

The Rockefeller Foundation and its support of Radiobiology up to the 1970s

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Radiation biology, or radiobiology, is a very young science, solely concerned with the study of the interactions between ionizing radiation and living matter. This science slowly became a recognized field of study after the discovery of ionizing radiation (i.e., X rays) in 1895. A broadly varied and evolving terminology has been applied to aspects of radiobiology and therefore, archival searches concerning it are complex.

This report is a work in progress, which mainly recounts support given by the Rockefeller Foundation (RF) to radiobiology. The RF was a most important player in the early history of radiobiology and a crucial influence in ensuring that the science steadily matured during its first six decades. Time constraints prevented all relevant items from being accessed, but a clear idea of the RF's strong influence on radiobiology's early history has resulted. Examples of RF activities to verify this assertion are given below, in by and large chronological order. After a brief analysis of RF aid, there is a short account of why its support so strongly benefitted the young science. To my knowledge there is very little written about the history of radiobiology and nothing about the role that the RF or other philanthropic bodies played in this history.

Inevitably, for an extensive time, individual radiobiologists first studied other fields of science before radiobiology. Even in 2011 there are only five universities in the U.S. offering undergraduate majors in this subject. Radiobiologists' principal initial fields of study have been

physics, chemistry, biology, genetics, pathology, cytology, biochemistry, and medicine. Elements of all of these and some others, notably mathematics, are often required before one can work in radiobiology and consequently radiobiology is a multidisciplinary subject, *par excellence*.

The Rockefeller family has supported many fields of science through its own academic institution the Rockefeller Institute for Medical Research (RIMR), which later became the Rockefeller University (RU), and also through its grant awarding bodies. These include the General Education Board (GEB), the International Education Board (IEB) and the RF. Members of many academic institutions often advised those who distributed RF funds. Therefore, a short overview of radiobiological activity at the RIMR follows, since this was the earliest support of radiobiology from Rockefeller funds

The RIMR and its Radiobiology

The RIMR was founded in 1901 with a grant of \$200,000 from John D. Rockefeller, Sr. Its first laboratory was opened in 1904, and a larger one in 1906, both in New York City.¹ The Institute's initial mission was to "to perform medical research, especially prevention and treatment of disease,"² was later changed to an emphasis on the study of basic science to aid medicine. As a result, medical fellowships were first introduced in 1920, with the purpose of strengthening "fundamental medical science, rather than clinical subjects."³ Studies of the effects of X rays on lymphatic tissue, and as a treatment for cancer, were made at the RIMR in 1915⁴ and in 1919 X rays' effects on TB bacilli and lymphocytes were reported.⁵ This X ray irradiation of lymphocytes, by James B. Murphy, was among the world's first such work. After radium (Ra) was purchased in 1926, results of irradiations using Ra, X rays, light, ultraviolet and infrared rays were reported.⁶ A wide variety of biological materials was then irradiated and

associated techniques improved,⁷ and as a consequence many publications resulted. A different aspect of research on the effects of X rays was that of Alexis Carrel (awarded the Nobel prize in physiology or medicine in 1912, while employed at RIMR). In 1927 he reported the biological effects of X rays, presciently suggesting that possibly their production of cancer can be more important than a therapeutic use.⁸ He further realized that their effect on the cell nucleus affects chromosomes and therefore progeny. Both of these, then revolutionary concepts, are now a current belief for certain circumstances. In 1929, radiobiological work continued with studies of the effects of very soft X rays on mice and cathode rays on tissue cultures, bacteria and viruses.⁹ By 1930 a broad range of radiation sources (those mentioned above, and electrons) was available at the RIMR and used for studying a wide variety of biological materials and organisms. Technical improvements to X ray sources were devised and published as well.¹⁰

