February 11, 1947

Dear Mr. Alsup: Thank you very much for your statement on Mr. Proctor and for the interesting news about yourself. I had heard you were back at Howard, but I didn't know about the ASTP training. I'm glad to know somebody got real benefit from that program. I got into the language end of it after a year in the Army and discovered too late that it was just a one-way street leading to a rifle company in the Infantry. Come to see us if you are ever out this way.

Sincerely yours,

WILLIAM C. HAYGOOD

WCH:rfl

Mr. Fred W. Alsup
334 "V" St., N. W. #31
Washington 1, D. C.

334 "Vee" St. N.W. #31
Washington, D.C.
February 2, 1947

Dear Mr. Haygood:

I believe it is about time that I give a report on myself coveing the past five years. After teaching Zoology at Howard University for a little more than a year I was called to the army. After about 18 months in the Army I was sent to the Medical School at Howard University under the Army Specialized Training Program. I had just about completed three years in medical school when I was discharged from the Army in March 1946. I decided that with my training in research and my medical training I would have an even better chance of doing some good research in the future. Therefore I am finishing my medecine in June, 1947 and after a year of internship at Lyderhom Hospital in New York I hope to return to my just love, research.

While studying medicine here at Howard University, I have been elected president of the Honorary Society, Kappa Pi.

Since my discharge from the Army I have taught Zoology at Howard University during the Summer and am now working as a Visiting Lecturer in Biological Sciences in the Evening School.

Mr. Proctor about whom I have given you my opinion is the only promising young scientist who has come to my attention in the past few years.

Sincerely yours,

Fred W. Alsop

Please fill out and return in order that we may complete our records on former Rosenwald Fellows:

Name: Fred W. Alsup Pfc.

Present position: Member Armed Forces -
Medical Student under A.S.T.P.

Address: 2515 SU. AST Howard University
Washington, D.C.

FELLOWSHIPS

Significant recent activities:
Entered Army September, 1942
Entered Medical College March, 1944

(Use additional sheet if desired)

Acting Director for Fellowships
Julius Rosenwald Fund
4901 Ellis Avenue
Chicago 15, Illinois

HOWARD UNIVERSITY
WASHINGTON, D. C.

FELLOWSHIPS

DEPARTMENT OF ZOOLOGY

April 9, 1942

Mr. William C. Haygood,
Director for Fellowships
Julius Rosenwald Fund
4901 Ellis Avenue
Chicago, Illinois

WCH 4/13 WCH

Dear Mr. Haygood:

I wish to acknowledge receipt of your letter of March 31 and to thank you for the same. Since I received it something has happened to put all things in a different light in so far as I am concerned. I have been informed by my Local Selective Service Board in Nashville, Tennessee that I am to be reclassified soon. Unless the Board sees fit to leave me in Class 2-a because I am a teacher of pre-medical students, I am quite likely to be called for Army service. Should I be called, I shall try to get into a branch of the Service for which my training best fits me. I have mentioned all this because I would not want to plan for a full year's work knowing that I might be called at any moment. Since the Fund would not consider granting me money to further my own researches and those of my graduate students here at Howard next year, I shall wait until more normal times before applying for aid to do further research work. I hope that next year will find things much nearer normalcy.

I shall send you the reprints in a few weeks. Again, thanks for your most kind offer to make an exception in case I had applied for a fellowship this year.

Sincerely yours,

Fred W. Alsup

Fred W. Alsup

March 31, 1942

Dear Mr. Alsup: Thank you for your good letter of March 23. Miss Menard applied to us for a fellowship, and I am glad to have your comment on her which I will bring to the attention of the Committee when it has its final meeting toward the middle of next month.

I shall be very glad to have two copies of the reprints for our files. I can well understand your desire to engage in further research, and as you know, the only way we have for aiding a program of this kind is through our fellowships. Therefore, any proposal for further study or for full time research would have to come to us through this channel, or in other words, as a regular fellowship application. As you probably remember, the deadline for receiving such applications was January 5, but since you have been a Rosenwald Fellow, I am willing to make a very unusual exception and allow you to present a plan of work and an application now, provided it can be in my office by next Monday. I am assuming that this is something of what you had in mind when you wrote me, and that you will be able to formulate a plan for a full year's work, since we do not give grants for summer projects.

Sincerely yours,

WILLIAM C. HAYGOOD

WCH:McK

Mr. Fred W. Alsup
Department of Zoology
Howard University
Washington, D. C.

HOWARD UNIVERSITY
WASHINGTON, D. C.

FELLOWSHIPS

alsup Fred

DEPARTMENT OF ZOOLOGY

March 23, 1942

	WHA	25	WCH	31
	ERE		EDR	0

The Director for Fellowships
The Julius Rosenwald Fund
4901 Ellis Avenue
Chicago, Illinois

Dear Sir:

I wish to advice you that in compliance with your request that I bring the purposes of the Fund to the attentions of deserving young persons of my aquaintance I had Miss Edith Menard, a graduate student at Howard University, make application for one of your fellowships. You already have statements about her scholastic record, a record that seems to me to be very derserving. I sincerely hope that she is successful in her attempt to become a Rosenwald Fellow.

In regards to my own progress and work since last June when I obtained the Ph.D. degree from the University of Pennsylvania, I wish to say that so far the school year has been a successful one for me. My thesis, for the publication of which you gave me an additional $100, is to appear next month in "Physiological Zoology". I shall send you a reprint or as many as you may desire as soon as I receive them. Perhaps you recall that upon completion of my work at the University of Pennsylvania I accepted a teaching position here at Howard University. When I did this I understood clearly that I was to serve in the place of Associate Professor Chase who had been called to the Army. In accepting this position I turned down several offers of jobs of a more permanent nature. I did this because I felt that by working at Howard I would have a chance to associate with Dr. E.E. Just and thereby better my ability to do research. However, I have not been able to realize this long-standing ambition because death stepped in to rob the world of Biology of this great scientist. The other phases of my work have gone very well. Since I am still desirous of continuing my research I felt that I should teach as many courses in zoology as possible so that I might strengthen myself on all phases of the field. Thus, this year I have taught and am still teaching courses in which we take up all the Invertebrates, the anatomy of Vertebrates and cellular Physiology. As a result of having this very large teaching load, I have not been able to do much research but have outlined some problems for future consideration.

This coming summer I plan to continue my research at the Marine Biological Laboratory and to get started on at least two new problems. Since I am substituting for Dr. Chase who is a Major in the Army, I will be at Howard next year and plan to do some research next year while teaching. However, as you probably know, due to lack of time, equipment and money with which to obtain material one can do very little research while teaching.

HOWARD UNIVERSITY
WASHINGTON, D. C.

DEPARTMENT OF ZOOLOGY

As I indicated when applying in 1937 for my first Rosenwald grant, I would like to do some extensive post-doctoral work of a research character. I realize now that I cannot do this easily with-out some financial help from some orginization such as yours. Even if that assistance were not such as to permit me to spend another year or so taking special courses and doing research but were such as to only permit me to do research while teaching, I believe I could get a good start toward being the sort of biologist Dr. Just was. I do not know what the attitude of the Fund has been toward granting financial aid for post-doctoral work, and would appreciate it very much if you would enlighten me on this point. I am determined that the training for research that I received at the University of Pennsylvania, thanks to the Fund, shall not be for naught. I would like for the Julius Rosenwald Fund to help me in this matter. Any help that I can get will be fully appreciated, and if necessary I will submitt a full outline of my plans for research.

I hope to hear from you soon; and again thanking you for what you have already done in helping me get up the first rungs of the ladder of success, I remain

Sincerely yours,

Fred W. Alsup

Fred W. Alsup

FELLOWSHIPS

Marine Biological Laboratory
Woods Hole, Massachusetts
August 10, 1941

	WCH	12	WCA	0
	MSW		MA	0

Mr. William C. Haygood
4901 Ellis Avenue
Chicago, Illinois

Dear Mr. Haygood:

This is to acknowledge receipt of your letter of July 31 inquiring as to what rank I will hold at Howard University. May I state that I have been appointed an Instructor in the Zoology department. You also asked for the full title of my dissertation. It is " The effects of light alone and photodynamic action on the relative viscosity of amoeba protoplasm." I shall send you a copy of it as soon as it is published.

My present research is on viscosity changes in the protoplasm of marine eggs. It is progressing nicely.

I plan to leave here on August 27 and to be in Washington by September 3. I shall write you in the future to let you know how I am getting along in my work.

Sincerely yours,

Fred W. Alsup

Fred W. Alsup

FELLOWSHIPS

July 31, 1941

Dear Mr. Alsup: We are in the midst of preparing a report for our trustees, and would like to know what rank you will hold at Howard University, and in what department. And will you please give us the full title of your dissertation?

I hope you are having a good summer of work at Woods Hole.

Sincerely yours,
WILLIAM C. HAYGOOD

WCH*MLU

Mr. Fred Alsup
Marine Biological Laboratory
Woods Hole, Massachusetts

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

Mr. Fred W. Alsup

3626 Sansom Street

Philadelphia, Pennsylvania

Payment Voucher No. 2956

Date May 29, 1941

Final payment on fellowship granted 4/18/40 - - - - - - - - - - - $80.00

Ck.#25018

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	39-7	$80.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

Mr. Fred W. Alsup

3626 Sansom Street

Philadelphia, Pennsylvania

Payment Voucher No. 2928

Date May 15, 1941

Payment in full of extension to fellowship grant - - - - - - - - $100.00

Ck.#24990

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	36-51	$100.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

FELLOWSHIPS

May 15, 1941

Dear Mr. Alsup: Enclosed you will find our check for $100, paying in full the recent extension made to your fellowship award to enable you to make the required deposit for the publication of your thesis.

Very truly yours,

DAE:AM

DOROTHY A. ELWOOD

Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

UNIVERSITY OF PENNSYLVANIA
PHILADELPHIA

THE COLLEGE

Zoological Laboratory
38th Street and Woodland Avenue

May 14, 1941

WCH 19 WCH 0

Mr. William C. Haygood,
Julius Rosenwald Fund,
4901 Ellis Avenue,
Chicago, Ill.

Dear Mr. Haygood:

I know that Mr. Alsup appreciates the additional help that the Julius Rosenwald Fund has given him, and my understanding is that he has already written you to that effect.

I am trying to arrange for him to borrow the money he needs for the summer from the University Loan Fund. If he doesn't get the money there, we will try some bank.

Sincerely yours,

L. V. Heilbrunn

LVH:A

	WCH		WCH	0
	DE		DE	5/15

FELLOWSHIPS

3626 Sansom St.
Philadelphia, Pa.
May 12, 1941

Mr. W.C. Haygood,
Acting Director for Fellowships
Julius Rosenwald Fund
4901 Ellis Avenue
Chicago, Illinois

Dear Mr. Haygood:

I wish to acknowledge receipt of your letter of May 7 in which you informed me of the addition to my grant. I want to thank you and the other officials for all that you have done for me during the course of my work here at the University of Pennsylvania. You showed confidence in me and my work by the numerous grants that you gave me, and I have felt that I should do all in my power to justify that confidence. If I have in any way done so, I am happy. I assure you that when I finish my work here in June, I shall feel that I have been given the go-signal, so to speak, and shall put all that I have learned to the best use.

I have been appointed an Instructor in Zoology at Howard University for the year 1941-42. I plan to continue my research work there and at the Marine Biological Laboratory, Woods Hole, Massachusetts.

The deposit for my thesis must be in the office of the Graduate School before May 26. If you prefer to send the one hundred dollars directly to the office, I shall merely go to the office to get the final details straightened out. My thesis has been accepted and I plan to submit it for publication at an early date.

DE. Please send.

Thanking you again for making it possible for me to further my education and scientific training, I remain

Sincerely yours,
Fred W. Alsup
Fred W. Alsup

May 7, 1941

Dear Mr. Heilbrunn: Mr. Reynolds has resigned his position with the Fund to take a government post in Washington, and your letter of May 2 has come to me for answer.

Mr. Embree and I have discussed Mr. Alsup's case in some detail. Since Mr. Alsup has had three awards, and since the current year's fellowships have been awarded, we have no funds available for what would mean essentially an extension of his present grant for several months of work. We are, however, concerned that his dissertation appear in print, and for that reason we are adding $100 to his present grant to cover the deposit which is now necessary. We hope very much that he will be able to be with you at Woods Hole this summer, but we see no way by which we can do more than aid with the expenses of publishing his dissertation.

We are very glad that Mr. Alsup has made such a fine record at the University of Pennsylvania, and we are more than grateful for all of the help which we know you have given him.

Sincerely yours,

WCH:MLU

Acting-Director
for Fellowships

Mr. L. V. Heilbrunn
Zoological Laboratory
University of Pennsylvania
Philadelphia, Pennsylvania

UNIVERSITY OF PENNSYLVANIA
PHILADELPHIA

THE COLLEGE

Zoological Laboratory
38th St. and Woodland Ave.

May 2, 1941.

WCH 5			WCH	6
DE			DE	0

Mr. George M. Reynolds,
Director of Fellowships,
Julius Rosenwald Fund,
4901 Ellis Avenue,
Chicago, Illinois.

Dear Mr. Reynolds:

Mr. Fred Alsup has finished his work for the Ph.D. degree. He has been a fine student and an excellent research worker, and I want to express my gratitude to you and to the Foundation for having sent him to me. Alsup's future seems assured. As a result of his work here, he has already published an excellent paper in a leading physiological journal, and his Doctor's thesis is now ready for publication. It has been passed by our faculty with highly favorable comments. I feel sure that Alsup has a fine future before him, and I am especially pleased by the fact that he has obtained a position for next year at Howard University. This should give him an opportunity to develop and to do the good research he is capable of doing.

There is a minor problem that now faces us. Our Graduate School has established a new regulation requiring each Ph.D. candidate to deposit a $100 as a guarantee that the thesis will be published. The money is then refunded as soon as 300 copies are delivered. Now there is no question that Alsup's thesis will be accepted for publication, but there is the problem of finding the $100. Moreover, I should like very much to have Alsup come with me again to Woods Hole where he has been able to do such successful research. In the past he has helped earn expenses at Woods Hole by washing dishes in the Laboratory Mess. Naturally, he could do more and better work if he were not tied down in this way. I have suggested to him, in view of the fact that his salary next year will be ample, that he attempt to borrow $300-$400 in order that he can deposit the required sum for his Ph.D. thesis and also in order that he can live through the summer and do a maximum amount of research.

Alsup can, of course, apply to a bank for a loan or he might possibly borrow money from the University, but it occurs to me that the Rosenwald Foundation might be willing to loan the money to him at a reasonable rate of interest, and I am therefore calling this matter to your attention.

Yours very truly,

L. V. Heilbrunn

LVH:A

L. V. Heilbrunn

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

Mr. Fred W. Alsup

3626 Sansom Street

Philadelphia, Pennsylvania

Payment Voucher No. 2786

Date April 30, 1941

Eleventh payment on fellowship grant - - - - - - - - - - - - - - - - $80.00

Ck.#24828

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	39-7	$80.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

Mr. Fred W. Alsup

3626 Sansom Street

Philadelphia, Pennsylvania

Payment Voucher No. 2605

Date March 31, 1941

Tenth installment on fellowship grant - - - - - - - - - - - $80.00

Ck.#14645

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	39-7	$80.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

CROSS REFERENCE RECORD

FIRM NAME OR SUBJECT FELLOWSHIPS ALSUP FRED W **FILE NO.**

DATE	REMARKS
3-22-41	H. M. Bond sends Alsup's reply to invitation to join faculty at Fort Valley - "A vailability for position mentioned uncertain".

SEE FELLOWSHIPS PALMER EDWARD N **FILE NO.**

DATE

SIGNED

FILE CROSS REFERENCE RECORD UNDER NAME OR SUBJECT LISTED AT TOP OF THIS SHEET, AND IN PROPER DATE ORDER.
THE PAPERS REFERRED TO SHOULD BE FILED UNDER NAME OR SUBJECT LISTED UNDER "SEE"

YAWMAN AND ERBE MFG. CO.
ROCHESTER, N. Y.

FORM NO. 099CR

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

To
Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

Payment Voucher No. 2455

Date February 28, 1941

Ninth installment on fellowship grant - - - - - - - - - - - - $80.00

Ck.#24425

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	39-7	$80.00	

Prepared by	Checked by	Posted by	
A,M			Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

Mr. Fred W. Alsup

3626 Sansom Street

Philadelphia, Pennsylvania

Payment Voucher No. 2507

Date January 31, 1941

Eighth installment on fellowship grant - - - - - - - - - - - - - $80.00

Ck.#24274

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	39-7	$80.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To Mr. Fred W. Alsup
5028 Sansom Street
Philadelphia, Pennsylvania

Payment Voucher No. 9206

Date December 28, 1940

Seventh installment on fellowship granted 4/18/40 - - - - - - $80.00

Ck.#9206 W. F.

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	39-7	$80.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

3626 Sansom Street
Philadelphia, Pa.
December 20, 1940

	DE	12/23	DE	-

Miss D.A. Elvidge, Comptroller
Julius Rosenwald Fund
4901 Ellis Avenue
Chicago, Illinois

Dear Miss Elvidge:

For the past two years you have sent me my January check just before the Christmas holidays, but as yet I have not received this January check. I thought that perhaps you had stopped this practice unless a Fellow had asked to have the check sent at this time. I would like to get mine just before Christmas, that is by next Tuesday. If you have already sent it, I am sure that you will overlook this anxious request. It may be that you have not started it to me, and in that case I hope that you will send it by special delivery so that I can get it at least by Christmas day.

check sent 12/23.

Thanking you for your indulgence and consideration in this matter, I remain

Yours sincerely,

Fred W. Alsup

Fred W. Alsup

wfa.

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

Payment Voucher No. 2009

Date November 29, 1940

Sixth installment on fellowship grant - - - - - - - - - - - - - $80.00

Ck.#23926

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	39-7	$80.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To
Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

Payment Voucher No. 1866

Date October 31, 1940

Fifth payment on fellowship grant - - - - - - - $80.00

Ck.#23776

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	39-7	$80.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

FELLOWSHIPS

3626 Sansom Street
Philadelphia, Pa.
October 28, 1940

	DE	10/30	DE	0
	MLA		MLA	0
	MeK		MeK	0

Miss D.A. Elvidge, Comptrolier
Julius Rosenwald Fund
4901 Ellis Avenue
Chicago, Illinois

Dear Miss Elvidge:

In your last letter to me you asked me to let you know my Philadelphia address. It is and will be as above.

Since my return from Woods Hole I have taken and successfully passed the preliminary examinations for the PhD. degree. I am registered at the University of Pennsylvania only for research work which I am now engaged in. While at Woods Hole I extended my previous research,and this new research is reported in the October issue of the Biological Bulletin.

I wish to thank you for yourindulgence of my requested deviations from my original plan for payments on the Fellowship. I shall stick to the original plan for the remaining payments.

Sincerely yours,

Fred W. Alsup

Fred W. Alsup

m L u Mem o

FELLOWSHIPS

September 24, 1940

Dear Mr. Alsup: In accordance with your request, I am enclosing herewith the October installment on your fellowship grant. I shall expect to hear from you before the November installment is due giving me your new address.

Very truly yours,

DOROTHY A. ELVIDGE

DAE:AM

Mr. Fred W. Alsup
Marine Biological Laboratory
Woods Hole, Massachusetts

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

Mr. Fred W. Alsup

Marine Biological Laboratory

Woods Hole, Massachusetts

Payment Voucher No. 1724

Date September 20, 1940

Fourth installment on fellowship granted 4/18/40 - - - - - - - - - - $80.00

Ck.#23592

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	39-7	$80.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

Marine Biological Laboratory FELLOWSHIPS

WOODS HOLE, MASSACHUSETTS

September 18, 1940

	DE	9/20	DE	9/23
	MLH		MLH	0

Miss D. A. Elvidge Comptroller
Julius Rosenwald Fund
4901 Ellis Avenue
Chicago, Illinois.

Dear Miss Elvidge:

I am remaining here longer than I had originally planned, because of the excellent facilities here for study in the field of Zoology. As you know I am going to take my preliminary examinations as soon as I return to Philadelphia. Since I am not sure at just what time I shall return to Philadelphia, I would like for you to send me my October check while I am here. In fact I will appreciate it if you can send the check by September 25th. Thanking you in advance for your indulgence in this departure from my original plan of payment, I remain

Yours sincerely,

Fred W. Alsup

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

Mr. Fred W. Alsup

Marine Biological Laboratory

Woods Hole, Massachusetts

Payment Voucher No. 1593

Date August 30, 1940

Third payment on fellowship granted 4/18/40 - - - - - - - - - - - - - - $40.00

Ck. #23456

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	39-7	$40.00	

Prepared by	Checked by	Posted by	
McK			Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

Mr. Fred W. Alsup

Marine Biological Laboratory

Woods Hole, Massachusetts

Payment Voucher No. 1551

Date July 25, 1940

Second payment on fellowship granted 4/18/40 - - - - - - - - - - - - - $40.00

Ck. #23392

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	39-7	$40.00	

Prepared by	Checked by	Posted by	
McK			Comptroller

Marine Biological Laboratory
WOODS HOLE, MASSACHUSETTS

FELLOWS

July 22, 1940

Miss D. A. Elvidge, Comptroller
Julius Rosenwald Fund
4901 Ellis Avenue
Chicago, Illinois

Dear Miss Elvidge:

In my letter to you in May concerning the payment of my grant for 1940-41, I requested that you send me a check for $80 about the first of September. Well, some unexpected expenses for material has come up, and now I must ask you to split the September check into two parts, sending me half if it this week and the other half on the first of September. I am very sorry that I have to bother you with this change of plan for the payments, but I must have the material for my work.

I shall expect to hear from you by Saturday of this week.

