with Emerson in the preparation of two short papers, one on the nature of the Blackman reaction in photosynthesis, the other on the influence of hydrogen ion concentration on the maximum rate of photosynthesis. One of these papers has appeared in print, and the other is now in press. Mr. Green also worked with Mr. John L. Webb on experiments designed to establish the constancy or range of variation of the so-called "chlorophyll unit" in photosynthesis, a subject of controversy in the literature. This work has not been carried far enough to warrant publication. Mr. Marston Sargent has been very useful in isolating certain lower organisms and in working out the conditions under which they will maintain themselves in the laboratory. These organisms have then been used for further work by Emerson. An effort is being made to prepare this work for publication.

Bibliography

Financial Reports

- 7/22/35 (covers RF 33106 - period 7/1/34 - 6/30/35)
- 12/17/36 (covers RF 33106 & RF 35047 - period
7/1/35 - 6/30/36)
- 10/14/37 (covers RF 33106 & RF 35047 - period
7/1/36 - 6/30/37)

Progress Reports

- 3/12/35
- 6/14/35
- 2/12/36
- 8/ 4/36
- 2/10/37
- 11/ 6/37 (summary of three years' work; covers all but
Robert Emerson's researches)
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