Radiobiology Supported Elsewhere before World War II

While radiobiology was studied at the RIMR, radiobiological work elsewhere was acknowledged, and selected funding for it was provided by the RF. The RF began supporting August Krogh (awarded the Nobel prize in physiology or medicine in 1920) in 1923, and continued to fund him for many years (including \$100,000 in 1924 for equipment and a laboratory.)¹¹ This support continued while he worked in close collaboration with Niels Bohr (awarded the Nobel prize in physics in 1922) and George de Hevesy (awarded the Nobel prize in chemistry in 1943) in Copenhagen. Another beneficiary of funding for radiobiology was the Radium Institute of Vienna in 1925. Most of its one-hundred and seventy-eight publications produced by 1925 were concerned with radiotherapy, but also some work was done in radiobiology.¹² The RF not only supported radiobiology research in Vienna, but also its teaching

there. In 1928 the RF appreciated the usefulness of disbursing funds to aid “the study of the entire field of effects of radiation on living organisms.”

For this reason the RF, in 1928, through its GEB, provided the National Research Council (NRC) with \$62,500 initially for this purpose, spread over five years. There were “thirty-five grants to individuals” and “a large number of notable contributions have been published.”¹³ In 1929 the RF started long-term support for the Curie Foundation and Radium Institute in Paris. This comprised funds for Claudius Regaud for thirteen years, including support for six staff members.¹⁴ Regaud had greatly improved radiation cancer treatment by applying radiobiological knowledge gained from classical laboratory experiments with rams’ testes, to suggest that a course of radiation spread over an extended period was much more effective than a single dose. This was in marked contrast to then accepted practice. The University of Cambridge was also a major beneficiary of the RF largesse, and before the Second World War received £700,000 in 1930, for the development of physics and biology,¹⁵ including radiobiology. An additional sum of \$20,000 was later given in 1935 to the Strangeways Laboratory at Cambridge for radiation studies, mainly with embryology and in tissue culture,¹⁶ and further sums were given by 1939, totalling £32,830, for extension of its laboratory building.¹⁷

Cooperation with other foundations was another way the RF supported chosen scientific teams. One such collaboration in 1929 was between the Carlsberg Foundation of Copenhagen and the RF, which respectively supplied both land and maintenance expenses, and the building for a Biological Research Laboratory.¹⁸ This cooperation was extended during World War II and the foundation agreed to continue paying the amounts promised by the RF in Denmark, because funds from the U.S. could not be transferred during wartime.¹⁹ In 1934 the Finsen Radium

Institute also in Copenhagen, was supported by the RF. As in Paris and Vienna, such institutes were mainly concerned with therapy, but also with radiobiology. In Copenhagen, the RF not only collaborated with the Carlsberg Foundation to aid radiobiology, but also with the Danish state. For as Hevesy wrote in 1935, physics is paid for by the state and the Carlsberg Foundation, while the RF “pays for the physico-biology activity.”²⁰ The RF continued funding Bohr and his co-workers until 1949.²¹ Frederick Joliot (awarded the Nobel prize in chemistry in 1935) at the Collège de France in Paris, working with a multidisciplinary team, was similarly very active in biological research, using techniques of physics and chemistry. He was also supported by the RF and in 1937 received \$15,000 for his work on radionuclide techniques applied to biology.²²

This steady progress of radiobiological science was slowed in the 1930s when much effort was expended in studying so called ‘mitogenic radiation.’ This was allegedly weak (very difficult to detect) X radiation emitted when cells were dividing. Many researchers studied it and by the end of the decade the controversy was settled when it was accepted that this effect did not exist.

Rockefeller Foundation Support for Radiobiology during and after World War II

Support for radiobiology in Europe continued sporadically during the war. In the postwar period, the RF gradually resumed its scientific work there. At the RIMR, interest in other fields resulted in the reduction of its radiobiological work. Although the RF greatly reduced expenditure for radiobiology in the early 1960s, in the context of atomic weapons, the RF did spend a total of about \$1,000,000 by 1954 in support of studies of “‘nuclear weapons’ fallout on living organisms,”²³ and in 1950 the natural science division spent eighty percent of its budget on experimental biology.