Thanking you in advance for this indulgence, I remain

Sincerly yours,
Fred W. Alsup
Fred W. Alsup

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To
Mr. Fred W. Alsup
3628 Sansom Street
Philadelphia, Pennsylvania

Payment Voucher No. 1289

Date May 31, 1940

Final installment on fellowship granted 4/12/39 - - - - - - - - - - - $60.00
First installment on fellowship granted 4/18/40 - - - - - - - - - - - 200.00
$260.00

Ck.#23067

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	38-9	$60.00	
Negro Fellowships	39-7	200.00	
		$260.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

FELLOWSHIPS

May 20, 1940

Dear Mr. Alsup: The payment plan which you have outlined is entirely agreeable to us. It is my understanding that all checks except the one due September 1 will be sent to you at your address in Philadelphia, and that the September 1 check will be sent to you in care of the Marine Biological Laboratory, Woods Hole, Massachusetts. If this second address is not correct, pleast let me know before the September payment is due.

Very truly yours,

DAE:RW

DOROTHY A. ELVIDGE

Mr. Fred W. Alsup
5626 Sansom Street
Philadelphia, Pennsylvania

FELLOWSHIPS

3626 Sansom Street
Philadelphia, Penna.
May 14, 1940

	DE	5/15	DE	5/20
	MLW		MLW	O

Miss D.A. Elvidge, Comptroller
Julius Rosenwald Fund
4901 Ellis Avenue
Chicago, Illinois

Dear Miss Elvidge:

I wish to submit a plan for payments on my Fellowship grant for the school year 1940-1941. I plan to leave Philadelphia on the 3rd of June ,and I shall be in Woods Hole, Massachusetts at the Marine Biological Laboratory from June until the end of September. Upon my return to Philadelphia I shall have the same address as the one above. Since I am leaving here on the third, I shall have to ask you to send me the first payment on my new grant at the same time that you send the last payment on my present grant, that is on June 1st. I plan to spend a week at my home in Nashville before going to Woods Hole, and I may not come through Philadelphia on my way from Nashville to Woods Hole, so I would like to have the check before I leave Philadelphia.

As I informed Mr. Reynolds when I applied for a renewal , I have completed my course requirements at the University of Pennsylvania and plan to do research at Woods Hole and at the University next school year. I will therefore not have a tuition bill but will have various expenses connected with my research. For this reason I am not listing any items in the plan for payments, that will have to be forwarded to your office for payment next year. I am taking my preliminary and final examinations for the PhD degree and shall complete all of my work next school year. I believe that it will be more convenient if I take care of these instead of submitting the bills to you. If I should decide to take a course next year, I will of course pay for it. of

Since I shall be in Woods Hole most of the month, September, I would like for the September check to be sent to me there. All the other checks may be sent to me at my present address. I hope that the plan for payments which is given below will meet your approval.

June 1, 1940	$200.00
September 1, 1940	80.00
October 1, 1940	80.00
November 1, 1940	80.00
December 1, 1940	80.00
January 1, 1941	80.00
February 1, 1941	80.00
March 1, 1941	80.00
April 1, 1941	80.00
May 1,1941	80.00
June 1, 1941	80.00
TOTAL	$1000.00

noted on form
Alsup

Yours sincerely,

Fred W. Alsup

Fred W. Alsup

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

To Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

Payment Voucher No. 1135

Date April 30, 1940

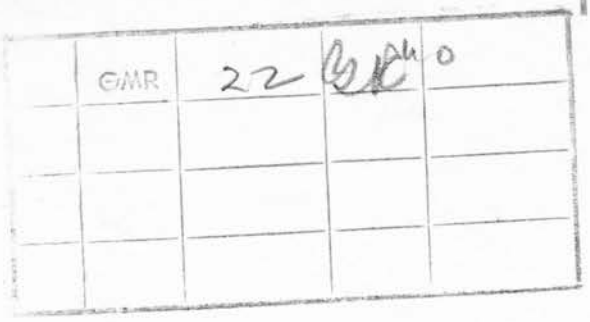
Twelfth installment on fellowship grant - - - - - - - - - - - - - $60.00

Ck.#22890

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	38-9	$60.00	

Prepared by	Checked by	Posted by	
AM			

Comptroller



3626 Sansom Street
Philadelphia, Penna.

April 19, 1940

Mr. George M. Reynolds
Director for Fellowships
Julius Rosenwald Fund
4901 Ellis Avenue
Chicago, Illinois

Dear Mr. Reynolds:

Your letter containing the very pleasant news about my being granted a renewal of my Fellowship reached me today. Being fully aware of just what a renewal implies in the way of confidence in a Fellow's endeavors, I am most grateful to the Committee for this repeated show of confidence in my work. I accept the grant and shall continue doing my best to maintain a high standard of work.

Very truly yours,

Fred W. Alsop

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

To Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

Payment Voucher No. 983

Date March 29, 1940

Eleventh installment on fellowship grant - - - - - - - - - - - - - - - $58.00

Ck.#22711

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	38-9	$58.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

Mr. Fred W. Alsup

3628 Sansom Street

Philadelphia, Pennsylvania

Payment Voucher No. 876

Date February 29, 1940

Tenth payment on fellowship granted 4/12/39 - - - - - - - - - - - - - - $80.50

Ck. #22601

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	38-9	$80.50	

Prepared by	Checked by	Posted by	
DAE			Comptroller

February 16, 1940

Gentlemen: Enclosed you will find our check for $112.50, representing payment in full of the tuition charges for Mr. Fred W. Alsup for the last half of the 1939-40 school term.

Very truly yours,

DOROTHY A. ELVIDGE

DE:AM

The Trustees of the University of Pennsylvania
Cashier's office
University of Pennsylvania
207 South 36th Street
Philadelphia, Pennsylvania

cc: Mr. Fred W. Alsup

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To The Trustees of the University of Pennsylvania
University of Pennsylvania

Cashier's Office
207 South 36th Street
Philadelphia, Pennsylvania

Payment Voucher No. 358

Date February 15, 1940

Tuition Fee for second term for Mr. Fred W. Alsup in Graduate School - - $112.50

Ck.#22563

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	38-9	$112.50	

Prepared by	Checked by	Posted by	
AM			Comptroller

UNIVERSITY OF PENNSYLVANIA

CASHIER'S OFFICE, 207 S. 36TH STREET

PHILADELPHIA

2/13/40 19

TO Julius Rosenwald Fund
4901 Ellis Avenue
Chicago. Illinios

ACCOUNT OF Fred W. Alsup DEPT. Grad, Sch.

Tuition Fee	2nd term	$ 112.50
Dormitory Rent		
Graduation Fee		
Late Registration Fee		
Gymnasium Locker Fee		
General Fee	*	
Collection Fee		
	DOROTHY A. ELVINGER	
Deposit		
Total		$ 112.50

This bill is now due and is payable at the Office of the Cashier, 207 So. 36th Street, Philadelphia, Pa. Draw cheques, etc., to the order of The Trustees of The University of Pennsylvania. Receipt will not be mailed unless requested.

February 14, 1940

Dear Mr. Alsup: Your tuition bill for the second semester of the current school term has not been received, but I imagine it will be coming within the next few days. I shall see that your March 1 installment is increased by the extra $22.50 which was originally allocated for tuition.

Very truly yours,

DE:AM

DOROTHY A. ELVIDGE

Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

FELLOWSHIPS

3626 Sansom Street

Philadelphia, Penna.

February 12, 1940

	DE	2/14	DE	2/14

Miss D.A. Elvidge, Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue

Chicago, Illinois

Dear Miss Elvidge:

According to the plan of the payments that I submitted to you last year, $135 were to be paid out for my tuition for the second semester at the University of Pennsylvania. I registered to-day for this second semester and found out that my bill would be only $112.50. Since there will be $22.50 not accounted for in the plan for payments, I will appreciate it very much if you will send me this money when you send me my next monthly check. I hope that this change in the plan for payments will not inconvenience you in any way.

Sincerely yours,

Fred W. Alsup

Fred W. Alsup

Mar 1 80 P.

Tuition not — yet

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

To
Mr. Fred W. Alsup
5626 Sansom Street
Philadelphia, Pennsylvania

Payment Voucher No. 748

Date January 31, 1940

Eighth payment on fellowship grant - - - - - - - - - - - - - - - - - - $58.00

Ck.#22424

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	38-9	$58.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

	GMR	26	6	26

3626 Sansom Street

Philadelphia, Penna.,

January 23, 1940

Dear Mr. Reynolds: I am desirous of applying for a renewal of my present grant and wish that you would send me one of the special application blanks for the renewal of grants.

Thanking you in advance for the blank, I remain

Sincerely yours,

Fred W. Alsup

Fred W. Alsup

Mr. George M. Reynolds

Director for Fellowships

Julius Rosenwald Fund

Chicago, Illinois

Alsup, Fred

January 5, 1940

Dear Mr. Alsup: Thank you very much for your letter of January 3 regarding Mr. William Gray, Jr. We shall be very glad to add your statement about him to his file.

All good wishes to you for the New Year.

Sincerely yours,

GEORGE M. REYNOLDS

GMR*MLU

Mr. Fred W. Alsup
3626 Sanson Street
Philadelphia, Pennsylvania

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

To Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

Payment Voucher No. 563

Date December 13, 1939

Seventh payment on fellowship granted 4/12/39 - - - - - - - - - - - - $58.00

Ck.#22222

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	38-9	$58.00	

Prepared by	Checked by	Posted by	
McK			Comptroller

December 11, 1939

Dear Mr. Alsup: I am arranging to mail all of the January 1 installments on fellowship grants about the middle of December. Your payment will reach you probably around the fifteenth, certainly before the twentieth.

Very truly yours,

DE:RW

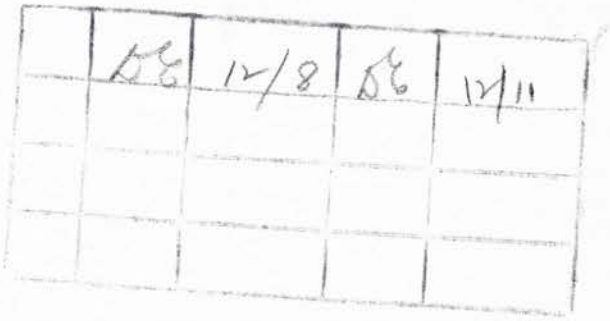
DOROTHY A. ELVIDGE

Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

3626 Sansom Street

Philadelphia, Penna.,

December 7, 1939



Miss D. A. Elvidge, Comptroller

Julius Rosenwald Fund

Chicago, Illinois

Dear Miss Elvidge:

Last year you sent me my check for January about the 20th of December. That was very convenient for me as you no doubt realized. This year I wish that you would send my check for January of next year to me about the 20th of this month.

My work is coming along fine and I hope to have very soon some more concrete proof of the things that I am accomplishing with the help of the Fund.

Thanking you in advance for indulging me in this change of plan for payment of my grant, I remain

Very truly yours,

Fred W. Alsop

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

Payment Voucher No. 452

Date November 30, 1939

Sixth installment on fellowship grant - - - - - - - - - - - - - - - - $60.00

Ck.#22106

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	38-9	$60.00	

Prepared by	Checked by	Posted by	
AM			

Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To
Mr. Fred W. Alsup
5626 Sansom Street
Philadelphia, Pennsylvania

Payment Voucher No. 336

Date October 31, 1939

Fifth payment on fellowship granted 4/12/39 - - - - - - - - - - - - - - - - $60.00

Ck.#21966

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	38-9	$60.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

FELLOWSHIPS

October 9, 1939

Dear Sir: The enclosed check for $125 is being sent to you to cover the tuition fee for Mr. Fred W. Alsup.

Very truly yours,

DOROTHY A. ELVIDGE

DE:AM

Office of the Cashier
University of Pennsylvania
207 South 36th Street
Philadelphia, Pennsylvania

cc: Mr. Fred W. Alsup

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To
The Trustees of The University of Pennsylvania
Office of the Cashier
207 South 36th Street
Philadelphia, Pennsylvania

Payment Voucher No. 299

Date October 9, 1939

Tuition Fee for Mr. Fred W. Alsup - - - - - - - - - - - - - - - - - $125.00

Ck.#21905

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	38-9	$125.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

UNIVERSITY OF PENNSYLVANIA

CASHIER'S OFFICE, 207 S. 36TH STREET

PHILADELPHIA

10/6/39 19

TO Julius Rosenwald Fund
4901 Ellis Avenue
Chicago Illinois

299
21905

ACCOUNT OF Fred W. Alsup DEPT. Grad Sch

Tuition Fee	125-
Dormitory Rent	
Graduation Fee	
Late Registration Fee	
Gymnasium Locker Fee	
General Fee *	
Collection Fee	
Deposit	
Total	125.00

DOROTHY A. ELVIDGE

This bill is now due and is payable at the Office of the Cashier, 207 So. 36th Street, Philadelphia, Pa. Draw cheques, etc., to the order of The Trustees of The University of Pennsylvania. Receipt will not be mailed unless requested.

FELLOWSHIPS

September 29, 1939

Dear Mr. Alsup: Enclosed you will find our check for $58 representing the installment for October on your fellowship grant.

I assume that bills covering your tuition will be sent to this office by the Bursar of the University, and I shall see that a check is sent to them promptly.

Very truly yours,

DOROTHY A. ELVIDGE

DE:AM

Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

Mr. Fred W. Alsup

5626 Sansom Street

Philadelphia, Pennsylvania

Payment Voucher No. 235

Date September 29, 1939

Third installment on fellowship granted 4/12/39 - - - - - - - - - - - $58.00

Ck.#21842

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	38-9	$58.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

Fred W. Alsup

3626 Sansom Street

Philadelphia, Pennsylvania

Payment Voucher No. 109

Date August 31, 1939

Second installment on fellowship granted 4/12/39 - - - - - - - - - $50.00

Ck. #21698

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	38-9	$50.00	

Prepared by	Checked by	Posted by	
McK			

Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

Mr. Fred W. Alsup

3626 Sansom Street

Philadelphia, Pennsylvania

Payment Voucher No. 8244

Date June 2, 1939

First installment on fellowship granted 4/12/39 - - - - - - - - - - - - - - $160.00

Ck.#21400

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	38-9	$160.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

MLU 0

FELLOWSHIPS

June 2, 1939

Dear Mr. Alsup: Thank you for your letter of May 27. The first payment on the fellowship awarded to you in April 1939, a check for $160, is enclosed with this letter. Payment of the balance will be made in accordance with the plan which you have submitted.

Very truly yours,

DOROTHY A. ELVIDGE

DE:AM

Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

FELLOWSHIPS

May 31, 1939

Dear Mr. Alsup: The enclosed check for $60 represents the final payment on the fellowship grant awarded to you in April 1938. For your information a schedule of the payments made on this award is given below.

June 13, 1938	$100
September 8	150
October 6, (tuition)	140
October 31	60
November 30	60
December 16	60
January 31, 1939	60
February 28	55
February 25 (tuition)	135
March 31	60
April 28	60
May 31 (enclosed)	60
	$1,000

When you are ready to begin work under your grant for the current year, kindly send me a payment plan which will meet your needs.

Very truly yours,

DOROTHY A. ELVIDGE

DE:AM

Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To
Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

Payment Voucher No. 8159

Date May 31, 1939

Final payment on fellowship granted 4/16/38 - - - - - - - - - - - - - - - - - $60.00

Ck.#21517

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	37-8	$60.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

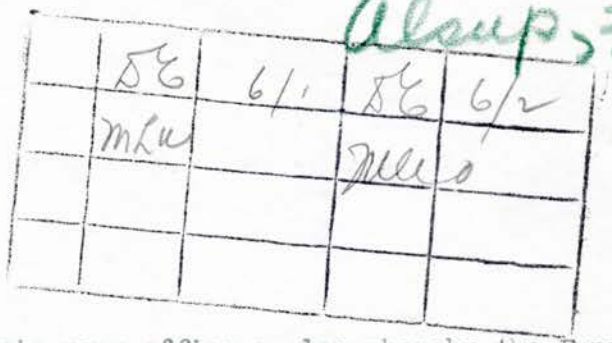
FELLOWSHIPS

3626 Sansom Street

Philadelphia, Penn.

May 27, 1939

Alsup, Fred



Miss D.A. Elvidge, Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue

Chicago, Illinois

Dear Miss Elvidge:

I have been requested to send into your office a plan whereby the Fund may send me payments on the renewal grant that I recieved for the next year. In view of the fact that I am planning to go to Woods Hole, Massachusetts for the summer to do researchwat the Marine Biological Laboratory, I shall need some assistance for the summer. Since I have to send in a request for this assistance, I felt that I could just as well send in my plan for payments during the entire school year. I therefore submit to you the following plan and trust that it will be satisfactory to you.

(1939)	June	$160 (160)
	September	50
	October	58
	October (tuition)	135
	November	60
	December	60
(1940)	January	58
	Febuary	58
	March	58
	April	58
	May	60
	June	60
	Febuary (tuition)	125
	TOTAL	$1000

You may send all the checks to the above address and since I am to be in Massachusetts by the 15th of June, I would like to recieve the $160 by the 12th. I will write you if I should have to remain in Massachusetts longer than August so that you may send me the September check there.

Very truly yours,

Fred W. Alsup

Fred W. Alsup

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

Mr. Fred W. Alsup

3626 Sansom Street

Philadelphia, Pennsylvania

Payment Voucher No. 8042

Date April 28, 1939

Eleventh installment on fellowship granted 4/16/38 - - - - - - - - - - $60.00

Ck.#21156

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	37-8	$60.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

3626 Sansom Street
Phila., Penn.
April 15, 1939

Mr. George M. Reynolds
Director of Fellowships
Julius Rosenwald Fund
4901 Ellis Avenue
Chicago, Illinois

Dear Sir:

It is with the greatest of pleasure that I am now writing you to let you know that I will accept the renewed fellowship that you informed me of. It is quite needless for me to try to put in words the happiness that the information brought me. I feel quite elated to know that my work has been appraised so highly by such an eminent body, as the one of which you are a part.

My work is coming along fine and I shall keep it so.

I shall submit a plan covering the details of payments as soon as you may want me to do so.

Sincerely yours,

Fred W. Alsup

Fred W. Alsup

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

To

Mr. Fred W. Alsup

3626 Sansom Street

Philadelphia, Pennsylvania

Payment Voucher No. 7905

Date March 31, 1939

Tenth payment on fellowship granted 4/16/38 - - - - - - - - - - - - - - $60.00

Ck. #21016

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	37-8	$60.00	

Prepared by	Checked by	Posted by	
DAE			Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

To
Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

Payment Voucher No. 7775

Date February 28, 1939

Eighth installment on fellowship granted 4/16/38 - - - - - - - - - $55.00

Ck.#20841

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	37-8	$55.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

To The Trustees of The
University of Pennsylvania

Office of the Cashier
207 South 36th Street
Philadelphia, Pennsylvania

Payment Voucher No. 7931

Date February 23, 1939

Tuition and general fees for Mr. Fred W. Alsup for the

second term of 1938-39 - $135.00

Ck.#20919

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	37-8	$135.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

UNIVERSITY OF PENNSYLVANIA

CASHIER'S OFFICE, 207 S. 36TH STREET

PHILADELPHIA

Feb 18 39 19

TO Julius Rosenwald Fund
4901 Ellis Avenue
Chicago. Ill.

DR

ACCOUNT OF Fred W. Alsup DEPT. Grad Sch

2nd Term 9 38 39

Tuition Fee		125
Dormitory Rent		
Graduation Fee		
Late Registration Fee		
Gymnasium Locker Fee		
General Fee	*	10
Collection Fee		
Deposit		
	Total	135

DOROTHY A. ELVIDGE

This bill is now due and is payable at the Office of the Cashier, 207 So. 36th Street, Philadelphia, Pa. Draw cheques, etc., to the order of The Trustees of The University of Pennsylvania. Receipt will not be mailed unless requested.

1931
20919

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To
Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

Payment Voucher No. 7645

Date January 31, 1939

Seventh payment on fellowship granted 4/16/38 - - - - - - - - - - - $60.00

Ck.#20695

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	37-8	$60.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

To
Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

Payment Voucher No. 7510

Date December 16, 1938

Sixth payment on fellowship granted 4/16/38 - - - - - - - - - $60.00

Ck.#20545

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	37-8	$60.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

recd. 1/5

December 14, 1938

Dear Mr. Alsup: We are preparing a short form for application for renewal of fellowships, and I shall be glad to send you one as soon as it is ready. The final filing date for renewals will be February 15.

Very truly yours,

CMR*MLU

Mr. Fred W. Alsup
~~3826 Sansom Street~~
Philadelphia, Pennsylvania

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To
Mr. Fred W. Alsup
3626 Sansom Street,
Philadelphia, Pennsylvania

Payment Voucher No. 7388

Date November 30, 1938

Fifth payment on fellowship granted 4/16/38 - - - - - - - - - - - - - - - $60.00

Ck.#20401

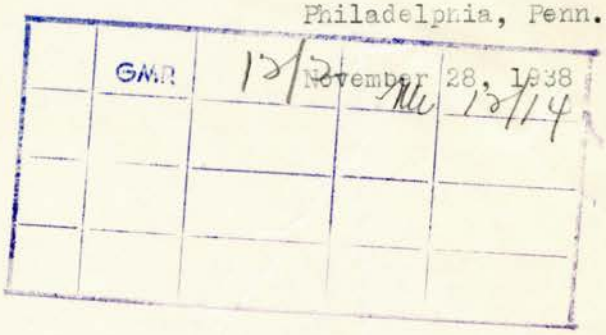
Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	37-8	$60.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

Rec'd 1/5

3626 Sansom Street

Philadelphia, Penn.



November 28, 1938

Mr. Raymond Paty

Director of Fellowships

Julius Rosenwald Fund

Chicago, Ill.

Dear Mr. Paty:

As you know I am now pursuing my studies in the field of Zoology at the University of Pennsylvania. I am enabled to do this because of the Fellowship that I was granted by the Fund last April. I am working toward a Doctor's degree and it is impossible for me to complete my work in one year. As I shall be in school all this school year I will need assistance to come back next year and it concerning this matter that I am now writing you.