Support for the University of Paris continued with a fellowship in 1951 to work in biophysics at Harvard University. Other support, through 1952, included funding for radioprotection work.²⁴ At the University of Copenhagen support continued through 1960, and included financing a new biology building,²⁵ but the RF's emphasis began to change towards education. As mentioned above, in the 1950s the RF significantly increased its funding for radiobiology studies because of concern about atmospheric radioactivity from weapons testing. One other field which benefitted greatly from radiobiological investigations then was genetics, which the RF very strongly supported at the University of Indiana, supplying a total of \$3,781,000 by 1956. This endorsed the ongoing work there of Hermann J. Muller (awarded the Nobel prize in physiology or medicine in 1946). He obtained this recognition "for the discovery of the production of mutations by means of X ray irradiation," and it was the first such honor for radiobiology. Support totaling \$250,000 was given to MIT in 1956 for the construction of a biological and medical radiation facility associated with a nuclear reactor, which went critical in 1958.²⁶ A RF report referred to the biological effects of slow neutron and gamma radiation studied there, and stated that the reactor program was "the only one of its kind in a university in the USA."²⁷ A similar sum was given to the National Academy of Science (NAS) the same year for study of "the effects of atomic radiation."²⁸

The University of Chicago first received funds from the RF for radiobiology research in 1955 to study the irradiation of dividing cells, which is directly relevant to radiotherapy. This work was extended in 1957 to include radiation from radioactive drugs and their effects on metabolism.²⁹ A further \$500,000, spread over ten years, was given in 1959 for the development of nuclear medicine and problems in "radiation health."³⁰ Radiobiological research was

supported at the University of Pittsburgh and through an extensive teaching program that is outlined below.

Fellowships

Fellowships have always been a mainstay of RF support for the advancement of academic activity, in addition to funding, teaching and research. In 1927 the RF sought Marie Curie's (Nobel prize in chemistry in 1911) opinion regarding criteria for the election of recipients of IEB Fellowships. She proposed that candidates' publications and their professors' opinions should be considered more important than an interview. This advice was followed.³¹ In 1936 through 1938 the RF's support for radiobiology was extensive and probably near its zenith. In 1938 the list of institutions that had already received RF funding (the Universities of Paris, Illinois, McGill, Utrecht, Delft, Minnesota, Brno, Stanford and MIT) to support radiobiology studies was extended to include the University of Rochester and Johns Hopkins University.³²

Teaching of radiobiology

Mention has already been made of the earliest support by the RF for radiobiological education, mainly as one means to encourage intellectual cross fertilization of those educated in the non-biological disciplines. In 1955 Alexander Hollaender, head of radiobiology at Oak Ridge National Laboratory, and a frequent consultant for the RF in radiobiology, indicated to Warren Weaver, director of the RF's natural sciences division that radiobiological courses were to be introduced to undergraduates. This later led to the RF's generous support for such teaching.³³ In 1957, the Universities of Pittsburgh, Johns Hopkins and Harvard each received \$500,000 for "radiation biology teaching and research." Similarly the University of Puerto Rico was supported with \$8,000 to set up "a radio isotope training centre."³⁴ New York University

received funds to develop a program to teach and research appropriate aspects of radiation hazards, in industry and public health, in 1957 as well.³⁵ Now there was a teaching program in radiobiology underway at Pittsburgh which received further funds from the RF, as did the NAS.

In 1958 the University of Chicago was granted \$500,000 more for “nuclear medicine education,” St. Louis University received \$62,000 for radiobiology education in the general curriculum,³⁶ and the University of Pittsburgh was awarded an additional \$7,600 to supplement radiation health education in its radiobiology graduate studies program,³⁷ with \$50,000 more provided by the RF in 1960 for the same purpose.³⁸ Meanwhile, at St. Louis University, by 1958 radiobiology was introduced into the curricula of all four years of medical studies. Relevant specialist courses, such as radiochemistry, were also added to the university’s graduate courses.³⁹ In 1959, The Brookhaven National Laboratory was granted \$1,400,000 for nuclear medicine education.⁴⁰ The total expenditure on radiation associated activity in the years 1955 through 1961 was \$2,277,000.⁴¹