I would like to apply to the Fund for a renewal of my grant for next year and I wish that you would send me any information that I am likely to need to do this. I am not sure that applications for renewals are due at the same time that other applications are due, but if they are I would like to have mine in on time. I will be most grateful to you if you will send me the blanks and other material needed to properly apply for this renewal.

Very truly yours,

Fred W. Alsup

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

To

Mr. Fred W. Alsup
3626 Sanson Street
Philadelphia, Pennsylvania

Payment Voucher No. 7279

Date October 31, 1938

Fourth payment on fellowship granted 4/16/38 - - - - - - - - - - - - $60.00

Ck.#20292

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	37-8	$60.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

FELLOWSHIPS

	DG	10/10	DG	o
	MLW		MLW	o

3626 Sansom Street

Philadelphia, Penn.

October 8, 1938

Miss D. A. Elvidge, Comptroller

Julius Rosenwald Fund

4901 Ellis Avenue

Chicago, Ill.

Dear Miss Elvidge:

I am now residing at the address given above and it shall be my address while here in Philadelphia. I have been here for quite some time and have gotten matters in hand so that I am now all set for my work at the University of Pennsylvania. I received the last check from you and it has stood me in good stead. According to our plan I had the University to forward the bill for my tuition to you. Since we agreed that there would be no check for the month of October, I shall not look for another before the first of November.

Very truly yours,

Fred W. Clamp

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

The Trustees of The University of Pennsylvania

207 South 36th Street

Philadelphia, Pennsylvania

Payment Voucher No. 7208

Date October 6, 1938

Your statement dated 10/3/38 for tuition and fees for

Mr. Fred W. Alsup - $140.00

Ck.#20201

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	37-8	$140.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

UNIVERSITY OF PENNSYLVANIA

CASHIER'S OFFICE, 207 S. 36TH STREET

PHILADELPHIA 10/3/38 19

TO D. A. Elvidge. Comp.
Julius Rosenwald Fund
4901 Ellis Ave
Chicago Ill

ACCOUNT OF Fred W. Alsup, pt. time DEPT. Grad Sch

Tuition Fee	125
Dormitory Rent	
Graduation Fee	
Late Registration Fee	
Gymnasium Locker Fee	
General Fee *	
Collection Fee	
Matric	5
Deposit	10
Total	140

DOROTHY A. ELVIDGE

This bill is now due and is payable at the Office of the Cashier, 207 So. 36th Street, Philadelphia, Pa. Draw cheques, etc., to the order of The Trustees of The University of Pennsylvania. Receipt will not be mailed unless requested.

7208
20201

FELLOWSHIPS

Alsup - Fred

September 9, 1938

Dear Mr. Alsup: The payment plan which you have suggested in your recent letter is entirely agreeable to us. Accordingly, I am enclosing our check for $150 to cover the September installment. Future payments will be sent to you on the first of each month. Kindly ask the University to send us a statement of your fees and we shall see that a check is sent to them promptly.

As soon as you are settled at the University let us know your address so that you will experience no delay in receiving your monthly checks.

Congratulations on the success with which you have completed your summer's work.

Very truly yours,

DE:AM

DOROTHY A. ELVIDGE

Mr. Fred W. Alsup
713-28 Avenue North
Nashville, Tennessee

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

Mr. Fred W. Alsup

713-28 Avenue North

Nashville, Tennessee

Payment Voucher No. 7108

Date September 8, 1938

Second installment on fellowship granted 4/16/38 - - - - - - - $150.00

Ck.#20086

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	37-8	$150.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

FELLOWSHIPS

Alsup - Fred

713-28 Avenue North
Nashville, Tennessee
September 6, 1938

	DE	9/8	DE	9/9
	MKA		MU O	

Miss D.A. Elvidge, Comptroller
Julius Rosenwald Fund
4901 Ellis Avenue
Chicago, Illinois

Dear Miss Elvidge:

In accord with your request, I am now submitting to you the plan by which I would like for the balance of my award to be paid during the school year. Before I do so I wish to say that I had a very fine Summer at the University of Michigan. I recieved my grades for the two courses in Chemistry that I took while there and happily to say they were both A's. I am now looking forward to my work at the University of Pennsylvania, which work will begin soon and which will, if all goes well, culminate in my getting a Doctor's degree in Zoology. In view of the fact that this will be my first time to stay in Philadelphia for any length of time, I am planning to go up early so as to pick out a nice place to stay and to have some conferences with Dr. Heilbrunn with whom I am to work. The plan that I wish to be followed is as follows:

September----------	$150.00
October--------	No check
November----------	$60.00
December----------	$60.00
January----------	$60.00
Feburary----------	$60.00
March----------	$55.00
April----------	$60.00
May----------	$60.00
June----------	$60.00
Total	$625.00

Since it is your custom to pay tuition and fees direct to the institution which a Fellow is attending, I have not included these items in the above plan. I have a statement from the school that there is an extra $25.00 that must be added to the tuition of $250 for the year and it is my plan that these bills be sent direct to your office. Any other fees that may arise will be paid out of my monthly checks by me. These others fees will be small if there should be any and I am sure that you will not object to my taking care of them. I would like to recieve the first check of $150 by the 15th of September and the others by the first of each month or as near as possible to the first of each month. The first check will carry me through the last part of September and the entire month of October. All these amounts add up to give a total of $900, the amount of my grant left. I trust that this plan will prove satisfactory to you and I hope to hear from you soon.

Very truly yours,

Fred W. Alsup

Fred W. Alsup

FELLOWSHIPS

June 14, 1938

Dear Mr. Alsup: I am enclosing our check for $100 as a first payment on your fellowship grant. I shall expect to hear from you again in the fall outlining a plan of payment for the balance of your award.

Very truly yours,

DOROTHY A. ELVIDGE

DE:AM

Mr. Fred W. Alsup
713-23 Avenue, North
Nashville, Tennessee

Julius Rosenwald Fund

4901 Ellis Avenue
CHICAGO

FELLOWSHIPS

To

Mr. Fred W. Alsup

713-28 Avenue, North

Nashville, Tennessee

Payment Voucher No. 6794

Date June 13, 1938

First payment on fellowship granted 4/16/38 - - - - - - - - - - - - - - - - $100.00

Ck.#19718

Accounts	Appropriation No.	Debit	Credit
Negro Fellowships	37-8	$100.00	

Prepared by	Checked by	Posted by	
AM			Comptroller

713-28 Avenue, North
Nashville, Tennessee
June 8, 1938

Miss D. A. Elvidge, Comptroller
Julius Rosenwald Fund
4901 Ellis Avenue
Chicago, Illinois

Dear Miss Elvidge:

I was told by Miss Utley, Secretary to Mr. Paty, to send into you a statement of when and how I want to begin getting money for living and travelling expenses for the Summer School work that I am to do. I have that statement ready and am now sending it to you. Miss Utley informed me that the usual method for sending out checks from the Fund is a monthly one. She also said that a different arrangement could probably be arranged to fit my particular needs this Summer. I hope that this arrangement that I am asking will not put you to any trouble.

I am going to the University of Michigan to get some Physical Chemistry and Organic Chemistry in preparation for my work next year at the University of Pennsylvania. The tuition will be $35 and I am not planning to take any laboratory work and therefore I think that that will be all that I will need for direct schooling. I will need living expenses and that is what my statement is mainly concerned with. I have figured that I can take care of my travelling, board, and incidentals for the 8 weeks that I will be at Ann Arbor with $65. I am hoping that I will not need any more than this $100 from my grant for the Summer. I want to leave for Ann Arbor about the 20 of June as registration begins on the 23 of June. I hope therefore that you can get the money to me by the 20 of June. I would rather get it on that exact date if it can be so arranged.

Thanking you in advance for you indulgence, I remain

Respectfully,

Fred W. Alsup

Fred W. Alsup

	DE	6/13	DE	6/17
	MLW		RP	O

FELLOWSHIPS

May 6, 1938

Dear Mr. Alsup: Mr. Paty is out of the office and in his absence I am replying to your letter of May 3. I can quite understand your anxiety, and I hasten to say that your letter was received promptly. The announcement of our Fellows has appeared in various newspapers during the last few days and you have undoubtedly seen it by this time.

It is our custom to pay tuition and fees direct to the institution which a Fellow is attending, upon receipt of a bill, and I think you will find this method satisfactory. We should like, however, to have a statement from you indicating when you would like payments for living expenses to begin. Checks are usually sent monthly, but should you for a particular reason desire some other plan it can probably be worked out. Will you please send your statement to Miss Dorothy Elvidge, Comptroller of the Fund, whenever you have it ready?

Very truly yours,
MARGARET L. UTLEY
Secretary to Mr. Paty

Mr. Fred W. Alsup
Morristown College
Morristown, Tennessee

FELLOWSHIPS

	RRP	6		

Morristown College
Morristown, Tenn.,
May 3, 1938

Mr. Raymond Paty
4901 Ellis Avenue
Chicago, Ill.
Dear Sir:

I recieved your letter announcing that I was the recipient of an award from the Julius Rosenwald Fund and in your letter you said that only those from whom acceptances had been received would be included in the official announcement of the Committee's selections. For that reason I wrote you the same day that I heard from you and gave my hearty acceptance of the grant. I have not heard from you nor the Committee and just to make sure that you got my letter I am writing you again to the effect that I do accept the grant. I hope that I do not appear impatient and I am sure that you can understand just how I feel about the matter. I do not want to do anything that might cause me to miss this honor.

You mentioned that a plan would be arranged to fit my particular needs; I gathered that you meant that the information in my application blank was sufficient for you to do this. If this was not what you meant, I will send you a restatement of my needs.

I want to attend Summer school this year and am intending to go the University of Michigan. I will need some assistance to realize this but the bulk of the grant will be needed to help me while I am at the University of Pennsylvania next Fall. I can send you a statement as to just how much I will need this Summer but you may not need this information as you have my blank.

I hope that that this letter is not needed as a reply to your letter and have little fear this one will be misunderstood.

Respectfully
Fred W. Alsup
Fred W. Alsup

P A

JULIUS ROSENWALD FUND

4901 ELLIS AVENUE

CHICAGO

Confidential Report on Candidate for Fellowship

Name of Candidate Mr. Fred W. Alsup

Report Requested of Dr. H. T. Folger, Head, Department of Zoology

Fisk University, Nashville, Tennessee

The above named candidate has applied to this Fund for a fellowship and has given your name as a reference. A statement of the candidate's plan of work is attached. Please return it with your statement.

We shall appreciate a frank statement of your opinion of this applicant's abilities and personal characteristics, and an appraisal of his plan of work. An early reply to this inquiry will be of great assistance in allowing the Fellowship Committee sufficient time for an adequate review of the large number of candidates who apply for grants.

Your reply will be held in strictest confidence.

Raymond Paty
Director for Fellowships

REPORT

From the first day that Fred Alsup entered my elementary course in Zoology, six or seven years ago, I have been aware that he is an outstanding student. He is industrious, intelligent, and has unusual power of concentration. A negro who aspires to a career in science faces certain peculiar difficulties, the most important of which, perhaps, is due to a lack of suitable positions available after one has completed his education. For this reason I have been somewhat reluctant to encourage students to continue into graduate work. But this man I have encouraged from the beginning. His training has been shaped definitely towards work in

OVER

experimental biology.

He has proved an exceptional ~~an exceptional~~ student in almost every course that he has taken, as his record will show. This record, I understand, is the best at Fisk, at least for many years.

In his graduate work here, he has shown an undoubted aptitude for research work. I reported in part the results of this work at the meeting of the American Society of Zoologists at Indianapolis, during the past holidays. An abstract of this paper, which is concerned with the effects of alternating electric current and light on Amoeba, has appeared in "Anatomical Record", vol. 70. His master's thesis is about ready for publication, and we expect to submit it to "Physiological Zoology" within a short time.

After the above account, it is perhaps superfluous to add that I consider Mr. Alsup a very promising student.

Is the candidate free from personality handicaps which would make it difficult to obtain and hold a position giving him opportunity to utilize his abilities? Yes

Signed Harry T. Folger

Position or Title Professor of Biology

Address Fisk University, Nashville, Tennessee.

Date Jan. 6, 1938

(Please return to Raymond Paty, Director for Fellowships, Julius Rosenwald Fund, 4901 Ellis Avenue, Chicago, Illinois. Addressed, stamped envelope is enclosed.)

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JULIUS ROSENWALD FUND

4901 ELLIS AVENUE

CHICAGO

Confidential Report on Candidate for Fellowship

Name of Candidate Mr. Fred W. Alsup

Report Requested of Dr. L. V. Heilbrunn, Professor of Physiology, University of Pennsylvania, Philadelphia, Pennsylvania

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The above named candidate has applied to this Fund for a fellowship and has given your name as a reference. A statement of the candidate's plan of work is attached. Please return it with your statement.

We shall appreciate a frank statement of your opinion of this applicant's abilities and personal characteristics, and an appraisal of his plan of work. An early reply to this inquiry will be of great assistance in allowing the Fellowship Committee sufficient time for an adequate review of the large number of candidates who apply for grants.

Your reply will be held in strictest confidence.

Raymond Paty
Director for Fellowships

REPORT

Last summer I got to know Mr. Alsup at Woods Hole. At that time he was taking a course in embryology. During the summer I had occasion to talk with him a number of times. Obviously, it is not very easy to gauge a younger man's ability unless he is actually in the relation of student to teacher. Last summer I took occasion to consult with the men on the embryology teaching staff, and they spoke very favorably of Mr. Alsup. From what I have seen of him I should judge him to be intelligent, and I should be glad to have him as a student. Moreover, I like his personality, and I believe him to be honest and dependable.

The work that Mr. Alsup has been doing is interesting, and it will prepare him for the type of work that we do in this laboratory. I sincerely believe that if he were granted a fellowship he would do well here.

Sincerely,

L. V. Heilbrunn

L. V. Heilbrunn

OVER

Is the candidate free from personality handicaps which would make it difficult to obtain and hold a position giving him opportunity to utilize his abilities?

Signed_____

Position or Title_____

Address_____

_____ Date_____

(Please return to Raymond Paty, Director for Fellowships, Julius Rosenwald Fund, 4901 Ellis Avenue, Chicago, Illinois. Addressed, stamped envelope is enclosed.)

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A

JULIUS ROSENWALD FUND

4901 ELLIS AVENUE

CHICAGO

Confidential Report on Candidate for Fellowship

Name of Candidate Mr. Fred W. Alsup

Report Requested of Dr. H. B. Goodrich, Head of Zoology Department, c/o Marine Biological Lab., Woods Hole, Massachusetts

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The above named candidate has applied to this Fund for a fellowship and has given your name as a reference. A statement of the candidate's plan of work is attached. Please return it with your statement.

We shall appreciate a frank statement of your opinion of this applicant's abilities and personal characteristics, and an appraisal of his plan of work. An early reply to this inquiry will be of great assistance in allowing the Fellowship Committee sufficient time for an adequate review of the large number of candidates who apply for grants.

Your reply will be held in strictest confidence.

Raymond Patty
Director for Fellowships

REPORT

Dear Dr. Patty:

I knew Mr. Alsup last summer when he was a student in the embryology course at the Marine Biological Laboratory at Woods Hole, Massachusetts. His work was done thoroughly, and the informal record which we keep of student attainments would, I believe, place him in the first quarter of that class. You understand that the admittance to this course is competitive, and so I think that a placement in the first quarter means more than it might in many other places. He was thorough, careful, and industrious in his work. During such a short session (five and a half weeks) we do not have much opportunity to assess a student's ability in experimental work as most of ours is observational. So in this field, I cannot give you any complete judgment, merely my expectation based on other characteristics that he would at least be very painstaking and

OVER

not improbably an able investigator. Mr. Alsup was quiet and unassuming, and a thorough gentleman. I should rate him among the best of the Negroes who have taken any work at Woods Hole.

Is the candidate free from personality handicaps which would make it difficult to obtain and hold a position giving him opportunity to utilize his abilities?

I do not know of any, unless his retiring disposition could be counted as such, but quite possibly with a Negro this is an asset rather than a liability. It seems to us to be an asset at Woods Hole.

Signed H B Goodrich

Position or Title Professor of Zoology

Address Wesleyan University, Middletown Conn

Date Dec 24, 1937

(Please return to Raymond Paty, Director for Fellowships, Julius Rosenwald Fund, 4901 Ellis Avenue, Chicago, Illinois. Addressed, stamped envelope is enclosed.)

UNIVERSITY OF PENNSYLVANIA
PHILADELPHIA

THE COLLEGE February 25, 1939

Zoological Laboratory
38th St. and Woodland Ave.

Mr. George M. Reynolds,
4901 Ellis Avenue,
Chicago, Illinois,

Dear Mr. Reynolds:

Your request for a confidential report concerning Mr. Fred W. Alsup, addressed to Professor McClung, arrived here this morning. Unfortunately, Dr, McClung is on his way to South Africa and cannot readily be reached.

Mr. Alsup has been a graduate student in this department since last September and enrolled in Dr. McClung's course in Microscopic Anatomy. In Dr. McClung's absence I am taking over the work of the course. Mr. Alsup's showing was most excellent in the first semester's work. I believe he was the only colored man in a group of 35, and he received a grade of "A" which was as good as the achievement of even the most advanced of the graduate students in the course. We do not find, ordinarily, that our colored students make such good grades in this course, which requires the exercise of considerable judgment, and this is to me an indication that Mr. Alsup is of very much more than average ability among students of his race.

Very truly yours,

H Irene Corey.
Assistant to Dr. McClung

JULIUS ROSENWALD FUND

4901 ELLIS AVENUE

CHICAGO

Confidential Report on Candidate for Fellowship

Name of Candidate Mr. Fred Werthly Alsup

Report Requested of Dr. L. V. Heilbrunn

University of Pennsylvania

The above-named candidate has applied to this Fund for a fellowship and has given your name as a reference. The candidate's plan of work is attached. Please return it with your statement.

We shall appreciate your frank opinion of this applicant's abilities and personal characteristics, and an appraisal of his plan of work. *An early reply to this inquiry will be of great assistance in allowing the Fellowship Committee sufficient time for an adequate review of the large number of candidates who apply for grants.*

Your reply will be held in strictest confidence.

George M. Reynolds
Director for Fellowships

REPORT

Mr. F. W. Alsup came to Pennsylvania this fall. I have been very favorably impressed with him. At present he is taking my course in general physiology, and he is also beginning research. In the physiology course he is one of the best, if not the best, student in a group that includes about 20 graduates. He is unusually intelligent and shows originality, and, in addition, he is conscientious and industrious. On the whole I believe Mr. Alsup compares very favorably with any of the graduate students that I have had in recent years, and I have had a large number. He has a real research interest, and the results that he has obtained so far in his work look very promising.

All in all, therefore, I am glad to recommend him without reservation, and I hope that you will give his application serious consideration.

OVER

Is the candidate free from personality handicaps which would make it difficult to obtain and hold a position giving him opportunity to utilize his abilities?

I believe Mr. Bishop is free from such handicaps

Signed L. V. Heilbrunn

Position or Title Associate Professor of Zoology

Address Zoological Laboratory, University of Pennsylvania,

Philadelphia, Pa. Date March 7, 1939.

(Please return to the Director for Fellowships, Julius Rosenwald Fund, 4901 Ellis Avenue, Chicago, Illinois. Addressed, stamped envelope is enclosed.)

UNIVERSITY OF MICHIGAN
ANN ARBOR
DEPARTMENT OF CHEMISTRY

FELLOWSHIPS

Feb. 27, 1939

Mr. George M. Reynolds
4901 Ellis Avenue
Chicago, Illinois

Dear Sir:

Mr. F. W. Alsup completed an introductory course in organic chemistry during the summer of 1938 in which he received an A grade. My impression of Mr. Alsup was very favorable. He appeared to be capable and intelligent, industrious and interested in his work. I am glad to recommend him for your consideration.

Very truly yours,

C. S. Schoepfle

Chairman

CSSchoepfle/m

JULIUS ROSENWALD FUND

4901 ELLIS AVENUE

CHICAGO

Confidential Report on Candidate for Fellowship

Name of Candidate Mr. Fred Werthly Alsup

Report Requested of Dr. A. L. Ferguson

University of Michigan

The above-named candidate has applied to this Fund for a fellowship and has given your name as a reference. The candidate's plan of work is attached. Please return it with your statement.

We shall appreciate your frank opinion of this applicant's abilities and personal characteristics, and an appraisal of his plan of work. *An early reply to this inquiry will be of great assistance in allowing the Fellowship Committee sufficient time for an adequate review of the large number of candidates who apply for grants.*

Your reply will be held in strictest confidence.

George M. Reynolds
Director for Fellowships

REPORT Mr. F. W. Alsup had a course with me in elementary physical chemistry last summer and received an A-. However, I did not come to know the man well enough to pass judgment other than what the grade indicates.

OVER

Is the candidate free from personality handicaps which would make it difficult to obtain and hold a position giving him opportunity to utilize his abilities?

Signed A. L. Ferguson

Position or Title Associate Professor of Chemistry, Univ. of Michigan

Address Ann Arbor, Michigan

Date Mar. 20, 1939

(Please return to the Director for Fellowships, Julius Rosenwald Fund, 4901 Ellis Avenue, Chicago, Illinois. Addressed, stamped envelope is enclosed.)

Plan of Work and Report

I have done work in Physical and Organic Chemistry at the University of Michigan. This work at Michigan was taken to fit me better for my present work and studies in General Physiology here at the University of Pennsylvania. I am also taking an advanced course in Microscopic Anatomy, inasmuch as most of my research in General Physiology is concerned with cells. At the present time I am working on the first stage of my research and plan to submit my results for publication this school year. This present research is concerned with the effects of light on the colloidal properties of protoplasm. I am endeavoring to tie up my results with the theory of stimulation that has been advanced by Dr. L.V.Heilbrunn, and that is being well supported by the results of various types of experiments being done on the protoplasm of simple forms.

After I have completed my present work with light, I plan to work with alternating current alone, and then with the two stimulating agents together. Using the two together, I found peculiar sensitizing effects on the protoplasm of Amoebae and, as no explanations for these effects are offered in present day literature, I hope to find these explanations in terms of the colloidal properties of protoplasm.

Moreover, since the present day literature affords very little data on the colloidal properties of phagocytes of mammalian blood, I plan to use this type of material in later experiments.

Fred W. Alsup

JULIUS ROSENWALD FUND

4901 ELLIS AVENUE

CHICAGO

Confidential Report on Candidate for Fellowship

Name of Candidate Mr. Fred W. Alsup

Report Requested of Dr. C. V. McClung

University of Pennsylvania, Philadelphia

The above-named candidate has applied to this Fund for a fellowship and has given your name as a reference. The candidate's plan of work is attached. Please return it with your statement.

We shall appreciate your frank opinion of this applicant's personal characteristics and qualifications, and an appraisal of his plan of work and of his ability to make a noteworthy contribution in the field of study proposed. *An early reply to this inquiry will be of great assistance in allowing the Fellowship Committee sufficient time for adequate consideration of the large number of candidates who apply for grants.*

Your reply will be held in strictest confidence.

George M. Reynolds

Director for Fellowships

REPORT

Mr. Alsup shows an aptitude for biological work quite uncommon among colored students. I do not usually find that they take very well to research, but he has shown a good deal of initiative. His primary interest is in physiology and I am not closely in touch with his problem, though I know Dr. Heilbrunn thinks very favorably of his work. Concerning the value of this contribution, I am afraid you will have to depend on the opinion of others, since it is too far removed from my own field to enable me to give an adequate judgment. My principal association with Mr. Alsup was in a course in microscopic anatomy which he took with me. He was a good technician, a careful and cooperative worker, a good artist, and was an "A" student in this course. Although he has no drawbacks which would stand in the way of successful pursuit of a scientific career, I may say that he is much better than appears from one's first impressions and that the longer I know him, the more highly do I regard his efforts as compared with other negro workers in our Department.

OVER

Is the candidate free from personality handicaps which would make it difficult to obtain and hold a position giving him opportunity to utilize his abilities? Yes

Signed C. F. W. Kling

Position or Title Chairman, Department of Zoology

Address University of Pennsylvania, Philadelphia, Pa.

Date

Please return to the Director for Fellowships, Julius Rosenwald Fund,
4901 Ellis Avenue, Chicago, Illinois. Addressed, stamped envelope is enclosed.

JULIUS ROSENWALD FUND

4901 ELLIS AVENUE

CHICAGO

Confidential Report on Candidate for Fellowship

Name of Candidate Mr. Fred W. Alsup

Report Requested of Dr. D. H. Wenrich

University of Pennsylvania, Philadelphia

The above-named candidate has applied to this Fund for a fellowship and has given your name as a reference. The candidate's plan of work is attached. Please return it with your statement.

We shall appreciate your frank opinion of this applicant's personal characteristics and qualifications, and an appraisal of his plan of work and of his ability to make a noteworthy contribution in the field of study proposed. *An early reply to this inquiry will be of great assistance in allowing the Fellowship Committee sufficient time for adequate consideration of the large number of candidates who apply for grants.*

Your reply will be held in strictest confidence.

George M. Reynolds

Director for Fellowships

REPORT

Mr. Alsup has been a student in my course in protozoology during this past semester. He has shown himself to be a superior student and made the highest grade in the final examination. I have great confidence in his ability so far as it can be judged from the work he has done with me. I also feel that he has a personality that is excellent and that he should be successful in future professional activities.

I am not qualified to pass judgment upon his plan of research since this is not in my field. However, judging from his general qualifications, I should suppose that he would be very successful.

OVER

Is the candidate free from personality handicaps which would make it difficult to obtain and hold a position giving him opportunity to utilize his abilities?

Signed D. H. Wenrich

Position or Title Professor of Zoology

Address Zool. Lab., University of Pennsylvania, Philadelphia, Pa.

Date February 14, 1940.

Please return to the Director for Fellowships, Julius Rosenwald Fund,
4901 Ellis Avenue, Chicago, Illinois. Addressed, stamped envelope is enclosed.

UNIVERSITY OF PENNSYLVANIA
PHILADELPHIA

Fellows

THE SCHOOL OF MEDICINE

Department of Physiology

February 14, 1940

Mr. George M. Reynolds
Director for Fellowships
from the Julius Rosenwald Fund
Chicago, Ill.

Dear Sir:

I am sorry not to be able to give you the desired report concerning Mr. Fred W. Alsup. Mr. Alsup is attending my lectures, but that is all I can tell you about him. As far as I know, he does laboratory work with Dr. V. Heilbrunn in the Zoology Institute of this University, and I believe you can get from him a report.

sincerely yours

R. Höber

JULIUS ROSENWALD FUND

4901 ELLIS AVENUE

CHICAGO

Confidential Report on Candidate for Fellowship

Name of Candidate Mr. Fred W. Alsup

Report Requested of Dr. M. H. Jacobs

University of Pennsylvania, Philadelphia

The above-named candidate has applied to this Fund for a fellowship and has given your name as a reference. The candidate's plan of work is attached. Please return it with your statement.

We shall appreciate your frank opinion of this applicant's personal characteristics and qualifications, and an appraisal of his plan of work and of his ability to make a noteworthy contribution in the field of study proposed. *An early reply to this inquiry will be of great assistance in allowing the Fellowship Committee sufficient time for adequate consideration of the large number of candidates who apply for grants.*

Your reply will be held in strictest confidence.

George M. Reynolds

Director for Fellowships

REPORT

Mr. Alsup has been attending one of my graduate classes since last October, but inasmuch as the work so far has consisted entirely of lectures I have had no way of forming a first-hand opinion of his ability. Such reports as I have had of him from others have been favorable. I know that Professor L. V. Heilbrunn with whom he has been working thinks very highly of him, but you have doubtless already heard from Dr. Heilbrunn directly, or will in the near future.

OVER

Is the candidate free from personality handicaps which would make it difficult to obtain and hold a position giving him opportunity to utilize his abilities?

Signed M. H. Jacobs

Position or Title Professor of General Physiology

Address Univ. of Penna.

Date 2/12/40

Please return to the Director for Fellowships, Julius Rosenwald Fund, 4901 Ellis Avenue, Chicago, Illinois. Addressed, stamped envelope is enclosed.

JULIUS ROSENWALD FUND

ver 38+39 2000

Application for reappointment should be filed by February 15, 1940. Please attach six copies of a report of your progress under your present grant, and of your plan of work for the coming year.

Name Fred Werthly Alsup Fred Werthly Alsup

Present address 3626 Sansom Street, Philadelphia, Pennsylvania.

Permanent address 713 - 28th Avenue, North, Nashville, Tennessee.

Field Biology General Physiology (Cellular Physiology)

Concise statement of plan of work I wish to continue my work on the colloidal properties of protoplasm. I plan to study the changes produced in these properties by: Photodynamic action, alternating current alone and alternating current followed and preceded by light. I also wish to find out how variations in the composition of the surrounding media affect the peculiar actions of citrates on cells.

If fellowship is renewed, where and how do you propose to spend your time?

I plan to spend the summer of 1940 at the Marine Biological Laboratory and the rest of the school year, 1940-41, at the University of Pennsylvania. I shall devote most of my time to research. I shall complete work at the University on my PhD. degree.

Under whose supervision? Dr. L. V. Heilbrunn.

For what period are you requesting a renewal? Next school year, 1940-1941.

Present status of work toward degree I have completed my course work and experimental work on my thesis. I plan to take my preliminary and final examinations next year.

List as references persons under whom you have worked during your present fellowship

Dr. L.V. Heilbrunn, Dr. D. H. Wenrich, Dr. M.H. Jacobs and Dr. Hober, DR.C.V. McClung.

ALL THE ABOVE MENTIONED PERSONS ARE ON THE FACULTY OF THE UNIVERSITY OF PENNA.

PHILADELPHIA, PENNA.

Amount requested from the Fund $1000 (One Thousand Dollars)

Publications, if any, since you were awarded a fellowship "Photodynamic Action in the Eggs of Nereis" (Abstract) Full accounts of this and thesis work now being prepared for publication.

Are you applying elsewhere for a fellowship? If so, where? No.

Do you plan to return to your former position? No.

1940 JW

Name Fred Werthly Alsup **Field:** Biology

3628 Sansom Street
Philadelphia, Pennsylvania REAPPOINTMENT

Plan of Work

To continue work on the colloidal properties of protoplasm. I plan to study the changes produced in these properties by Photodynamic action, alternating current alone, and alternating current followed and preceded by light. I also wish to find out how variations in the composition of the surrounding media affect the peculiar actions of citrates on cells.

Wishes to spend summer of 1940 at Marine Biological Laboratory and balance of school year at University of Pennsylvania to complete work on Ph.D.

Personal Data Born Nashville, Tennessee, August, 1914. **Age:** 25
Married, one child.

Undergraduate Work Fisk University, A. B., 1934.

Graduate Work Fisk University, M. A., 1936.

University of Pennsylvania, 1938 -.

Experience Head, Science Department, Morristown College, Tennessee, 1936-38, $700.

Accomplishments

Publications: Article in Physiological Zoology.

Four undergraduate scholarships at Fisk, 1931-34, $150; two graduate fellowships, 1934-36, $300; two Rosenwald fellowships, 1938-39, 1939-40, total of $2000.

References
L. V. Heilbrunn
D. H. Wenrich
M. H. Jacobs
Dr. Hober
C. V. McClung
(all of University of Pennsylvania)

Budget Summary

Total Amount Needed	$1000.00
From Applicant	- - - -
From Fund	$1000.00

AMOUNT GRANTED

PROGRESS UNDER MY PRESENT GRANT

I have completed experimental work on several problems dealing with the effects of ordinary light on the colloidal properties of the cortex and inner portions of cells (Amoeba proteus and A. dubia). These experiments were performed on cells immersed: in normal culture media, in solutions containing singla cations (Potassium and Sodium), and in solutions (citrate) which removed Calcium from the cells. Ordinary light was found to affect protoplasm in ways different from all other stimulating agents that have been studied by other workers. The removal of calcium from the cells prevented the action of light on protoplasm. The results of these experiments are now being written up for early publication and as a thesis for the Ph.D. degree.

I am also writing up for early publication some experiments on Photodynamic Action in the eggs of Nereis limbata. The results of these experiments show that when cells immersed in solutions of fluorescent dyes are exposed to light, they become activated (cleave parthenogenetically), show nuclear breakdown, extrude cortical jelly and cytolyze. These photodynamic effects were found not to occur in the abscence of free oxygen, but to be increased by potassium cyanide, a salt which prevents cellular respiration. Quantitative data were obtained on the variation of photodynamic effects with concentration of dyes and length of exposure to light. These results were reported last summer at the General Scientific Meeting held at the Marine Biological Laboratory, Woods Hole, Mass. An abstract of this report may be found in the October issue of the Biological Bulletin.

I have fulfilled the foreign language requirements and the course requirements for the Ph.D. degree in General Physiology. I have been able to lead my classes.

I have been elected to membership in Sigma Xi, the National Honorary Scientific Society, and also to membership in the Philadelphia Physiological Society.

PLAN OF WORK FOR THE COMING YEAR

In some earlier experiments the results of which have already been published, I found that stimulation by light sensitizes an amoeba to subsequent stimulation by alternating current and vice versa. As was mentioned above, I have just completed experiments dealing with the effects of light on the colloidal properties of this simple protoplasm. I wish to carry out during the coming school year some experiments designed to show how these two stimulating agents when used together may affect the colloidal properties of protoplasm, and thereby get a better insight of the processes involved in the peculiar sensitization just mentioned.

My recent experiments indicate that ordinary light produces on protoplasm effects different from those produced by ultra-violet light. Photodynamic Action is in some respects similar that of ultra-violet light and I plan to see how far this similarity holds for effects of the two agents on colloidal properties of simple protoplasm

Although citrates usually prevent coagulation of blood, they are also known under certain conditions to favor coagulation of blood. Moreover, citrates may prevent cells from responding to stimulation, or they may themselves stimulate cells. In the course of my recent experiments I found that citrates sometimes decrease and sometimes increase the viscosity of protoplasm. No data are available in present day literature on how closely the peculiar effects of citrates are tied up with variations in the composition of the media surrounding cells. I hope to do some work on this problem.

Since I have completed my course requirements, I will spend the greater part of my time doing research work. Therefore, I shall be able to work on all of the problems that have developed from my previous work. I plan to spend the coming summer doing research at the Marine Biological Laboratory and shall spend the rest of the school year at the University of Pennsylvania. I will take my preliminary examinations in October, 1940 and my finals in May, 1941. I will get my Ph.D. degree from the University of Pennsylvania in June, 1941. In doing this I will be the first student under Dr. Heilbrunn to get the degree in as short a time as three years.

Fred W. Alsup

LETTERS OF REFERENCE

Fred W. Alsup

Dr. L. V. Heilbrunn, Associate Professor of Zoology, University of Pennsylvania, Philadelphia

Mr. Alsup is one of the ablest students I have had in recent years, and he shows a fine aptitude for research. I am therefore hoping that his fellowship will be extended.

Mr. Alsup's ability as a student is evidenced by the fact that he led his class in two graduate courses which he has taken here. These are the only two large graduate courses which Mr. Alsup has taken, and in both instances the competition was severe.

On the research side Mr. Alsup is unusually capable. He shows originality and he is able to think his problems through by himself. In addition he works very hard and his experimental technique in the laboratory is excellent.

- - - - -

Dr. D. H. Wenrich, Professor of Zoology, University of Pennsylvania

Mr. Alsup has been a student in my course in protozoology during this past semester. He has shown himself to be a superior student and made the highest grade in the final examination. I have great confidence in his ability so far as it can be judged from the work he has done with me. I also feel that he has a personality that is excellent and that he should be successful in future professional activities.

I am not qualified to pass judgment upon his plan of research since this is not in my field. However, judging from his general qualifications, I should suppose that he would be very successful.

- - - - -

Dr. C. E. McClung, Chairman, Department of Zoology, University of Pennsylvania

Mr. Alsup shows an aptitude for biological work quite uncommon among colored students. I do not usually find that they take very well to research, but he has shown a good deal of initiative. His primary interest is in physiology and I am not closely in touch with his problem, though I know Dr. Heilbrunn thinks very favorably of his work. Concerning the value of this contribution, I am afraid you will have to depend on the opinion of others, since it is too far removed from my own field to enable me to give an adequate judgment. My principal association with Mr. Alsup was in a course in microscopic anatomy which he took with me. He was a good technician, a careful and cooperative worker, a good artist, and was an "A" student in this course.

Although he has no drawbacks which would stand in the way of successful pursuit of a scientific career, I may say that he is much better than appears from one's first impressions and that the longer I know him, the more highly do I regard his efforts as compared with other Negro workers in our department.

- - - - -

Dr. M. H. Jacobs, Professor of General Physiology, University of Pennsylvania

Mr. Alsup has been attending one of my graduate classes since last October, but inasmuch as the work so far has consisted entirely of lectures I have had no way of forming a first-hand opinion of his ability. Such reports as I have had of him from others have been favorable. I know that Professor L. V. Heilbrunn with whom he has been working thinks very highly of him.

- - - - -

Dr. R. Hober, Department of Physiology, University of Pennsylvania

Mr. Fred W. Alsup is attending my lectures, but that is all I can tell you about him. As far as I know, he does laboratory work with Dr. Heilbrunn, and I believe you can get from him a report.

AM

JW

1939

24

JULIUS ROSENWALD FUND

(RENEWAL)

Age

Candidate Fred Werthly Alsup

Special Field Zoology

Graduate Student, University of Pennsylvania
3626 Sansom Street, Philadelphia

Plan of Work

I wish to continue my experiments designed to show how the peculiar sensitizing effects of light and current on protoplasm, that I have found, are related to the colloidal properties of cells. I wish to continue my studies in physiology.

Digest of Application

Born August, 1914, Nashville, Tennessee. Married, one child.

A. B. Fisk University, 1934. M. A. Fisk, 1936. Marine Biological Laboratory, Woods Hole, Massachusetts, summer, 1937. University of Pennsylvania, 1938 -.

Head, Science Department, Morristown College, Tennessee, 1936-38, $700.

Four undergraduate scholarships at Fisk, 1931-34 ($150); two fellowships for graduate work, 1934-36, ($300). Rosenwald Fellowship, $1938-39, $1000.

Has published this year, "Relation Between Responses of Amoeba Proteus to Alternating Electric Current and Sudden Illumination," - Jan. Physiol. Zool. 1939.

References

Dr. L. V. Heilbrunn, University of Pennsylvania
Dr. Schoeple, University of Michigan
Dr. A. L. Ferguson, University of Michigan
Dr. C. V. McClung, University of Pennsylvania

Budget Summary

Total amount needed	$ 1000
From applicant	- - -
From Fund	$ 1000

Committee Notes

Granted

Plan of Work and Report

I have done work in Physical and Organic Chemistry at the University of Michigan. This work at Michigan was taken to fit me better for my present work and studies in General Physiology at the University of Pennsylvania. I am also taking an advanced course in Microscopic Anatomy, inasmuch as most of my work in General Physiology is concerned with cells. At the present time I am working on the first stage of my research and plan to submit my results for publication this school year. This present research is concerned with the effects of light on the colloidal properties of protoplasm. I am endeavoring to tie up my results with the theory of stimulation that has been advanced by Dr. L.V.Heilbrunn, and that is being well supported by the results of various types of experiments on the protoplasm of simple forms.

After I have completed my present work with light, I plan to work with alternating currents alone, and then with the two stimulating agents together. Using the two together, I found peculiar sensitizing effects on the protoplasm of amoebae and, as no explanations of these effects are offered in the present day literature, I hope to find these explanations in terms of the colloidal properties of protoplasm.

Moreover, since the present day literature affords very little data on the colloidal properties of phagocytes of mammalian blood, I plan to use this material in later experiments.

Fred W. Alsup

LETTERS OF REFERENCE

Fred W. Alsup

Dr. H. Irene Corey, Assistant to Dr. McClung, Department of Zoology, University of Pennsylvania

Your request for a confidential report concerning Mr. Fred W. Alsup, addressed to Professor McClung, arrived here this morning. Unfortunately, Dr. McClung is on his way to South Africa and cannot readily be reached.

Mr. Alsup has been a graduate student in this department since last September and enrolled in Dr. McClung's course in Microscopic Anatomy. In Dr. McClung's absence I am taking over the work of the course. Mr. Alsup's showing was most excellent in the first semester's work. I believe he was the only colored man in a group of 35, and he received a grade of "A" which was as good as the achievement of even the most advanced of the graduate students in the course. We do not find, ordinarily, that our colored students made such good grades in this course, which requires the exercise of considerable judgment, and this is to me an indication that Mr. Alsup is of very much more than average ability among students of his race.

- - - - -

Dr. L. V. Heilbrunn, Associate Professor of Zoology, University of Pennsylvania

Mr. Alsup came to Pennsylvania this fall. I have been very favorably impressed with him. At present he is taking my course in general physiology, and he is also beginning research. In the physiology course he is one of the best, if not the best, student in a group that includes about 20 graduates. He is unusually intelligent and shows originality, and, in addition, he is conscientious and industrious. On the whole I believe Mr. Alsup compares very favorably with any of the graduate students that I have had in recent years,

and I have had a large number. He has a real research interest, and the results that he has obtained so far in his work look very promising.

All in all, therefore, I am glad to recommend him without reservation, and I hope that you will give his application serious consideration.

- - - - -

Dr. C. S. Schoepfle, Chairman, Department of Chemistry, University of Michigan

Mr. Alsup completed an introductory course in organic chemistry during the summer of 1938 in which he received an A grade. My impression of Mr. Alsup was very favorable. He appeared to be capable and intelligent, industrious and interested in his work. I am glad to recommend him for your consideration.

LETTERS OF REFERENCE

Fred Werthly Alsup

Dr. A. L. Ferguson, Associate Professor of Chemistry, University of Michigan

Mr. Alsup had a course with me in elementary physical chemistry last summer and received an A-. However, I did not come to know the man well enough to pass judgment other than what the grade indicates.

- - - -

DS

1938 JULIUS ROSENWALD FUND Age 23

Candidate Fred Werthly Alsup Special Field Zoology

Head of the Science Department, Morristown College
Morristown, Tennessee

Plan of Work

I am to work on the nature of response in animals with special emphasis on Amoeba and physiological problems under Dr. L. V. Heilbrunn at the Zoological Laboratory of the University of Pennsylvania. This work is to lead to the degree of Doctor of Philosophy.

Does not wish to return to present position but desires work in a college of higher rating where research work can be done.

Digest of Application

Born August,1914, Nashville, Tennessee. Married, one child.

Obtained A.B. from Fisk University, 1934; M.A. from the same school, 1936. Marine Biological Laboratory, Woods Hole, Massachusetts, summer,1937.

Graduate Assistant, Fisk University, Nashville, Tennessee, 1934-36, $15 month. Head of the Science Department, Morristown College, Morristown, Tennessee, 1936- , $700 year.

Sigma Gamma Pi, Fisk University Scholarship Society.

Work for Master at Fisk included original experimental work on the Relation of light and alternating current as shock agents in Amoeba proteus. This experimental work to be published the first of the year by one of the leading Zoological magazines of the country.

References

Four undergraduate scholarships at Fisk($150), 1931-34. Two Fellowships,$300, for graduate work, 1934-36.