In the 1950s relevant education at the University of Chicago extended beyond the instruction of the university’s students. At this time there was great public concern about the effects of large increases in atmospheric radioactivity resulting from nuclear weapon explosions. The question was posed, “how can we reassure the public?” An answer given by scientists was, “We are not going to reassure. We are going to inform and let an enlightened public adjudge the facts.”⁴²

During the 1960s the RF’s support for radiobiology steadily decreased. However, it continued at the University of Pittsburgh until 1969, when a payment of \$50,000 was made.⁴³ Similarly, support for the University of Chicago’s radiobiology grant expired at the end of 1969. In 1970, the RF again reclassified the scientific fields in which it was interested, and as a result,

radiobiology no longer had its own heading or subheading, but was a part of Biomedical Science. By 1972 Biomedical Science's five subsections did not include radiobiology or any associated field.⁴⁴ The reason for this was presumably because the immediate practical problems of radioprotection no longer required detailed investigation of their basic mechanisms because they were believed to be understood. Also, fundamentals in the science were considered subordinate to biochemical and other investigations, such as the effects of hypoxia, and the validity of certain compounds being radiation protectors or enhancers. This is of particular interest for radiotherapy.

Relevant Personal Interests of Members of the Rockefeller Family

John D. Rockefeller, Sr., and other members of his family, frequently indicated deep interest in the affairs of the RF. This was illustrated by his request to Wickliffe Rose, (retired as president of the IEB in 1928), to continue working for him in a personal capacity on the cooperation projects, which they both thought were very important. Similarly in 1951, John D. Rockefeller, Jr. commissioned a "Statement of the trend in medical research in the next quarter century," to aid his understanding of the relevance of the RIMR's current and future work.⁴⁵ This was written by Herbert S. Gasser (Nobel prize in physiology and medicine in 1944, while second director of the RIMR). His major work in electrophysiology was concerning the understanding of pain and reflex action in terms of nerve conduction, consequently he had good reason to write that "physics is highly illuminating for medical research," and that "biophysics merges well with other disciplines." After completion of this report, clarifications and amplifications were requested and as a result a second document was written which emphasized the premise that basic research is more important than efforts directed solely against one disease.⁴⁶

The Rockefeller Foundation's Philosophy Concerning Multidisciplinary Science

The RF's formal adoption in 1933 of support for multidisciplinary science was not a mainstream opinion, but was prescient and anticipated the general shift in scientific thinking of a few decades later. However, the immediate reasons for the RF's change in policy were more pragmatic. They depended on the realization that pure sciences, having recently suffered upheavals with the introduction of exotica, such as quantum theory, relativity, etc., no longer lacked funding, and that biology remained a qualitative science. It can be argued that the RF's initial support for radiobiology was fortuitous and a result of its desire to encourage the multidisciplinary science needed for biology and to reduce the foundation's activity in the pure sciences. However, after some years of funding radiobiology, the RF appreciated its intrinsic value and therefore continued and increased such support, as outlined above.

In 1932 the RF established four major programs. The first was "Physics and Chemistry of Vital Processes," which included radiobiology.⁴⁷ When Warren Weaver was appointed the RF's director of natural sciences in 1932, he was encouraged to review the RF's policy concerning scientific fields worthy of support. He was well aware that biology at that time was qualitative, descriptive and isolated from the quantitative natural sciences. With remarkable foresight he advocated that the RF change direction to support cross disciplinary work to allow the powerful techniques of physics, mathematics, chemistry and allied sciences to be applied in a quantitative manner to elucidate the mysteries of biological mechanisms, or as Weaver wrote, to "aid in the analyses, understanding and control of vital forces."

Initially the biology supported by the RF was called 'vital processes' and consumed almost forty percent of the RF's funds for natural science, and also some funding from the medical sciences division, with mainly fellowships and grants-in-aid for both the U.S. and

Europe.⁴⁸ At the same time, the RF's support for pure science steadily diminished to near zero.

Weaver strove intensely and successfully to ensure that academic institutions shared his views, provided posts for the new multidisciplinary biologists and encouraged the cross fertilization of different quantitative sciences as a powerful method of making advances in biology.