Dr. H. B. Goodrich, Head,Zoology Dept. Woods Hole, Massachusetts.
Dr. L. V. Heilbrunn, Prof. Physiology, University of Pennsylvania
Dr. H. T. Folger,Head,Zoology Dept., Fisk University

Budget Summary

Total amount needed	$1112
From applicant	100
From Fund	$1000

Committee Notes

Granted

Statement of Plan of Work

My work is to be on one of the most baffling problems of modern physiology. I hope to add some thing to the presend day information about what effect stimulating agents have on the protoplasm of living cells. This work will of necessity involve work on simple forms that will live under the conditions of experiments involving stimulations by chemicals, ultra-violet light, electricity and similar agents. The protozoan Amoeba being one of the simplest and best animals for this sort of work will be used unless some of the other organisms to be used give better results. While at Fisk I did experiments on the relationships of shocks by light and alternating current on the protoplasm of Amoeba proteus. These experiments were very sucessful and suggested other problems whose solving should aid in understanding what is happening to protoplasm when it is stimulated.

I have been accepted by Dr. L. V. Heilbrunn of the University of Pennsylvania as a student. I shall be working toward the degree of Doctor of Philosophy. Dr. Heilbrunn is one of the pioneers in the field involving the study of changes in protoplasm upon stimulation. All my expermental work done at the University of Pennsylvaniawill be published as soon as it is deemed fit for such.

Any work that yields an explanation of how protoplasm is effected by stimulating agents will be of great value in the field of physiology. Since all protoplasm has very much the same constitution, results explaining how protoplasm is caused to respond and also to cease responding would have almost immeasurable value. I hope to pursue this provlem even more after I have finished my Doctorate and have learned more approaches to the problem.

Fred W. Alsop

Fisk University

NASHVILLE, TENN.

OFFICE OF THE REGISTRAR

Official Transcript of the Record of Fred Werthly Alsup

I. *Attendance:* Admitted Freshman Class of Fisk University (Name of School reporting) " Magna Cum Laude "

Attended—From Jan. 31 to June 34 Graduated June 13 34 Degree B A

II. *Present Status:* Graduate. Sept. 1934 to June 1936 " June 3, 1936 " M A.

III. *Entrance Units:* From Pearl High School, Nashville, Tennessee

SUBJECT	UNITS	SUBJECT	UNITS	SUBJECT	UNITS	SUBJECT	UNITS
English	3	Trigonometry		Commercial Law		Music	
Greek		Physics		Bookkeeping		Public Speaking	
Latin	2	Chemistry	1	Shorthand		Biology	1
French		Botany		Typewriting		Civics	
German		Zoology		Domestic Art		Other Subjects	
Spanish		Physiography		Domestic Science			
History	3	Geography		Mechanical Drawing			
Social Studies		Introductory Science		Industrial Training	1		
Algebra	1½	Physiology		Free Hand Drawing			
Geometry	1	Agriculture		Manual Training		TOTAL	15½

*Placement Examination required in this subject. Source of credit, Fisk High School. Units Estimated on basis of definition of the Carnegie Foundation.

How admitted: By examination and certification.

IV. *College Credits:*

COURSES	CATALOG NUMBERS	DESCRIPTIVE NAMES OF COURSES	QUARTER HOURS OF CREDIT AND GRADE I. QUARTER	II. QUARTER	III. QUARTER	IV. QUARTER	REC'S PER WEEK	Lab.Pds.per Wk. No.	Length
		Year 1930-31							
		Accepted from A & I State College, Nashville, Tennessee.							
		Education-Principles	3 Quarter Hours						
History	100	Early European		5-B			5		
Biology	102-3	General		5-A	5-A		2	3	110"
English	101	Rhetoric		5-B			5		
English	102	Written Composition			5-B		5		
Religion	100	General Survey			5-A		5		
Physical Ed		Physical Education		½-C	½-B		5		
		1931-32							
Biology	101	General	5-A				2	3	110"
French	101-2-3	Elementary	5-A	5-A	5-A		5		
Mathematics	101-2-3	Elementary Analysis	5-A	5-A	5-A		5		
English	120	Survey of English Lit		5-A			5		
Sociology	120	Introduction			5-A		5		
Physical Ed		Physical Education	½-B	½-C			5		

Total number of credits secured 180½ Qr Hrs / 52 Sem Hrs Number of credits required for graduation 180 Qr Hrs For M A -- 27 Sem Hrs

Grading System—Letter Average passing grade, C.

Each quarter is twelve weeks long.

This transcript issued December 6, 1937

x Mary D Shaw
Registrar.

HEMPHILL PRESS

Fisk University

NASHVILLE, TENNESSEE

OFFICE OF THE REGISTRAR

Official Transcript of the Record of Fred Werthly Alsup

IV. *College Credits*—Continued.

Courses	Catalog Numbers	Descriptive Names of Courses	Quarter Hours of Credit and Grade				Rec's Per Week	Lab. Pds. per week No. Length
			I. Quarter	II. Quarter	III. Quarter	IV. Quarter		
		Year 1932-33						
Education	100	Health Education	5-B				5	
Biology	107	Genetics	5-A				3	2-110"
Mathematics	113-14-15	The Calculus	5-A	5-A	5-A		5	
Biology	110	Invertebrate Zoology		5-A			2	3-110"
Philosophy	108	Ethics		5-A			5	
English	132	Types of the Novel			5-C		5	
B iology	109	Cytology & Histology			5-A		5	
Physical Ed		Physical Education		½-C			3	
		1933-34						
Psychology	101	General	5-A				5	
B iology	111	Vertebrate Zoology	5-A				5	
Physics	101-2-3	General	5-B	5-B	5-A		3	2-110"
Philosophy	100	Gen Problems of Philosophy	5-A				5	
Anthropology		Primitive Religion		5-A			5	
Biology	105-6	Botany		5-A	5-A		3	2-110"
Biology	108	Embryology		5-A			3	2-110"
Biology	112	Mammalian Physiology & Anatomy			5-A		3	2-110"
		Work done in Pursuit of the Master of Arts degree						
		1934-35						
Biology	204-5-6	Comparative Physiology	5-A	5-B	5-B		2	3-110"
Chemistry	101-2	General Inorganic	5-A	5-A			3	2-110"
German	101-2-3	Elementary	5-B	5-A	5-B		5	
Chemistry	103	Qualitative Analysis			5-A		2	3-110"
		1935-36	I Sem		II Sem			
Physics	211-12	Electrical Measurements	3-A		3-B		1	2-110"
Biology	391a-b	Investigations in Biology	5-A		5-A		2	3-110"
Mathematics	210	Topics: Adv Calculus	3-B				3	
Biology	104	Botany	3-A				2	1-110"

********** THE END **********

Total number of credits secured 180½ Qr Hrs ≠ 52 Sem Hrs

Number of credits required for graduation 180 Qr Hrs
For M A - 27 Sem Hrs

This transcript issued December 6, 1937

Mary D. Shaue
Registrar.

LETTERS OF REFERENCE

Fred W. Alsup

Dr. H. T. Folger, Head, Department of Zoology, Fisk University, Nashville, Tennessee

From the first day that Mr. Alsup entered my elementary course in Zoology, six or seven years ago, I have been aware that he is an outstanding student. He is industrious, intelligent, and has unusual power of concentration. A negro who aspires to a career in science faces certain peculiar difficulties, the most important of which, perhaps, is due to a lack of suitable positions available after one has completed his education. For this reason I have been somewhat reluctant to encourage students to continue into graduate work. But this man I have encouraged from the beginning. His training has been shaped definitely towards work in experimental biology.

He has proved an exceptional student in almost every course that he has taken, as his record will show. This record, I understand, is the best at Fisk, at least for many years.

In his graduate work here, he has shown an undoubted aptitude for research work. I reported in part the results of this work at the meeting of the American Society of Zoologists at Indianapolis, during the past holidays. An abstract of this paper, which is concerned with the effects of alternating electric current and light on Amoeba, has appeared in "Anatomical Record", vol. 70. His master's thesis is about ready for publication, and we expect to submit it to "Physiological Zoology" within a short time.

After the above account, it is perhaps superfluous to add that I consider Mr. Alsup a very promising student.

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(Letters of Reference, Fred W. Alsup)

Dr. L. V. Heilbrunn, Professor of Physiology, University of Pennsylvania, Philadelphia, Pennsylvania

Last summer I got to know Mr. Alsup at Woods Hole. At that time he was taking a course in embryology. During the summer I had occasion to talk with him a number of times. Obviously, it is not very easy to gauge a younger man's ability unless he is actually in the relation of student to teacher. Last summer I took occasion to consult with the men on the embryology teaching staff, and they spoke very favorably of Mr. Alsup. From what I have seen of him I should judge him to be intelligent, and I should be glad to have him as a student. Moreover, I like his personality, and I believe him to be honest and dependable.

The work that Mr. Alsup has been doing is interesting, and it will prepare him for the type of work that we do in this laboratory. I sincerely believe that if he were granted a fellowship he would do well here.

- - -

Dr. H. B. Goodrich, Head of Zoology Department, Marine Biological Laboratory, Woods Hole, Massachusetts

I knew Mr. Alsup last summer when he was a student in the embryology course. His work was done thoroughly, and the informal record which we keep of student attainments would, I believe, place him in the first quarter of that class. You understand that the admittance to this course is competitive, and so I think that a placement in the first quarter means more than it might in many other places. He was thorough, careful, and industrious in his work. During such a short session (five and a half weeks) we do not have much opportunity to assess a student's ability in experimental work as most of ours is observational. So in this field, I cannot

(Letters of Reference, Fred W. Alsup)

give you any complete judgment, merely my expectation based on other characteristics that he would at least be very painstaking and not improbably an able investigator. Mr. Alsup was quiet and unassuming, and a thorough gentleman. I should rate him among the best of the Negroes who have taken any work at Woods Hole.

HJ

May 7, 1941

Dear Mr. Alsup: Mr. Heilbrunn has written us concerning the new regulation requiring a deposit of one hundred dollars as a guarantee that your thesis will be published. Since we are naturally concerned that the work you have done at the University of Pennsylvania will be published, we are, at Mr. Heilbrunn's suggestion, adding one hundred dollars to your present grant in order that you may meet the requirement.

We are entirely sympathetic with Mr. Heilbrunn's request that funds be extended to you to enable you to engage in active research at Woods Hole this summer. We are sorry to say that our fellowships have been awarded for the year, and our free balance for emergencies is so small that we do not feel that we can place another commitment against it at this time.

Mr. Heilbrunn has said very nice things about your work at the University of Pennsylvania, and we are glad to have had a part in this additional preparation for your teaching career. All good wishes to you.

Sincerely yours,

WCH:MLU

Acting-Director
for Fellowships

Mr. Fred W. Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

April 18, 1940

Dear Mr. Alsup: It is a pleasure to inform you that you have been selected by the Committee on Fellowships of the Julius Rosenwald Fund to receive a renewal grant of one thousand dollars ($1,000) to assist you in carrying forward your studies in biology at the University of Pennsylvania during the year 1940-41.

Please let us know at once whether or not you can accept this grant. An official announcement of the Committee's selections for the year will be made soon and it can include only those from whom acceptances have been received.

Very truly yours,

GEORGE M. REYNOLDS

GMR:MLU

Mr. Fred Werthly Alsup
3626 Sansom Street
Philadelphia, Pennsylvania

April 12, 1939

Dear Mr. Alsup: It is a pleasure to inform you that you have been selected by the Committee on Fellowships of the Julius Rosenwald Fund to receive a renewal grant of One thousand dollars ($1,000) to assist you in carrying forward your study of zoology in accordance with the plan of work which you submitted to our Committee.

A plan covering the details of payments under this grant will be arranged to fit your particular needs.

Please let us know at once if you accept this grant. An official announcement of the Committee's selections for the year will be made soon and can include only those from whom acceptances have been received.

Very truly yours,

GMR:JW

GEORGE M. REYNOLDS

Mr. Fred W. Alsup
5626 Sansom Street
Philadelphia, Pennsylvania

FELLOWSHIPS

April 16, 1938

Dear Mr. Alsup: It is a pleasure to inform you that you have been selected by the Committee on Fellowships of the Julius Rosenwald Fund to receive a grant of One thousand dollars ($1,000) to assist you in carrying forward your study of zoology in accordance with the plan of work which you submitted to our Committee.

A plan covering the details of payments under this grant will be arranged to fit your particular needs.

Please let us know at once if you accept this grant. An official announcement of the Committee's selections for the year will be made soon and can include only those from whom acceptances have been received.

Very truly yours,

RAYMOND R. PATY

RP:MLU

Mr. Fred W. Alsup
Department of Science
Morristown College
Morristown, Tennessee

FELLOWSHIPS

ACCOUNT Negro Fellowships APPROPRIATION No. 36-31

NAME OF STUDENT Fred W. Alsup

ADDRESS

Institution Attending: University of Pennsylvania

INSTITUTION

RECOMMENDED BY Specific Field: Biology - zoology

STATEMENT OF OFFER

WCH to Mr. Alsup - 5/7/41: Extension

"Mr. Heilbrunn has written us concerning the new regulation requiring a deposit of one hundred dollars as a guarantee that your thesis will be published. Since we are naturally concerned that the work you have done at the University of Pennsylvania will be published, we are, at Mr. Heilbrunn's suggestion, adding one hundred dollars to your present grant in order that you may meet the requirement."

AMOUNT OF OFFER $100 PAYMENT DATES

CHECKS PAYABLE TO

TIME PERIOD OF OFFER

APPROVED BY AUTHORIZED BY

PAYMENTS

DATE	EXPLANATION	AMOUNT	DATE	EXPLANATION	AMOUNT

FELLOWSHIPS

ACCOUNT Negro Fellowships APPROPRIATION No. 39-7

NAME OF STUDENT Fred Werthly Alsup (Fred W. Alsup)

ADDRESS

INSTITUTION ATTENDING University of Pennsylvania

INSTITUTIONAL POSITION Head, Science Dept. Morristown College, Tennessee

SPECIFIC FIELD Zoology

STATEMENT OF OFFER

GMR to Mr. Alsup - 4/18/40 Renewal

"It is a pleasure to inform you that you have been selected by the Committee on Fellowships of the Julius Rosenwald Fund to receive a renewal grant of one thousand dollars ($1,000) to assist you in carrying forward your studies in biology at the University of Pennsylvania during the year 1940-41."

AMOUNT OF OFFER $1,000 PAYMENT DATES

CHECKS PAYABLE TO

TIME PERIOD OF OFFER Twelve months

APPROVED BY GMR AUTHORIZED BY EdE

PAYMENTS

DATE	EXPLANATION	AMOUNT	DATE	EXPLANATION	AMOUNT

ACCOUNT Negro Fellowships APPROPRIATION No. 38-9

NAME OF STUDENT Fred Werthly Alsup

ADDRESS

INSTITUTION ATTENDING University of Pennsylvania

INSTITUTIONAL POSITION Head, Science Dept. Morristown College, Tennessee

SPECIFIC FIELD Zoology

STATEMENT OF OFFER

GMR to Mr. Alsup - 4/12/39:

"It is a pleasure to inform you that you have been selected by the Committee on Fellowships of the Julius Rosenwald Fund to receive a renewal grant of One thousand dollars ($1,000) to assist you in carrying forward your study of zoology in accordance with the plan of work which you submitted to our Committee."

AMOUNT OF OFFER $1,000 PAYMENT DATES

CHECKS PAYABLE TO

TIME PERIOD OF OFFER One year

APPROVED BY [signature] AUTHORIZED BY

PAYMENTS

DATE	EXPLANATION	AMOUNT	DATE	EXPLANATION	AMOUNT

FELLOWSHIPS

ACCOUNT Negro Fellowships APPROPRIATION No. 37-8

NAME OF STUDENT Fred Worthly Alsup

ADDRESS

INSTITUTION ATTENDING University of Pennsylvania

INSTITUTIONAL POSITION Science Department, Morristown College, Morristown, Tennessee

SPECIFIC FIELD Zoology

STATEMENT OF OFFER

RP to Mr. Alsup - 4/16/38:

"It is a pleasure to inform you that you have been selected by the Committee on Fellowships of the Julius Rosenwald Fund to receive a grant of One thousand dollars ($1,000) to assist you in carrying forward your study of zoology in accordance with the plan of work which you submitted to our Committee."

AMOUNT OF OFFER $1,000 PAYMENT DATES

CHECKS PAYABLE TO

TIME PERIOD OF OFFER

APPROVED BY AUTHORIZED BY

PAYMENTS

DATE	EXPLANATION	AMOUNT	DATE	EXPLANATION	AMOUNT

THE EFFECTS OF LIGHT ALONE AND PHOTODYNAMIC ACTION ON THE RELATIVE VISCOSITY OF AMOEBA PROTOPLASM

FRED W. ALSUP

Reprinted for private circulation from
PHYSIOLOGICAL ZOÖLOGY, Vol. XV, No. 2, April 1942
PRINTED IN THE U.S.A.

FRED W. ALSUP

THE EFFECTS OF LIGHT ALONE AND PHOTODYNAMIC ACTION ON THE RELATIVE VISCOSITY OF AMOEBA PROTOPLASM[1]

FRED W. ALSUP[2]
Department of Zoölogy, University of Pennsylvania

THERE is virtually no evidence indicating the nature of the action of the longer waves of light on protoplasm. The small amount of information available on this subject is all the more noteworthy in view of the fact that protoplasm is almost continuously being exposed to the stimulating action of visible light. In their review of the literature on the action of radiation Heilbrunn and Mazia (1936) repeatedly point out that the living colloid is vastly different from any known inanimate colloid. Hence, information about the action of light on protoplasm is best obtained by direct study of protoplasm itself and not by inference from the known effects of light on proteins or other nonliving colloids.

Weber (1927), investigating the effects of direct sunlight on the cells of the plant *Ranunculus ficaria*, obtained results which indicate that the viscosity of the protoplasm is higher in the light than in the dark. However, as Weber himself noted, the increased viscosity might have been due to an indirect effect of the sunlight. Earle (1928) observed that, in general, when blood is illuminated the protoplasm of leucocytes is at first liquefied and then coagulated; but he was not certain that these changes were due to direct action of the light. On the basis of microscopic observations investigators have suggested that the cessation of protoplasmic streaming, observed when amoebae are suddenly exposed to intense light, is due to gelation of the cortical protoplasm, i.e., gelation of the plasmagel. There has, however, been no direct evidence in favor of this point of view.

It has been known since 1900 that various types of cells are markedly affected by the combined action of visible light and a sensitizing substance, i.e., by photodynamic action (see Raab, 1900; Blum, 1941; and Alsup, 1941). Yet, up to the present time, no experimental studies have been directly concerned with the effect of photodynamic action on the colloidal properties of protoplasm.

Since changes in the fluidity or viscosity of protoplasm cannot be detected with any great amount of certainty by microscopic observations, viscosity determinations are clearly necessary if one is to be certain of the effects of visible light and photodynamic action on the physical state of protoplasm.

Several reasonably accurate methods of measuring protoplasmic viscosity are available to students of protoplasm (see Heilbrunn, 1928). One of these, the centrifuge method, has been used extensively in determining the changes produced in the relative vis-

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cosity of cells by such stimulating agents as ultra-violet rays, X-rays, mechanical agitation, heat, electric current, and hydrostatic pressure. This method of studying protoplasmic viscosity can readily be applied to the two protozoan forms, *Amoeba proteus* and *A. dubia*, and has already given reliable data about the changes produced in the viscosity of their protoplasm by various stimulating agents (see Heilbrunn and Daugherty, 1931, 1932, 1933; and Angerer, 1936, 1937, 1940).

The essential properties of the protoplasm are the same in the two species; but centrifugal studies of *A. proteus* afford information about the viscosity of cortical protoplasm (plasmagel), whereas similar studies of *A. dubia* furnish data about the viscosity of the main mass of protoplasm (plasmasol). Both species respond to sudden illumination and photodynamic action by cessation or retardation of movement (see Mast, 1932; and Hyman and Howland, 1940); and, as was mentioned above, it has been suggested that these responses involve changes in the viscosity of the protoplasm (see Mast, 1932; Folger, 1925; and Alsup, 1939). The results that are presented in the following pages are primarily concerned with the effects of visible light alone and of photodynamic action on the relative viscosity of *Amoeba* protoplasm and have been obtained by centrifugal determinations.

MATERIALS AND METHODS

Amoeba proteus used in the experiments were taken from subcultures of strains originally obtained from either the Carolina Biological Supply Company or Dr. J. A. Dawson. All original cultures of *A. dubia* were obtained from Dr. Dawson. Most of the amoebae used were cultivated in glass bowls containing 30–100 cc. of a modified Ringer's solution (see Hopkins, 1926) or spring water, to which either raw hay and wheat (one grain) or two grains of rice had been added. Most of the modified Ringer's solution used was made up with water distilled in a metal still; for some of the later experiemnts this solution was made up with water which had been redistilled in a fused silica still. In the ordinary distilled water, cultures of amoebae grew well, but the protoplasmic viscosity appeared to be high. A few experiments were performed on amoebae that had been raised in culture solutions made by adding raw hay and wheat to water from the metal still or to boiled tap water. Cultures in excellent condition were continuously at hand.

The apparatus used in subjecting the amoebae to illumination consisted essentially of a compound microscope and a 1,000-watt Mazda electric bulb mounted in an asbestos-lined wood ventilating shaft. The microscope rested on a shelf situated below a circular aperture in the front wall of the shaft, 50 mm. in diameter. The microscope, with the substage condenser removed, was so placed and the substage mirror so adjusted that the image of the glowing bulb filament was reflected up through the stage. The intensity of the light (the brightest portion) just above the stage was found to be approximately 300,000-meter candles when measured with a Weston photometer. The electric current used in the bulb was drawn from a 115-volt alternating-current lighting circuit. During the experiments the temperature around the front wall of the shaft varied very little from that of the room in which the experiments were carried out. This constancy of temperature was obtained by allowing the light rays to pass through distilled water for absorption of heat and in most of the experiments by the additional cooling action of an electric fan situated in the ventilating shaft.