Radiobiology was one of the most important disciplines which consequently benefitted. The RF had faith in Weaver's opinions and followed his advice. In 1933 the RF ceased supporting pure physics, but allowed some "out of program" projects to continue. One such exception was its continuing support for the University of California's Berkeley cyclotron with large grants.

Although purely a physics enterprise for some years, it finally resulted in some unique and most useful radiobiological studies, to be outlined below. In 1947 the RF ceased all support of nuclear physics with the exception of two small groups, one in Brazil and another working with cosmic rays.⁴⁹

After Weaver's appointment the RF steadily increased its support for radiation effects, disbursing \$234,340 in the five years after 1933, out of a total expenditure of \$9,870,000 for natural science.⁵⁰ Yet this sum did not include support for relevant fellowships, biological effects of high voltage beams, heavy water and radioactive isotopes.⁵¹ Weaver also realized that the policy of cross-disciplinary studies that he promoted could overlap with medical research. Such overlap and the need for symbiotic cooperation between the two divisions was also the understanding of other RF officers. The RF trustees upheld this philosophy and the understanding between the divisions. This resulted in successful cooperation between them after 1934, or in Weaver's words, he obtained approval "for physics and chemistry applications to experimental biology to overlap with medicine."⁵² Terminology continued to vary, and Weaver indicated that support for physical science was likely to "furnish results of importance to

biology,” through support for cyclotrons, etc. It should be noted that the RF was a principal funder of the University of California’s Berkeley cyclotron project, led by Ernest O. Lawrence (Nobel prize in physics in 1939), which led to much pioneering work in neutron and other irradiation before World War II.

Discussion

Although with hindsight the RF’s decision to move towards multidisciplinary science in support of biology seems an obvious change in direction, there were many influential physical scientists who had no interest in participating in or supporting the move. Augustus Trowbridge, the RF Board’s director for physics and biological science in Europe, visited Ernest Rutherford of the University of Cambridge in 1928. At the time, Rutherford was the world’s preeminent experimental physicist (Nobel prize for chemistry in 1908), and Trowbridge learned that he had “given a great deal of thought to the development of ... the question of the borderland work between physics, chemistry and biology.”⁵³ Rutherford’s opinion on this “surprised and greatly relieved” Trowbridge, because it clearly contrasted with other accounts of Rutherford’s attitude.⁵⁴ Hence, persisting in its change of policy for scientific funding, the RF encountered some opposition from those believing that the pure sciences merited more support.

There is no doubt that direct application of techniques of physics and chemistry to solve biological questions has been very successful. However, pure sciences can offer more than sophisticated technical support to biology. A subtle advantage of such cross-disciplinary studies is that physics can provide its way of thinking and reasoning to biological problems. In physics usually one independent variable can be identified and this facilitates subsequent investigation. Clearly, this is much more difficult in biological systems, where many variables, often unknown,

may be involved. Even so, sometimes this is possible, such as when considering the electrical properties of nerve fibers and the effects of radiation on living cells.

The many examples of RF aid to radiobiological studies made it clear that the RF employed multipronged approaches to achieve this end. These resulted in support with sizeable well disbursed funding, including almost all of the most important players in the field, whose ability and potential was appreciated by the RF usually before they achieved fame for their radiobiology. The RF's varied approaches to support radiobiology include:

- Direct support of those with recognized ability in radiobiology, if necessary with funding continuing for a decade or more.
- Encouragement and support of relevant in-house research at the RIMR.
- Setting up of educational programs in both general and medical university curricula, and short courses to inform those working in various disciplines of the value of the methods and results of radiobiology.
- Support for training fellowships, which were often awarded to young scientists in training to work with recognized experts, and if appropriate, to take the expertise gained back to their parent institution. Such fellowships also encouraged more persons to enter the field because no formal courses existed that taught this subject.
- Funding of bodies to promote appropriate research by third parties to maintain progress in the science (for example the NRC).
- Seeking of external experts' opinions (notably Hollaender of the Oak Ridge National Laboratory). If necessary, as Trowbridge wrote in 1925, "we can secure the temporary services of the very best men in their fields." They were to be given an honorarium of \$2,000-\$3,000 and "there would be no dictation ... to where these specialists should travel" to assess appropriate institutions.
- Cooperation with other funders (for example the Carlsberg Foundation in Denmark)
- A wide range of other appropriate activities were supported, including support for meetings, publications, salaries of assistants, and official government and other bodies (such as British MRC researchers and the International Commissions on Radiation Protection and on Radiological Units and Measurements).
- The use of external experts was sometimes more formal than holding a discussion with an individual to learn his/her opinion. A distinguished review committee was commissioned in 1939 to produce a "Report of a Committee of Review, Appraisal and Advice for the RF Division of Natural Science." This report stated that those "applying physics or chemistry to biology, should have some knowledge of biology by direct study or cooperation."⁵⁵
- The RF also used its detailed knowledge of different organizations to encourage the acquisition of skills by persons in one RF-funded institution through visits at other RF supported institutions.

- The RF encouraged the universities it supported to disseminate appropriate information to educate the public. During the 1950s, when there was serious concern about atmospheric radioactive debris from nuclear weapons testing, the University of Chicago provided appropriate information to the public and others.

These various methods of supporting radiobiology were, of course, also used appropriately by the RF in other fields of science. This aid addressed all aspects of the subject as follows: research (particularly the encouragement of the understanding of basic mechanisms and their practical applications, notably cancer treatment and genetic consequences), training at all levels (and because of its cross-disciplinary nature support for entry into the field of those having studied other subjects) and dissemination of appropriate material to other academic disciplines and to the public. I am not aware of any other body, philanthropic or otherwise, which had such a broad interest in all the many activities related to radiobiology, and encouraged them so consistently, widely and with so much material support. Although radiobiology was initially viewed as simply a range of techniques which could increase understanding of some biological processes with additional practical benefits, it slowly evolved into a scientific discipline.

The RF's initial support for radiobiology arose from an intrinsic interest in a new and barely understood phenomena, which followed the discovery of X rays. However, this interest was increased after the RF's change in philosophy, when it began to concentrate on cross-disciplinary work to encourage the use of quantitative pure sciences to aid biology. Radiobiology is the quintessential multidisciplinary science and its valuable contributions to biological understanding were quickly appreciated by the RF and others. Consequently, until the fundamental mechanisms of radiobiology were understood, the RF had good reason to give broad support to the science. The range of support from the RF allowed persons with both incredibly varied interests, and/or previous scientific experience, to make the advances in radiobiology, outlined above. In this way, in its early formative decades, the science began to be

consolidated. It led toward appreciation from those whose initial interests may only have been in one aspect (e.g. cancer treatment, genetics, cancer initiation, viral or TB infectivity, or lymphocytic mechanisms), to a wider range of investigations possible in their own field of interest, or another related one. As a result, benefits of RF aid were instrumental in allowing this science to mature.

Support from the RF appears intended only to maintain progress in the science, not to seek self-aggrandizement of the foundation, or any laudatory publicity. Therefore, the RF was always willing to cooperate with any appropriate and competent organization to ensure such progress. Examples of this have been given. The RF had supported radiobiology at times when there were incredibly few sources for such funding. Its role as a major influence on the development of the field deserves to be recognized accordingly.

Conclusion

From the RF's earliest days it has a long history of support for radiobiology. The reasons for initiating such support depended in part on the RF's policy to encourage a cross-disciplinary approach to use knowledge of the pure sciences to aid biology. However, the intrinsic merits of the new field of radiobiology were recognised by the RF and as a result its funding continued for decades. The magnitude, timing and variety of this support caused the RF to become a very effective influence on the development of radiobiology in the first half of the last century.