The relative viscosity of the plasmagel of irradiated and nonirradiated *A. proteus* was determined with an Emerson hand centrifuge. This instrument developed a centrifugal

force 2,474 times gravity when the handle was turned at the rate of one revolution per 2 seconds. Determinations of the relative viscosity of the plasmasol of *A. dubia* were made with an old-model Bausch and Lomb hand centrifuge of the same type as that employed by Heilbrunn and Daugherty (1931, 1933). A centrifugal force 512 times gravity was sufficient for determining the relative viscosity of the rather fluid plasmasol of *A. dubia*.

The centrifugal values that are recorded in this paper for *A. proteus* represent the smallest number of complete revolutions that the handle of the Emerson centrifuge had to be turned in order to shift the crystals of the plasmagel into one-half of the cell. The centrifuge values for *A. dubia* represent the shortest time in seconds required for the crystals of the plasmasol to move through one-half of the diameter of the cell under a centrifugal force 512 times gravity. The centrifuge values recorded for any given experiment were obtained only after a series of determinations. Definitive centrifuge values were not considered reached unless the crystals in at least 80 per cent of the specimens examined showed the specified degree of movement. Because of the differences in relative viscosity of amoebae from different cultures and because of the remarkable constancy of viscosity of amoebae from the same culture, the amoebae used in any given experiment were always taken from the same culture.

In those experiments in which amoebae were immersed in pure salt solutions before being irradiated and centrifuged, all speciments were washed at least once in the solutions. Those solutions whose effects on the action of light were to be tested were made up with Merck's blue-label salts and water, redistilled in the fused silica still.

Only two photodynamically active dyes, rose bengal and eosin, were used in the experiments designed to elucidate the effect of photodynamic action on the viscosity of the plasmagel and plasmasol. Both dyes were obtained from the Coleman and Bell Company. Stock solutions of each dye were made up in the proportions of 1 part dye to 2,000 parts modified Ringer's solution. In the experiments with eosin, only the stock solution was used. More dilute solutions of rose bengal were obtained by adding modified Ringer's solution to the stock solution.

In the course of each photodynamic experiment amoebae were transferred from the culture dish to a small Stender dish. Most of the culture fluid carried over in the transfer was removed by means of capillary pipettes, and then 10–25 cc. of the dye solutions were added in the dark to the dish. Amoebae were left in the dark in the various dye solutions for 1–6 hours before they were irradiated or centrifuged.

The amoebae to be studied were taken from the culture fluids or the experimental solutions and placed in glass centrifuge tubes by means of capillary pipettes. Those amoebae that were not to be irradiated were usually centrifuged immediately after being placed in the tubes. Pairs of tubes containing amoebae to be subjected to illumination were laid on the stage of the microscope in such a way that the organisms were directly over the brightest portion of the image of the bulb filament. In some experiments the pairs of tubes were held before the aperture in the front wall of the ventilating shaft so that they were directly in front of the glowing filament. Essentially the same results were obtained with these two methods of exposing amoebae to the light. The exposure time for most experiments was 2 minutes. The irradiated amoebae were centrifuged at various times after the exposures, depending on the type of experiment being done. All centrifuged amoebae were examined under a second microscope as fast as they could be removed from the centrifuge tubes to a glass slide on the stage of this microscope. In most

experiments the interval of time between the end of the centrifugation period and the beginning of the observation period did not exceed 10 seconds.

EXPERIMENTAL RESULTS

I. THE EFFECT OF LIGHT ALONE ON *Amoeba* PROTOPLASM

a) Changes in the viscosity of the plasmagel of A. proteus immersed in culture fluids and pure salt solutions.—When specimens of *A. proteus* immersed in culture fluids are exposed to intense visible radiation, the relative viscosity of the plasmagel is markedly increased. This is clearly shown by the data in Table 1. In this table each line is the summarized result of a series of tests on the effect of light on a given culture of amoebae. Normal centrifuge values for amoebae from various cultures generally fell be-

TABLE 1

THE ACTION OF LIGHT ON THE RELATIVE VISCOSITY OF THE PLASMAGEL OF *A. proteus* TESTED IMMEDIATELY AFTER IRRADIATION

(Time exposed to light, 2 minutes; temperature range, 19°–23° C.)

Expt. No.	Normal Centrifuge Value	Centrifuge Value after Exposure to Light	Percentage Increase in Viscosity after Exposure to Light	Expt. No.	Normal Centrifuge Value	Centrifuge Value after Exposure to Light	Percentage Increase in Viscosity after Exposure to Light
1	90	135	50	10	125	155	24
2	120	150	25	11*	120	190	58.3
3	65	90	38	12*	95	130	35
4	95	125	31.5	13	100	135	35
5	105	125	19	14	95	140	48
6	150	175	16.6	15	125	165	32
7	120	160	33	16	105	135	28.5
8	125	165	32	17	90	135	50
9	150	190	26.6				

* Time exposed to light, 1 minute.

tween 90 and 125. The centrifuge values of the irradiated amoebae are seen to be from 16.6 to 58.3 per cent greater than those for nonirradiated amoebae, with most of the values being about 30 per cent greater. The centrifuge tests on all irradiated amoebae considered in Table 1 were begun 7–10 seconds after the exposures, i.e., as fast as it was possible to place the tubes in the arms of the centrifuge.

Examination of the data in Table 2 shows that the increase in viscosity of the plasmagel, which can be detected in 7–10 seconds after the exposure of the amoebae to light, persists for a considerable length of time. The normal centrifuge values for amoebae from various cultures are given in the second column of this table. The third, fourth, fifth, sixth, seventh, and eighth columns contain the centrifuge values for amoebae from these cultures at various times after their irradiation. Upon comparing the values in the second column with those in the last six columns, it becomes evident that in all cases the viscosity did not return to the normal level until about 30 minutes after the exposures to light. Moreover, the viscosity values, 1, 5, and 15 minutes after irradiation, are seen to be approximately the same as those at the end of the regular 7–10-second period.

The experimental results given in Tables 1 and 2 were obtained with amoebae immersed in culture fluids which contained various inorganic and organic compounds. Heilbrunn and Daugherty (1932) have shown that each of the four common cations—namely, sodium, potassium, magnesium, and calcium—has a definite effect on the viscosity of the plasmagel of *A. proteus*. The chlorides of sodium, potassium, and magnesium decrease the viscosity of the plasmagel, whereas calcium chloride increases it. Since visible light alters the colloidal state of the plasmagel in the same direction that calcium does, quite logically the question arises as to whether calcium ions are involved in the gelating action of light. The answer to this question can be ascertained experimentally by determining the effect of light on the plasmagel of amoebae immersed either in a solution of a calcium-binding or of a calcium-removing substance, like ammonium oxalate, or in

TABLE 2

THE VISCOSITY OF THE PLASMAGEL OF *A. proteus* AT VARIOUS TIMES AFTER EXPOSURE TO LIGHT

(Time exposed to light, 2 minutes; temperature range, 18°–24° C.)

Expt. No.	Normal Centrifuge Value	Centrifuge Values after Exposures to Light					
		7–10 Seconds after Exposure	1 Minute after Exposure	5 Minutes after Exposure	15 Minutes after Exposure	30 Minutes after Exposure	45 Minutes after Exposure
1	105	135	145	148	148	108	105
2	110	165	168	165	168	115	105
3	90	138	145	140	135	95	100
4	60	85	85	90	85	70	70
5	110	140	145	140	145	120	118
6	115	160	165	165	165	135	120
7	95	120	125	128	120	100	95
8	95	115	115	115	120	95	95
9	55	70	70	75	68	55	55
10	120	155	155	160	155	120	130

solutions containing calcium-replacing ions, like sodium or potassium. In addition, experiments performed with amoebae immersed in pure solutions of sodium or potassium chloride should reveal whether these two cations bear any essential relationship to the effect of light on viscosity. Experiments designed to obtain answers to these questions were made, and the results obtained are presented in Tables, 3, 4, and 5.

Table 3 shows the effect of light on the viscosity of the plasmagel of amoebae immersed in a M/40 solution of potassium chloride. The fifth column of this table contains the centrifuge values for amoebae immersed in the solution but not irradiated, whereas the seventh column lists the centrifuge values for amoebae irradiated for 2 minutes after immersion in the potassium chloride solution for the lengths of time given in the sixth column. Upon comparing the values in the fourth and fifth columns with the normal centrifuge values given in the second column, it may be seen that the plasmagel is much more fluid after long immersions (45–90 minutes) in potassium chloride solution than after short immersions (15–45 minutes) in this solution. A comparison of the values in the fourth and fifth columns with those in the sixth and seventh columns, respectively,

reveals that light can increase the viscosity of the plasmagel after it has been lowered by short immersion in potassium chloride solution but not after it has been lowered further by long immersion in this solution.

As the results presented in Table 4 show, sodium bears essentially the same relationship to the action of light that potassium does. The viscosity of the plasmagel can be in-

TABLE 3

THE EFFECT OF LIGHT ON THE VISCOSITY OF THE PLASMAGEL OF *A. proteus* IMMERSED IN M/40 POTASSIUM CHLORIDE SOLUTION

Expt. No.	Normal Centrifuge Value	Centrifuge Value after Exposure to Light	Time in KCl in Minutes	Centrifuge Value after Exposure to KCl	Time in KCl in Minutes	Centrifuge Value after Exposure to Light and KCl
1	.....	.....	15–25	50	15–25	75
2	.....	.....	15–25	75	15–25	110
3	.....	.....	15–25	70	15–25	120
4	.....	.....	15–25	70	15–25	90
5	.....	.....	15–25	100	15–25	120
6	125	150	45	100	45	140
			120	50	125	50
7	150	170	15	135	20	140
			60	60	60	60
8	125	170	20	105	20	125
			90	35	95	35
9	105	135	20	70	20	90
			60	45	60	45
10	125	160	20	100	30	135
			45	45	45	55
11	140	210	15	110	15	165
			60	80	75	75
12	90	120	25	75	30	90
			90	65	90	60
13	75	95	15	55	15	65
			55	20	65	25
14	75	95	18	45	25	60
			60	30	60	33
15	132.5	165	25	120	25	120
			90	40	90	40

creased by irradiation following short immersion of the amoebae in M/40 sodium chloride but not by irradiation following long immersion in this concentration of sodium chloride. It is interesting to note that sodium is not so effective as potassium either in lowering the viscosity of the plasmagel or in preventing the gelating action of light. The gelating action of light is prevented only after the amoebae have been immersed in the sodium chloride solution for very long periods, usually 2–3 hours; and even after these long immersions the decrease in viscosity due to the sodium is often slight.

Heilbrunn and Daugherty (1933) found that if calcium is removed from the plasmagel by immersing amoebae in M/32 ammonium oxalate solution the viscosity of this protoplasmic region tends to be lowered very markedly. The results given in Table 5 of the

TABLE 4

EFFECT OF LIGHT ON THE VISCOSITY OF THE PLASMAGEL OF *A. proteus* IMMERSED IN M/40 SODIUM CHLORIDE SOLUTION

Expt. No.	Normal Centrifuge Value	Centrifuge Value after Exposure to Light	Time in NaCl in Minutes	Centrifuge Value after Exposure to NaCl	Time in NaCl in Minutes	Centrifuge Value after Exposure to NaCl and Light
1	45	65	30	37.5	45	45
			110	27.5	115	30
2	145	180	45	135	50	160
			75	127.5	80	120
3	125	162.5	50	125	60	150
			190	85	200	90
4	132.5	170	50	125	60	150
			110	95	118	100
5	140	175	35	120	43	140
			108	120	115	125
6	120	155	25	100	32	135
			130	95	120	90
7	70	90	40	75	35	95
			125	55	130	50
8	145	175	20	140	60	145
			150	110	160	115
9	125	155	35	120	45	150
			190	110	176	95
10	110	145	50	90	60	105
			120	85	110	90

TABLE 5

THE EFFECT OF LIGHT ON THE VISCOSITY OF THE PLASMAGEL OF *A. proteus* IMMERSED IN M/32 AMMONIUM OXALATE SOLUTION

Expt. No.	Normal Centrifuge Value	Centrifuge Value after Exposure to Light	Time in NH_4 Oxalate in Minutes	Centrifuge Value after Immersion in NH_4 Oxalate	Time in NH_4 Oxalate in Minutes	Centrifuge Value after Exposure to NH_4 Oxalate and Light
1	125	155	60	80	75	80
2	80	110	60	25	65	27
3	80	110	46	30	46	30
4	70	95	60	25	70	20
5	90	120	45	55	45	65
6	110	135	50	40	50	45
7	105	135	76	55	70	60
8	75	110	30	35	80	30
9	105	135	72	30	80	30
10	80	110	50	25	55	23
11	80	125	6	35	8	35
12	135	175	8	45	12	40

present paper are in accord with this finding. Moreover, the data recorded in this table show quite clearly that visible light cannot gelate the plasmagel of amoebae immersed in oxalate solution, even though the immersion periods be relatively short.

b) Changes in the viscosity of the plasmasol of A. dubia immersed in culture fluids and pure salt solution.—Up to this point we have been concerned with the effect of light on the viscosity of the plasmagel of *A. proteus*. As mentioned above, the study of protoplasmic viscosity in amoebae has a particular advantage in that it is possible to determine not only the viscosity of the cortex or plasmagel but also that of the interior protoplasm or plasmasol. It should, therefore, be possible to discover whether exposure to intense light has any effect on the relative viscosity of the plasmasol of *A. dubia*. Such was, indeed, found to be the case, as is shown by the data in Table 6.

TABLE 6

THE EFFECT OF LIGHT ON THE RELATIVE VISCOSITY OF THE PLASMASOL OF *A. dubia*

(Temperature, 20°–25° C.)

Expt. No.	Normal Centrifuge Value	Centrifuge Value after Exposure to Light	Exposure Time in Minutes	Percentage Increase in Viscosity after Exposure to Light
1	9	22	2	140
2	7	5	2	— 28
3	4	11	2	175
4	10	23	2	130
5	4	7	2	75
6	2	4	2	100
7	9	21	2	132
8	7	17	2	143
9	5	11	3	120
10	13	25	2	92
11	6	11	3	83
12	5	15	4	200
13	10	21	4	110
14	5	16	2	220
15	6	6	3	0

Comparison of the values in the second and third columns of this table shows that visible radiation has a real gelating effect on the plasmasol. After irradiation the centrifuge values of the plasmasol of the amoebae considered in this table showed an average increase of 123 per cent over the normal values when intervals of 7–10 seconds elapsed between cessation of irradiation and the beginning of the centrifuge tests. In a few (five) experiments determinations of the centrifuge values were begun 30, 120, and 180 seconds after the cessation of irradiation. The increases in centrifuge values detected after these longer intervals were of the same order of magnitude as those noted after the regular 7–10-second intervals. In other words, the centrifuge values remained constant at the increased values at least until an interval of 180 seconds had elapsed between cessation of irradiation and beginning of centrifugation.

In the case of the plasmagel, it has been seen that calcium which itself gelates the

plasmagel is essential for the gelating action of light on the plasmagel. Calcium tends to make the plasmasol less viscous, although in excess it presumably makes it more viscous (Heilbrunn and Daugherty, 1933). This being true, it seemed worth while to find out what effect removal of cacium from the plasmasol has on the gelating action of light. However, before considering experimental data bearing on this question, it should be mentioned that the removal of calcium from the interior of an amoeba is probably a more complex operation than the removal of calcium from the cortex of an amoeba. It seems reasonable to suppose that oxalate produces few, if any, secondary effects when it removes calcium from the outer portion of a cell; but this is most likely not the case when

TABLE 7

THE EFFECT OF LIGHT ON THE VISCOSITY OF THE PLASMASOL OF *A. dubia* IMMERSED IN M/32 AND M/40 AMMONIUM OXALATE SOLUTIONS

Expt. No.	Normal Centrifuge Value	Centrifuge Value after Exposure to Light	Time in NH_4 Oxalate in Minutes	Centrifuge Value after Exposure to NH_4 Oxalate	Time in Oxalate in Minutes	Centrifuge Value after Exposure to NH_4 Oxalate and Light	Concentration of NH_4 Oxalate
1	7	12	50	3	45	3	M/32
2	10	20	60	8	60	8	M/32
3	2	4	75	4	60	4	M/32
4	15	31	20	20	25	20	M/32
5	17	22	55	26	65	20	M/32
6	8	16	15	4	22	3	M/32
			100	4	103	3	M/32
7	8	15	50	11	60	8	M/32
8	4	8	15	10	20	9	M/32
9	5	8	45	4	55	4	M/32
			130	4	125	4	M/32
10	9	16	70	11	75	11	M/40
11	7	13	45	6	55	5	M/40
			105	6	100	5	M/40
12	10	18	60	4	67	4	M/40
13	12	19	80	13	90	12	M/40
14	10	20	75	5	65	5	M/40

oxalate must remove calcium from the cell interior. A good indication that the removal of calcium from the interior of an amoeba is not a simple process comes from the experimental finding that ammonium oxalate has a variable effect on the viscosity of the plasmasol of *A. dubia*. This is seen when the values in the second column of Table 7 are compared with those in the fifth column of the same table. In some experiments the oxalate lowered, in others increased, and in still others had little effect on the viscosity of the plasmasol. Since the amoebae used in the experiments reported in Table 7 had been raised in culture fluids which varied considerably in electrolyte content, it seemed possible that the manner in which ammonium oxalate affects the viscosity of the plasmasol is, to a large extent, determined by the electrolytes present in the original environment of the amoebae. Indeed, some preliminary experiments indicate that this is true and that calcium and magnesium ions in the culture fluids are the ions of primary importance in determining just how oxalate will affect the viscosity of the plasmasol.

Even though it is not clear just what secondary effects oxalate may have on the interior of an amoeba, there can be little doubt that oxalates prevent the free movement of calcium in a cell. Therefore, if oxalate solutions have a consistent effect on the gelation of the plasmasol by visible light, one can safely attribute this effect to the binding or removal of free calcium. Ammonium oxalate does have a consistent effect on the gelating action of light on the plasmasol of *A. dubia*. It prevents the action of light. This may be seen from the data in Table 7. In this table the centrifuge values of the irradiated oxalated amoebae must be compared not with the centrifuge values of the normal amoebae but with the centrifuge values of the control oxalated amoebae which were not subjected to radiation. These values are given in the fifth and seventh columns. A comparison shows that irradiation produces no appreciable increase in the viscosity of oxalated amoebae. Thus the gelation of plasmasol by light, as well as the gelation of the plasmagel by light, is dependent upon the presence of free calcium in the amoebae.

II. THE EFFECT OF PHOTODYNAMIC ACTION ON *Amoeba* PROTOPLASM

As mentioned above, fluorescent dyes, like rose bengal and eosin, make various types of cells more sensitive to visible light. Amoebae immersed in weak solutions of rose bengal or eosin are readily cytolyzed by short exposure to intense light, whereas amoebae immersed in culture solutions are not killed by prolonged exposures to light of the same intensity. In the dark, weak solutions of rose bengal and eosin are relatively nontoxic to amoebae. This is evident inasmuch as amoebae live as long as a week in such solutions. Thus, when acting alone, intense light and weak dye solutions have little or no injurious effects on amoebae; but when acting together, i.e., photodynamically, these two agents very soon cause the death of the amoebae.

The effects of weak solutions of the two photodynamically active dyes and photodynamic action on the protoplasm of *A. proteus* and *A. dubia* have been studied, and the results obtained are considered in the two following sections of this paper.

a) Changes in the viscosity of the plasmagel of A. proteus immersed in weak solutions of rose bengal and eosin.—Table 8 summarizes the results of a series of tests on the effects of photodynamically active dyes and photodynamic action on the relative viscosity of the plasmagel of *A. proteus*. In this table the second and third columns, respectively, give the centrifuge values for nonirradiated and irradiated control amoebae immersed in culture fluids. The centrifuge values of amoebae immersed in dye solutions but not irradiated are given in the sixth column. The last column of the table gives the centrifuge values of amoebae exposed for 2–5 minutes to light from the 1,000-watt bulb after having been immersed in the dye solutions for the time given in the seventh column. It can be seen at a glance that in every case exposure to photodynamic action causes a drop in the centrifuge value of the plasmagel. On the average, the centrifuge value of the plasmagel of amoebae exposed to light while immersed in dye solutions is 23 per cent lower than that of normal amoebae. Comparison of the values in the sixth column with those in the second column brings out the interesting fact that amoebae immersed for 2–6 hours in the dark in 1:10,000 and 1:50,000 rose bengal and in 1:2,000 eosin have practically the same centrifuge values as normal amoebae. In other words, the dyes alone have little or no effect on the viscosity of the plasmagel. Thus, when acting separately, light and the dyes respectively increase and leave unaltered the viscosity of the plasmagel of *A. proteus* but, when acting together, cause a real liquefaction of the plasmagel.

This liquefaction of the plasmagel persists for quite some time after the exposures to photodynamic action. In all of the experiments listed in Table 8 the centrifuge values were determined 7–10 seconds after the exposures. In nine of these experiments a second set of centrifuge values was determined 4–15 minutes after the exposures. In each of these nine cases the centrifuge values were approximately the same after the longer intervals as after the regular 7–10-second intervals. It is interesting to note that normal protoplasmic flow usually began immediately after the short exposures were over.

b) Changes in the viscosity of the plasmasol of A. dubia immersed in weak solutions of rose bengal and eosin.—Table 9 presents the results obtained from fourteen experiments designed to ascertain what effect the two dyes, rose bengal and eosin, have on the viscos-

TABLE 8

THE EFFECT OF PHOTODYNAMIC ACTION ON THE VISCOSITY OF THE PLASMAGEL OF *A. proteus*

Expt. No.	Normal Centrifuge Value	Centrifuge Value after Exposure to Light Alone	Concentration of Dye*	Time in Dye in Minutes	Centrifuge Value after Exposure to Dye Alone	Time in Dye in Minutes	Centrifuge Value after Exposure to Dye and Light
1	85	110	1:50,000	140	85	130	60
2	120	150	1:50,000	175	112.5	165	80
3	50	65	1:50,000	105	57.5	120	37.5
4	145	175	1:50,000	190	142.5	200	105
5	160	190	1:50,000	165	160	175	115
6	45	60	1:50,000	90	42.5	120	32.5
7	122.5	165	1:50,000	135	135	140	90
8	80	105	1:50,000	180	85	200	67.5
9	65	95	1:50,000	110	55	120	35
10	175	230	1:10,000	110	175	115	105
11	300	410	1:10,000	100	320	180	240
12	80	95	1:10,000	180	75	175	50
13	95	120	1:10,000	300	120	305	75
			1:2,000 E†	340	100	355	75
14	165	205	1:10,000	305	170	315	115
			1:2,000 E†	285	165	275	120

* Concentration of rose bengal expressed as ratio of parts of dye to parts of modified Ringer's solution.
† Concentration of eosin expressed as ratio of parts of dye to parts of modified Ringer's solution.

ity of the plasmasol of *A. dubia* when acting alone and in combination with light from the 1,000-watt bulb. The procedure for these experiments was identical with that for the experiments just described, except that the smaller hand centrifuge was used to measure the relative viscosity of the rather fluid plasmasol. The data in Table 9 are arranged in exactly the same manner as those in Table 8. Examination of Table 9 shows that the results obtained with *A. dubia* are quite similar to those obtained with *A. proteus*. The average centrifuge value of the plasmasol of amoebae immersed for 1–5 hours in the dark in 1:10,000 and 1:50,000 rose bengal and 1:2,000 eosin is approximately the same as that of normal amoebae. The centrifuge values of the plasmasol of amoebae exposed to light for 0.5–2.0 minutes while immersed in the dye solutions are seen to be lower than those of normal amoebae. On the average, the centrifuge value of the plasmasol of amoebae exposed to photodynamic action is only a little over a half that of normal

amoeba. It should be noted that photodynamic action lowers the viscosity of the plasmasol of *A. dubia* much more sharply than it does that of the plasmagel of *A. proteus*. Moreover, just as was true for the plasmagel, the drop in viscosity of the plasmasol, which can be detected in 7–10 seconds after the exposure to photodynamic action, persists for considerable lengths of time (4–28 minutes) after the exposure. Protoplasmic flow usually began soon after the exposure was over.

TABLE 9

THE EFFECT OF PHOTODYNAMIC ACTION ON THE RELATIVE VISCOSITY OF THE PLASMASOL OF *A. dubia*

Expt. No.	Normal Centrifuge Value	Centrifuge Value after Exposure to Light Alone	Concentration of Dye*	Time in Dye in Minutes	Centrifuge Value after Exposure to Dye Alone	Time in Dye in Minutes	Centrifuge Value after Exposure to Dye and Light
1	5	10	1:50,000	180	6	180	2.5
2	13	.....	1:50,000	200	12	210	9
3	10	14	1:50,000	240	10	260	7
4	2	5	1:50,000	280	2	300	1
5	11	16	1:50,000	160	9	180	5
6	9	14	1:50,000	150	9	130	5
7	11	16	1:50,000	200	12	200	5
8	12	16	1:50,000	120	12	130	6
9	12	17	1:50,000	150	12	170	5
10	9	16	1:50,000	120	9	180	7
11	11	16	1:50,000	210	11	220	7
			1:10,000	194	11	190	5
			1:2,000 E†	132	11	198	6
12	10	10	1:50,000	250	10	260	5
13	6	8	1:50,000	220	6	280	3
			1:10,000	250	6	290	2
			1:2,000 E†	305	6	270	3
14	4	8	1:10,000	100	4	120	2
			1:2,000 E†	100	5	180	2

* Concentration of rose bengal expressed as ratio of parts of dye to parts of modified Ringer's solution.

† Concentration of eosin expressed as ratio of parts of dye to parts of modified Ringer's solution.

DISCUSSION

It is interesting to note that, whereas light and photodynamic action have consistent effects on both the plasmagel and the plasmasol of amoebae—light causing gelation and photodynamic action a liquefaction of each of these regions—this is not true for stimulating agents like ultra-violet light, mechanical agitation, and electric current. The latter three stimulating agents have been found to solate, as well as gelate, the plasmasol of *A. dubia* and to cause only a liquefaction of the plasmagel of *A. proteus* (see Heilbrunn and Daugherty, 1933; and Angerer, 1936 and 1937). However, visible light and ultra-violet do have one property in common: neither of these two stimulating agents can alter the viscosity of the plasmagel or plasmasol of oxalated amoebae. In view of the fact that oxalates remove calcium from protoplasm, the conclusion has been drawn that calcium must be essential for the actions of visible and ultra-violet light on amoeba protoplasm. Although no study has been made of the effect of photodynamic action on

the viscosity of the protoplasm of oxalated amoebae, some experimental results obtained with the eggs of *Nereis limbata* indicate that photodynamic effects are also conditioned by the removal of calcium from cells (see Alsup, 1941). Doubtless, factors other than calcium are involved in the liquefying and gelating effects of photodynamic action and visible light, respectively; but my results indicate that any explanation of the stimulating action of these two agents must take into consideration the role of calcium. Therefore, it appears worth while to discuss the experimental results presented in this paper from the standpoint of Heilbrunn's calcium-release theory of general stimulation (see Heilbrunn, 1937).

This theory holds that ordinary stimulating agents cause the breakdown of a cortical calcium-containing gel, with the resultant passage to the cell interior of free calcium ions. It is assumed that this release of calcium from the cortical protoplasm or plasmagel occasions the liquefaction of this layer and that the released calcium upon entering the interior of the cell causes first a liquefaction and then a gelation of the inner protoplasm (plasmasol). My results indicate that calcium is involved in the action of visible light on amoeba protoplasm, but they show clearly that light does not produce the shift of calcium ions which results in such a series of viscosity changes in amoeba as is outlined by the calcium-release theory. Intense visible radiation causes a gelation of both the cortical and the interior protoplasm of the amoeba. Now, if calcium is responsible for the stiffening of the plasmagel of the amoeba, this would seem to indicate that light is able to release calcium from some combination in the interior of the amoeba. In other words, it appears that in the amoeba there is a source of calcium other than the one in the cortex, a source that light may be able to affect because of its ability to penetrate the protoplasm of the amoeba. If there is a source of calcium in the interior of the amoeba, light might be expected to release calcium from this source and thereby effect a gelation of the plasmagel even when the calcium content of this outer region has been reduced by immersion in calcium-free solutions. Eventually, the calcium content of the interior would also be reduced, and then the light should no longer be able to gelate the plasmagel. Actually, experimental evidence which seems to support this notion has been obtained with amoebae immersed in pure solutions of potassium and sodium chloride. Light can gelate the plasmagel of amoebae that have been immersed in pure potassium or sodium chloride solutions for short periods of time, during which the potassium or sodium probably replaces only the calcium in the cortex of the amoebae. However, when the amoebae have been in either of these two solutions long enough for most or all of their calcium to be replaced, light is ineffective in gelating the plasmagel. Moreover, it is interesting to note that ammonium oxalate solution, which presumably is much more efficient than potassium or sodium chloride solutions in reducing the calcium content of amoebae, is much more efficient in preventing the gelating action of light on the plasmagel. Thus it seems that there is a source of calcium in the interior of amoebae which persists for some time after calcium in the cortical protoplasm has been replaced. It is possible, of course, to propose alternative theories, and the gelation of the plasmagel of amoebae may be dependent on factors other than calcium; but, as far as these experiments go, they indicate that calcium is involved in one way or another. At present there is no definite evidence as to the nature of any calcium combination in the interior of an amoeba that might be affected by light. It may well be that one of the many types of crystals which can be seen in the protoplasm of amoebae (cf. Pollack, 1928; and Schewiakoff, 1893) is a source of calcium.

Some of the results presented in the body of this paper show clearly that photody-

namic action tends to liquefy the protoplasm in the interior, as well as that at the surface, of amoebae. These liquefying effects cannot be due to light alone or to the dye solutions alone, since, as has been shown, light causes gelation of the two protoplasmic regions of the amoeba and since the dye solutions used in these experiments have practically no effect, in the dark, on the viscosity of amoeba protoplasm. This being true, it becomes a question of just how the combined action of light and rose bengal or eosin can effect a liquefaction of amoeba protoplasm. According to the calcium-release theory, a liquefaction of the plasmagel indicates a release of calcium from a cortical gel or proteinate, whereas a liquefaction of the plasmasol indicates that only small amounts of the calcium released by the stimulant is reaching the interior of the amoeba. In view of the fact that phthalein dyes, like rose bengal and eosin, have a great affinity for proteins (see Rosenthal, 1926), it appears feasible that the dyes could combine with a cortical calcium proteinate and thus sensitize it to light. Exposure to light might then result in the release of calcium from the proteinate, with subsequent liquefaction of the plasmagel. But, what about the liquefying effect of photodynamic action on the plasmasol? Here the main question is whether or not in the light the dyes pass into the cell interior. If the dyes do not get any farther than the cortex, some of the dye molecules—those not already combined with protein—may form calcium bengalate or eosinate with the calcium that has been released from any part of the cell. Thus, only a small amount of calcium would enter or remain free in the interior of the amoeba, and this would result in a liquefaction of the plasmasol (see Heilbrunn, 1928). On the other hand, if the dye molecules readily enter amoeba protoplasm under the influence of light, they might keep the free calcium content of the plasmasol low by tying up most of the calcium as calcium bengalate or eosinate, even though considerable amounts of calcium had been released. Obviously, the validity of either of these proposed mechanisms for photodynamic action on the viscosity of amoeba protoplasm depends upon the ability of calcium to combine with dyes under such conditions as exist in amoeba protoplasm. Although any definite proof of this point must come from future experiments, it should be noted that acid phthalein dyes do combine with calcium (see Beacall, 1926). In any case, my results indicate that only a small amount of any calcium released in amoebae by photodynamic action remains free to produce changes in the viscosity of the protoplasm.

As was mentioned above, the experiments on amoebae represent the first direct study of the effects of photodynamic action on the viscosity of protoplasm. Obviously, the question as to whether photodynamic action in general has a liquefying effect on the physical state of protoplasm can be answered only after more such direct studies have been made. However, some experiments done on the unfertilized eggs of *N. limbata* indicate a negative answer to this question. Citrates and oxalates, which presumably remove calcium from the cortex as well as bind free calcium inside the eggs, tend to prevent photodynamic action and other stimulating agents from producing germinal-vesicle breakdown in the eggs (see Alsup, 1941; Heilbrunn and Wilbur, 1937; and Wilbur, 1941). In other words, photodynamic action seems to produce germinal-vesicle breakdown only when the calcium content of the cortex has not been greatly reduced and when most of the calcium released to the interior of the egg remains free. Such a penetration of free calcium to the interior of the egg would, on the basis of the calcium-release theory, entail a gelation of the internal protoplasm—a situation that would be directly opposed to that which seems to obtain for amoeba protoplasm. Thus it seems probable that photo-

dynamic action can either increase or decrease the viscosity of protoplasm, depending on which living system is involved.

Should viscosity studies show that photodynamic action actually does gelate the protoplasm of such living systems as marine eggs, the mechanism involved would not necessarily have to be different from one of those proposed in this paper for the liquefying action of light-activated dye molecules on amoeba protoplasm. Activated dye molecules which seem to tie up free calcium might act on marine eggs in much the same way that dilute solutions of citrates and oxalates do. Wilbur (1941) found that solutions of the latter two calcium-binding substances can produce germinal-vesicle breakdown as well as prevent its production by stimulating agents. Thus, substances which remove calcium from protoplasm and prevent stimulation (gelation of internal protoplasm) can, under some conditions, act as stimulating agents, i.e., cause gelation of internal protoplasm. At present no satisfactory explanation is available for this twofold action of citrates and oxalates. In the case of photodynamic action it might merely be a matter of the degree to which activated dye molecules penetrated the protoplasm. Gelation of internal protoplasm by photodynamic action might mean that few activated dye molecules were entering the cortex or interior of the cells, and thus few of them would be available to tie up any free calcium in the cells. At any rate, it must be mentioned again that more investigations are needed before any of these suggestions as to the relationship of activated dye molecules to free calcium can be accepted.

It has frequently been pointed out that the colloidal behavior of protoplasm is similar to the colloidal behavior of vertebrate blood (see Heilbrunn, 1937, 1940); and, indeed, in both cases calcium is intimately concerned with the mechanism of gelation or clotting. It is interesting to note that the liquefying effect of photodynamic action on amoeba protoplasm finds a parallel in photodynamic studies of blood. Howell (1921) and Sellards (1918) find that blood-clotting is prevented by photodynamic dyes in the presence of light.

SUMMARY

1. Centrifuge tests on *A. proteus* show that intense artificial illumination increases the viscosity of the plasmagel approximately 30 per cent. This increase in viscosity can be detected within 10 seconds after the exposure and persists for over 15 minutes.

2. Calcium is essential for this gelating action, since light does not increase the viscosity of the plasmagel of oxalated amoebae.

3. In pure solutions of potassium or sodium chloride the effect of light depends upon the period of immersion. After relatively short immersions light increases the viscosity of the plasmagel, whereas after long periods it cannot do so. This is interpreted to mean that light can release calcium from a source in the interior of the amoeba after it has been removed from the cortex by the action of these salts.

4. The plasmasol or inner protoplasm of *A. dubia* is also gelated by short exposures to intense visible radiation. This effect can be detected within 10 seconds after the exposure and persists for at least 3 minutes.

5. The gelating action of light on the plasmasol is prevented by the removal of calcium from the amoeba.

6. In strengths of 1:50,000 and 1:10,000 rose bengal has no effect in the dark on the viscosity of either the plasmagel or the plasmasol of amoeba. Eosin in a strength of 1:2,000 also produces, in the dark, no changes in the viscosity of amoeba protoplasm.

7. Light acting in combination with either of these two fluorescent dyes, i.e., photodynamic action, causes a decrease in the viscosity of the plasmagel of about 23 per cent.

8. Photodynamic action causes a pronounced liquefaction of the internal protoplasm or plasmasol of *A. dubia*.

9. All of the liquefying effects of photodynamic action are detectable within 10 seconds after the exposures and last as long as 28 minutes.

10. In view of the fact that calcium in relatively small concentration causes a decrease in protoplasmic viscosity (of the cell interior), it is suggested that the liquefying effects of photodynamic action are due primarily to a binding by light-activated dye molecules of most of the free calcium in amoebae.

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PHOTODYNAMIC ACTION IN THE EGGS OF NEREIS LIMBATA[1,2]

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ONE TEXT FIGURE AND ONE PLATE (SIX FIGURES)

Visible light usually has very little observable effect on living systems unless they contain large amounts of natural pigment. However, as Raab ('00) accidentally discovered, if some photosensitizing substance is added to a living system, visible light becomes effective. The changes produced in living systems by the combined action of visible light and a sensitizing substance, usually a fluorescent dye, are said to be due to photodynamic action. Since the discovery of this phenomenon, it has been studied by numerous investigators in various fields and many interesting results have been obtained. Muscle cells, red blood cells, protozoa, bacteria, nerve cells, marine ova and various physiological phenomena have been shown to be markedly affected by photodynamic action. For comprehensive reviews of the literature on the subject see Tappeiner ('09) and Blum ('32, '35).

The photodynamic studies on red blood cells have for the most part been quantitative in nature, but this has not been true for studies of this type on marine ova and other cells. The unfertilized eggs of Nereis limbata have proved useful material for quantitative studies of the action of ultra-violet radiation (see Heilbrunn and Wilbur, '37; and Wilbur, '39). The germinal vesicle breakdown which is produced in these eggs by stimulation affords a definite measure of the effects of stimulation. The use of this reaction has made it possible to study photodynamic action in Nereis eggs in a more quantitative manner than has been possible in the eggs of other marine forms. The results of such studies on Nereis eggs are presented in this paper.

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MATERIAL AND METHODS

The light source used in most of the experiments was a 1000 watt Mazda electric bulb mounted in an asbestos-lined wood ventilating shaft. For the greater part, the light set-up was quite similar to one previously described (Alsup, '39) in connection with some experiments involving visible light. The light from the bulb passed through a circular aperture in the front wall of the shaft and was reflected through the condenser of a microscope by means of the substage mirror. The intensity of the light just above the condenser was found to be approximately 350,000 candle-meters when measured by a Weston photometer. Heat was removed from the set-up by an electric fan and a water cell.

The temperature of the room in which the experiments were conducted varied between 22°C. and 25.8°C. from day to day. Even though the light was sometimes on for 30 minutes, the temperature around the stage of the microscope never increased more than 3°C. over that of the room. Moreover, the irradiated dye solutions showed the same constancy of temperature.

Only two photodynamically active dyes, rose bengal and eosin, were used in these experiments. Rose bengal was obtained from the Coleman and Bell Company; the eosin was a Grübler's product. Stock solutions of dyes were made up in the proportions of 1 part dye to 2000 parts sea-water. In the experiments with eosin, only the stock solution was used. More dilute solutions of rose bengal were obtained by adding sea-water to the stock solution. In some experiments with rose bengal, the dye was dissolved in isotonic salt solutions instead of sea-water.

In the course of each photodynamic experiment, one or two concentrated drops of unfertilized eggs from a single female were placed by means of pipettes in each of several stender dishes or small vials which contained 5–25 cc. of the dye solutions. Each dish was then shaken gently so that the eggs became loosely packed at the center. After the eggs had been in the solutions for 5–25 minutes, they were placed on the stage of the microscope and were exposed for various lengths of time to light from the 1000 watt bulb. The eggs in each dish were examined at intervals during and after the exposures.

EXPERIMENTAL RESULTS

A. The effects of irradiation without dye

Experiments were first made to learn if visible light alone had any effect on the unfertilized eggs of Nereis. The eggs from most females were unaffected when exposed in sea-water to light from the bulb for

1–30 minutes, and upon insemination these irradiated eggs developed normally. However, the eggs of a few females showed a small percentage (1–3%) of germinal vesicle breakdown after long exposures (10–30 minutes) to the light.

B. The effects of dyes without irradiation

Various investigators have found that in sufficient concentration most photodynamically active substances are capable of producing injurious effects on cells in the dark. This has also been found to be true in Nereis eggs. In concentrations of rose bengal greater than 1 part in 20,000 parts sea-water, the entire egg becomes stained, some of the cortical jelly is extruded, the germinal vesicle breaks down and finally cytolysis sets in. These "dark reactions" are death reactions. It may be noted that they occur as readily in pure hydrogen as in air. Much higher concentrations of eosin are required to produce the same degree of reaction. Not only is eosin in a concentration of 1 part in 2000 parts sea-water relatively ineffective in the dark, but some eggs can be fertilized and develop into normal larvae while immersed in a solution of this strength. In the dark 1 : 20,000 rose bengal produces no observable effects, but the same concentration in the presence of diffuse light does cause observable changes. Eggs cannot be fertilized in this concentration, and even if removed to sea-water, the percentage fertilizable is very low and there is little cleavage. In 1 : 40,000–1 : 200,000 rose bengal solutions, eggs retain their normal appearance both in the dark and in the diffuse light and can be fertilized. Indeed, 70–80% of the eggs are fertilizable in non-irradiated 1 : 200,000 rose bengal solutions and cleave while still in the dye; many develop into larvae. If inseminated after removal to sea-water, 80–90% develop.

Although eggs which have been in 1 : 40,000–1 : 20,000 rose bengal solutions, in the dark, are not always fertilizable when returned to sea-water, they are not killed by these exposures. This is shown by the fact that such eggs can still respond to stimulation by photodynamic action. Moreover, the cytoplasm was not stained. Shippen ('07), Menke ('35) and others have found that fluorescent dyes stain only dead cells. In other words, injury to the surface membrane precedes staining and subsequent cytolysis. It is quite conceivable that 1 : 40,000–1 : 20,000 rose bengal solutions do initiate some injury or change in the eggs since some of the eggs returned to sea-water become cytolyzed after insemination. It is interesting to note that if not inseminated after the removal to sea-water, eggs retain their normal appearances indefinitely.

C. Effect of irradiation and dye

(*a*) *General effects of photodynamic action.* The first indication of the effect of light on unfertilized Nereis eggs immersed in solutions of rose bengal was the appearance of uniform wide spaces beneath the vitelline membranes. These perivitelline spaces became evident in 1–3 minutes. As the spaces approached their maximum widths, the protoplasmic surfaces of the eggs became pulled up into sharply pointed mounds. These disappeared and the egg surfaces became smooth again in 10–15 minutes after the exposures to the light; by which time much of the cortical jelly had been extruded. Except for those that cytolyzed immediately after the perivitelline spaces appeared, the eggs showed germinal vesicle breakdown. Some eggs remained indefinitely at this stage of activation; some became cytolyzed; but still others showed a more striking effect, namely photodynamically induced development.

The best development was obtained in eggs exposed in solutions containing 1 part rose bengal in 200,000 parts sea-water to light from the 1000 watt bulb. In these parthenogenetically developing eggs, first and second polar body formation and first cleavage-division showed the same time sequence as in inseminated eggs developing normally in sea-water. Figure 1 is an activated egg with two polar bodies that were present 65 minutes after the egg had been exposed in this concentration to light for 30 seconds. Figure 2 is a picture of an egg from the same female that was inseminated in sea-water at approximately the same time. It may be seen that except for the width of their perivitelline spaces the two eggs are quite similar in appearance. A few activated eggs showed fairly normal looking daughter cells (fig. 3). In most cases later cleavages were irregular, but many of these parthenogenetic eggs gave rise to abnormally ciliated larvae which swam slowly and showed varying degrees of differentiation (figs. 4 and 5). When some activated eggs were moved to sea-water, development was not better than that of eggs left in the dye solution.

Controls of non-irradiated uninseminated eggs in sea-water and in each concentration of dye used were made for each experiment. These controls which were left in the dark or in the diffuse light of the room never showed any changes from their normal appearances.

(*b*) *Nuclear breakdown as a measure of response to photodynamic action.* All of the photodynamic effects produced in unfertilized Nereis eggs are variable and depend upon the length of exposure to light and the concentration of the rose bengal solution. As was mentioned above, one of these effects, nuclear breakdown, lends itself readily to quantitative studies. For this reason only this phase of the response of the

eggs to photodynamic action was considered in experiments designed to elucidate the relation of the response to the concentration of rose bengal and the time of exposure to light from the bulb.

Eggs were irradiated while immersed in various concentrations of rose bengal. The percentage of nuclear breakdown was determined 1–2 hours after the different periods of irradiation by compressing the eggs between slide and cover glass and counting 100 or more. The results of experiments of this type are presented in the form of graphs in figure 6, in which exposure time is plotted against the percentage of germinal vesicle breakdown for four different dye concentrations. Each point on the continuous portions of the curves represents the average

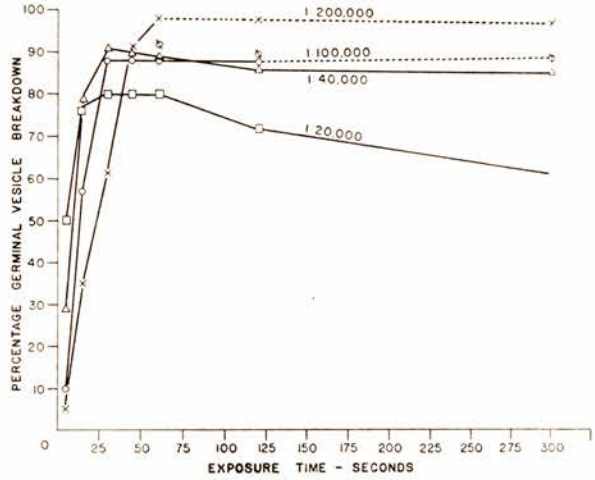

Fig. 6 Graphs, showing percentage germinal vesicle breakdown in Nereis eggs irradiated for various lengths of time in four concentrations of rose bengal.

of fourteen experiments, while each point on the broken portions of the curves represents the average of nine experiments. The eggs used in experiments with a given concentration of rose bengal were from individuals different from those whose eggs were used in experiments with any other concentration. Moreover, the eggs used to determine points on the broken portions of a given curve were not from the females whose eggs were used to determine points on the continuous portions of the curve.

As indicated by the graphs, the percentage of germinal vesicle breakdown in eggs irradiated in a given concentration of rose bengal rises quickly to a maximum as the exposure time is increased. The percentage of breakdown is greater in eggs exposed to light in 1:200,000 rose

bengal solutions than in eggs irradiated in higher concentrations. However, the maximal percentages are reached in the latter after shorter exposures. From the curves for the two lower concentrations, 1:200,000 and 1:100,000, it may be seen that, once the maximal percentage of breakdown is reached, it is maintained even when the exposure time is increased. On the other hand, eggs in 1:40,000 rose bengal solution show a slight drop and eggs in 1:20,000 rose bengal solution show a considerable drop in percentage of germinal vesicle breakdown when they are exposed to light longer than is just necessary to produce maximal percentage of breakdown in either of these two concentrations. Many more eggs were found to be cytolyzed in the higher concentrations of rose bengal after a given period of irradiation than in the lower concentrations. Since eggs which became cytolyzed immediately after showing perivitelline spaces did not always show germinal vesicle breakdown, the low percentage of breakdown noted in eggs subjected to considerable amounts of photodynamic action is probably to be correlated with the great amount of cytolysis produced under such conditions.

(*c*) *Effects of previously irradiated dye solutions.* The experimental findings reported by various investigators as to the effects produced on cells in the dark by previously irradiated solutions of photodynamically active substances have not been in agreement. Raab ('00) maintains that acridine solutions irradiated alone are unable to kill paramecia in the dark. Ledoux-Lebard ('02) found that previously irradiated eosin solutions kill and cytolyze paramecia. Moore ('28) contends that light acting upon eosin separately forms a toxic compound which is able, in the dark, to kill but not to cytolyze the eggs of the sea urchin, Strongylocentrotus purpuratus. On the other hand, Pereira ('25) was unable to kill Arbacia larvae by using previously irradiated eosin solutions. In view of these and other discordant results, it was thought worth while to investigate the effects of such solutions on the eggs of Nereis.

Eosin solutions containing 1 part dye in 2000 parts sea-water were exposed for 20–25 minutes to light from the electric bulb or for 30–45 minutes to sunlight. Rose bengal solutions containing 1 part dye in 20,000–200,000 parts sea-water were exposed for 20–25 minutes to artificial light or for 30–60 minutes to sunlight. All dishes of solutions exposed to sunlight were allowed to cool on a sea-water table for 15–30 minutes before eggs were added. Eggs were added to the solutions exposed to artificial light 1–3 seconds after the exposures. After the eggs had been in the dark in the irradiated solutions for 1–2 hours, they were examined for photodynamic effects.

Solutions of rose bengal which had been exposed to sunlight or to artificial light produced, in the dark, no immediately observable effects on eggs. However, when eggs were removed from previously irradiated 1 : 200,000 rose bengal solution to sea-water and inseminated, it became evident that the irradiated solution did have some effect on the eggs. Many of these eggs cleaved irregularly or cytolyzed; whereas eggs transferred to sea-water from non-irradiated dye solutions of the same concentration cleaved regularly and did not become cytolyzed upon insemination. After long exposures (1.5–3.0 hours) to sunlight, 1 : 20,000 rose bengal solution loses most of its red color. Such a bleached solution had little if any effect on the eggs and sperm of Nereis. This is shown by the fact that eggs could be fertilized in and would cleave in the bleached solution, whereas this was not true in unbleached solutions of the same concentration.

Previously irradiated eosin solution did produce, in the dark, some observable effects on the unfertilized eggs of Nereis: As many as 75% of eggs from some females showed germinal vesicle breakdown, but in most cases the percentage was much smaller (8–30%); a few eggs became stained and cytolyzed. On the other hand, when eggs were irradiated together with eosin, practically all of them showed germinal vesicle breakdown; some cleaved; and many were subsequently cytolyzed. The stock solution of eosin used in these experiments was not bleached to any perceptible extent by exposure to sunlight for 1 hour.

D. Chemical factors affecting photodynamic reactions

(*a*) *Effect of lack of oxygen on photodynamic reactions.* Considerable evidence has accumulated to indicate that photodynamic reactions require the presence of molecular oxygen (see Blum, '32). Experiments with the eggs of Nereis show that the changes produced in these eggs by rose bengal and light or by eosin and light do not take place in an atmosphere of pure hydrogen.

Eggs were placed in a drop of 1 : 20,000 rose bengal solution or of 1 : 2000 eosin solution on a glass slide which was inverted and sealed with vaseline to the top of a small Englemann chamber. The chamber rested on the stage of the microscope in such a way that the hanging drop was over the condenser of the microscope. Hydrogen was washed by passing it through water and then purified by passing it over hot platinized asbestos. After the hydrogen had been passing through the gas-tight chamber for 40–50 minutes, the eggs in the hanging drop of dye solutions were exposed to light from the 1000 watt bulb for 10–23 minutes. These irradiated eggs were kept in the hydrogen atmosphere

for 60–90 minutes and were examined at various intervals with a low power objective. Fifteen experiments of this type were carried out. No photodynamic effects, whatsoever, could be produced in an atmosphere of pure hydrogen. As controls for these experiments, eggs in hanging drops of 1:20,000 rose bengal solution and of 1:2000 eosin solution were irradiated for 5 minutes in air. These control eggs showed extensive photodynamic changes even before the irradiations were over.

(*b*) *Effect of KCN on photodynamic reactions.* Experimental results such as were presented in the preceding section of this paper indicate that photodynamic reactions are oxidative in nature. Besides, Wohlgemuth and Szorenyi ('33); Kosman and Lillie ('35) have found that photodynamic action increases the oxygen consumption of various cells and tissues. The conflicting results (see Blum, '35) which have been reported by various workers on the effect of cyanide on the production of photodynamic changes indicate that the increased oxygen uptake due to photodynamic action is different from the uptake of oxygen in normal tissue respiration. Indeed, my experimental results show that photodynamic reactions occur readily in Nereis eggs poisoned by KCN.

Two solutions containing KCN and rose bengal were made up in sea-water. One solution contained 1 part dye to 20,000 parts sea-water and 0.01 M KCN, a concentration of KCN which completely inhibits normal respiration in marine ova (see Barron and Hamburger, '32). The other solution contained 1 part dye to 200,000 parts sea-water and 0.01 M KCN.

Eggs irradiated in both of these solutions showed wide perivitelline spaces and germinal vesicle breakdown; some were cytolyzed. The results in table 1 show that KCN augments photodynamic nuclear breakdown. Furthermore, it may be seen that the percentage of nuclear breakdown is more consistently augmented by KCN when the eggs are immersed in the higher concentration of the dye than when the eggs are immersed in the lower concentration. Control eggs left in the dark in these solutions containing KCN showed no nuclear breakdown.

(*c*) *Photodynamic and dark reactions in calcium-free solutions.* Germinal vesicle breakdown due to photodynamic action in Nereis eggs is to some extent dependent on calcium. This is evident from the results of some experiments in which eggs were first immersed in citrate solutions, which presumably removed calcium from the outer layer of the protoplasm, and were then exposed to photodynamic action in solutions containing no calcium. These results are presented in table 2 in which the values in the third and fourth columns are to be compared with those in the fifth and sixth columns, respectively. As may be seen from

the table, small percentages (0–18%) of the eggs which were immersed in an isotonic solution of potassium citrate for 10–14 minutes and were then removed to a solution of rose bengal in isotonic potassium chloride (solution I) showed germinal vesicle breakdown when subjected to photodynamic action for as long as 10 minutes. Furthermore, it may be seen that if eggs were removed from the potassium-chloride-dye

TABLE 1

Showing the effect of KCN on nuclear breakdown produced by photodynamic action

EXPERIMENT NUMBER	EXPOSURE TIME (SECONDS)	% BREAKDOWN IN 1 : 20,000 ROSE BENGAL PLUS 0.01 M KCN	% BREAKDOWN IN 1 : 20,000 ROSE BENGAL	% BREAKDOWN IN 1 : 200,000 ROSE BENGAL PLUS 0.01 M KCN	% BREAKDOWN IN 1 : 200,000 ROSE BENGAL
	5	93	23	0	0
I	15			35	40
	30			100	69
	5	75	71	89	10
II	15			80	65
	30			98	93
	5	60	25	0	0
III	15			27	15
	30			76	70
	5	86	44	20	2
IV	15			55	57
	30			85	62
	5	40	5	5	0
V	15			84	14
	30			93	58
	5	85	10	0	0
VI	15			54	14
	30			81	77
	5	100	55	0	0
VII	15			50	23
	30			100	100
	5	95	72		
VIII	15			99	74
	30			100	100
	5	74	42	1	0
IX	15			52	41
	30			89	89
	5	18	10	1	0
X	15			15	20
	30			33	65
	5	65	41	1	1
XI	15			58	42
	30			62	56
	5	40	25	0	1
XII	15			69	44
	30			80	81

solution to sea-water containing rose bengal (solution II), their germinal vesicles were readily broken down when they were exposed to photodynamic action for 0.5–2.0 minutes.

When eggs were removed from sea-water (or isotonic citrate solutions) to isotonic citrate solutions containing small amounts of rose bengal, all of them became stained and some showed germinal vesicle breakdown (see table 3). These changes occurred in the dark and were always accompanied by cytolysis.

TABLE 2

Showing the effect of citrate treatment on the percentage of nuclear breakdown in eggs exposed to photodynamic action [1]

Solution I — 1 part rose bengal in 200,000 parts 0.53 M KCl
Solution II — 1 part rose bengal in 200,000 parts sea-water

NUMBER OF EXPERIMENT	IMMERSION TIME IN 0.35 M K-CITRATE (MINUTES)	PERIOD OF IRRADIATION OF EGGS AFTER REMOVAL TO SOLUTION I (MINUTES)	% BREAKDOWN IN EGGS IRRADIATED IN SOLUTION I AFTER REMOVAL FROM K-CITRATE	PERIOD OF IRRADIATION OF EGGS AFTER REMOVAL TO SOLUTION II (MINUTES)	% BREAKDOWN IN EGGS IRRADIATED IN SOLUTION II AFTER REMOVAL FROM SOLUTION I
I	11	3	4	2	80
II	10	2	7	2	80
III	14	5	12	2	98
IV	14	10	18	2	100
V	12	5	7	2	82
VI	12	10	0	2	30
VII	10	10	0	2	38
VIII	10	10	0	0.75	77
IX	10	1	0	1	90
X	11	0.5	0	0.5	39

[1] Table 2 shows only results with potassium salts. Similar results were obtained with sodium salts.

TABLE 3

Showing the percentage of nuclear breakdown in eggs immersed in citrate solutions which contain small amounts of rose bengal

Solution A — 1 part rose bengal in 200,000 parts 0.35 M K-citrate.
Solution B — 1 part rose bengal in 200,000 parts 0.35 M Na-citrate.

NUMBER OF EXPERIMENTS DONE		PERCENTAGE NUCLEAR BREAKDOWN OCCURRING IN THE DARK
4	Eggs removed from sea-water to solution A	58 28 70 31
1	Eggs removed from sea-water to solution B	92
2	Eggs removed from 0.35 M K-citrate to solution A	50 32
3	Eggs removed from 0.35 M Na citrate to solution B	31 90 28

DISCUSSION

According to the calcium-release theory of stimulation (see Heilbrunn, '37), free calcium must be present in the cortical protoplasm before a cell can respond to ordinary types of stimulation. When an unfertilized egg responds to stimulation, it usually does so by beginning maturation. In the eggs of Nereis limbata one of the first steps in maturation consists of the breakdown of the germinal vesicle. The results obtained by Heilbrunn and Wilbur ('37) indicate that the nuclear breakdown which can be produced in this egg by ultra-violet radiation, sodium chloride or potassium chloride, is dependent upon calcium in the cortex of the egg. The data presented in the preceding sections of this paper indicate that photodynamic nuclear breakdown in this egg is also conditioned by calcium release from the cortex. In view of the fact that some Nereis eggs could be cytolyzed in calcium-free solutions by photodynamic action, it cannot be held that all photodynamic effects in these eggs are dependent upon calcium. It should be noted that at least one investigator, Moore ('28), has suggested that photodynamic action affects the calcium balance in cells. He based his suggestion on his finding that when developing eggs of the California sea urchin, Strongylocentrotus purpuratus, were subjected to photodynamic action, the larvae arising from the eggs showed aberrant skeletons.

Under at least one set of conditions germinal vesicle breakdown can be produced in Nereis eggs from whose cortical protoplasm calcium has been removed. Eggs which had been immersed in isotonic citrate solution showed nuclear breakdown when they were transferred to isotonic citrate solutions containing very small amounts of rose bengal. Since this particular breakdown could occur in the dark, it cannot be considered a photodynamic effect. Rather, it would seem that the citrate potentiates "dark reactions" in the eggs, that is to say, concentrations of dye which do not produce observable effects on the eggs in the dark can do so when acting in unison with the citrate.

Tennent ('38) and others have concluded that sunlight also raises the effectiveness of dilute solutions of photodynamically active dyes to the level of results produced by strong solutions without irradiation. In other words, they seem to think that photodynamic reactions are essentially the same as "dark reactions." However, the results presented in this paper and those obtained by some other investigators indicate that the two types of reactions are produced in different ways.

In all concentrations of rose bengal used, the surfaces of eggs seemed to be colored as if the dye were adsorbed there, but as far as could be detected with the naked eye, rose bengal and eosin solutions did not

stain the inner protoplasm of uninjured Nereis eggs. Eggs that appeared stained invariably showed some degree of cytolysis. These findings are in accord with the results of other investigators and it is quite likely that only the dye molecules adsorbed at the surfaces of cells are involved in photodynamic reactions (see Blum and Hyman, '39). Photodynamic effects such as the photodynamic activation which has been reported in this paper for Nereis eggs and by Lillie and Hinrichs ('23) for starfish and sea urchin eggs would therefore seem to be secondary effects of some primary action at the surfaces of cells. Ponder ('35) has shown that in sufficient concentration rose bengal has a lytic effect on red blood cells. Since the nuclear breakdown produced in the dark in Nereis eggs by strong solutions of rose bengal was always accompanied by visible staining of the protoplasm, it is quite probable that the dye molecules destroy the nuclear membrane by direct lytic action after having altered or destroyed the egg membrane and the cytoplasm. In other words, in the "dark reactions" the action does not appear to be confined to the surface of the eggs. An even greater difference between the "dark reactions" and photodynamic reactions in Nereis eggs is that the former occur as readily in pure hydrogen as in air, whereas the latter do not occur in pure hydrogen. This finding is in accord with that of Blum and McBride ('31) who showed that strong solutions of eosin can produce hemolysis of red blood cells in the absence of free oxygen but that this is necessary for photodynamic hemolysis. Thus it would seem that the mechanism of the two types of reactions involving photodynamically active dyes are quite different.

It is evident that photodynamic changes in cells are related to oxidation, but the exact nature of the relationship is not known. Some workers maintain that the dye molecules activated by light transfer their energy of activation to oxygen molecules which then oxidize cell constituents. Experimental results obtained when Nereis eggs and other cells have been placed in the dark in previously irradiated dye solutions make it necessary to conclude that either the activated dye molecules or the activated oxygen molecules retain their energy of activation for many minutes. Gaviola ('27) has presented results which indicate that the lifetime of an activated dye molecule is of the order of 10^{-9} to 10^{-8} seconds. If this estimate is accepted, it would seem on the basis of the experiments with previously irradiated dye solutions, that the oxygen retains its energy of activation for quite some time. As yet, however, no convincing evidence has been offered to support this particular point. Menke ('35) and others believe that light converts the dye into a photocompound capable of producing photodynamic effects

in the dark. In contrast to the activation theory, this photocompound theory does not afford any explanation of how oxygen is involved in photodynamic reactions. However, neither of these two theories furnishes any suitable explanation of the finding of Bier and Silva e Rocha ('35) that photodynamic hemolysis is augmented by KCN, or of my results which show that photodynamic nuclear breakdown in Nereis eggs is also increased by KCN. Undoubtedly more investigations are necessary before we can have a complete explanation of the intimate mechanisms of photodynamic action.

CONCLUSIONS AND SUMMARY

The following conclusions have been drawn from the results which have been presented in the preceding pages of this paper:

1. Visible light acting alone has very little effect on Nereis eggs.

2. In sufficient concentration rose bengal kills and stains these eggs in the dark.

3. Light activates unfertilized Nereis eggs immersed in weak solutions of rose bengal or eosin. These activated eggs throw off polar bodies and in some cases give rise to ciliated larvae.

4. One phase of this photodynamic activation, nuclear breakdown, varies quantitatively with the concentration of rose bengal and the time of exposure to light.

5. No photodynamic effects can be produced in Nereis eggs in an atmosphere of hydrogen.

6. In the dark, strong solutions of rose bengal produce their effects on Nereis eggs in an atmosphere of hydrogen.

7. Photodynamic nuclear breakdown is augmented by KCN.

8. Photodynamic nuclear breakdown is markedly reduced when the calcium in the eggs has been reduced by means of citrate solutions.

9. Nereis eggs become stained and show nuclear breakdown when immersed, in the dark, in isotonic citrate solutions which contain very small amounts of rose bengal.

10. Only injured and dead Nereis eggs are stained perceptibly by rose bengal and eosin.

11. Previously irradiated eosin solutions produce, in the dark, small amounts of nuclear breakdown and even smaller amounts of cytolysis in Nereis eggs.

12. Previously irradiated weak solutions of rose bengal produce no immediately observable effects on unfertilized Nereis eggs.

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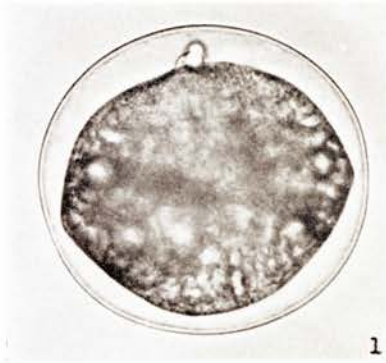

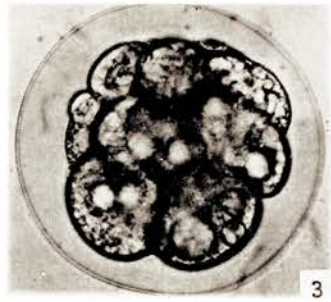

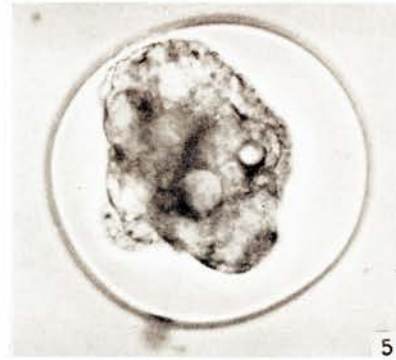

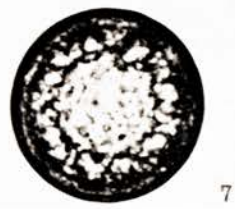

Photomicrographs of living Nereis limbata eggs.

1 Photodynamically activated egg showing two polar bodies. Note the wide perivitelline space.
2 Normal fertilized egg showing two polar bodies.
3 Activated egg which has cleaved quite regularly.
4 and 5 Ciliated larvae which have arisen from activated egg.
7 Normal unfertilized egg. Note the large germinal vesicle.