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Future Research

The most important and interesting continuation study would be to determine how the RF's many interactions with radiobiology over the years influenced its attitude to the wider funding of life sciences and relevant medical science. During such a fuller study of the archives, more material concerning radiobiology could also be found. Its terminology was very quite varied and it evolved steadily during the last century, including the following: biophysics, radiation effects, atomic medicine, radiology, biomedical science, radio isotope or nuclide studies, radiotracer techniques, radioresistance, radiosensitisation, nuclear medicine, radiation dosimetry, high energy or voltage beam irradiation, radiation damage and repair, radioprotection, and radiation therapy for cancer. All have different relations to the subject and perhaps other relevant terms can be discovered, leading to further pertinent material.

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The ideas and opinions expressed in this report are those of the author and are not intended to represent the Rockefeller Archive Center.

ENDNOTES:

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- ¹ Rockefeller University (RU), RG 439, Series C661, Box 8, Folder 2.
 - ² Rockefeller Institution for Medical Research (RIMR), Volume 1, 1902-1908.
 - ³ Rockefeller Foundation (RF), RG 3, Series 906, Box 1, Folder 9.
 - ⁴ RIMR, Volume 4, 1914-1915.
 - ⁵ RIMR, Volume 7, January-October 1919.
 - ⁶ RIMR, Volume 14, 1926.
 - ⁷ RIMR: Volume 8, January-October 1920; Volume 9, January-October 1921; Volume 10, January-October 1922; Volume 11, 1922-1923; Volume 12, 1923-1924; Volume 13, 1924-1925.
 - ⁸ RIMR, Volume 16, 1927-1928.
 - ⁹ RIMR, Volume 17, 1928-1929.
 - ¹⁰ Rockefeller University (RU), RG 439, Series C661, Box 8, Folder 2.
 - ¹¹ RF, RG International Education Board (IEB), Series 1, Box 6, Folder 85.
 - ¹² RF, RG General Education Board (GEB), Series 12, Box 26, Folder 90.
 - ¹³ RF, RG 3, Series 915, Box 1, Folder 7.
 - ¹⁴ RF, RG 6.1, Series 1.1, Box 3, Folder 36.
 - ¹⁵ RF, RG IEG, Series 1, Sub-Series 2, Box 31, Folder 437.
 - ¹⁶ RF, RG 1.1, Series 401D, Box 41, Folder 522.
 - ¹⁷ RF, RG 1.1, Series 401D, Box 41, Folder 523.
 - ¹⁸ RF, RG 6.1, Series 1.1, Box 1, Folder 16.
 - ¹⁹ RF, RG 1.1, Series 713, Box 5, Folder 51.
 - ²⁰ RF, RG 6.1, Series 1.1, Box 1, Folder 15.
 - ²¹ RF, RG 1.1, Series 713, Box 5, Folder 51.
 - ²² RF, RG 3.1, Series 915, Box 3, Folder 17.
 - ²³ RF, RG 3.2, Series 900, Box 31, Folder 167.
 - ²⁴ RF, RG 6.1, Series 2.1, Box 8, Folder 55.
 - ²⁵ RF, RG 1.2, Series 713, Box 1, Folder 7.
 - ²⁶ RF, RG 1.2, Series 200A, Box 136, Folder 1221.
 - ²⁷ RF, RG 1.2, Series 200A, Box 136, Folder 1221.
 - ²⁸ RF, RG 3, Series 922, Box 1, Folder 1.
 - ²⁹ RF, RG 1.1, Series 216D, Box 9, Folder 117.
 - ³⁰ RF, RG 1.2, Series 200, Box 98, Folder 850.
 - ³¹ RF, RG GEB, Series 12, Box 26, Folder 90.
 - ³² RF, RG 3.1, Series 915, Box 3, Folder 17.
 - ³³ RF, RG 12.1, Series Officers' diaries, Box 4, Folders 17-20.
 - ³⁴ RF, RG 3, Series 922, Box 1, Folder 1.
 - ³⁵ RF, RG 3.2, Series 924, Box 1, Folder 1.
 - ³⁶ RF, RG 3.2, Series 924, Box 1, Folder 1.
 - ³⁷ RF, RG 1.2, Series 200, Box 103, Folder 902.
 - ³⁸ RF, RG 1.2, Series 200, Box 103, Folder 903.
 - ³⁹ RF, RG 1.2, Series 200, Box 148, Folder 1325.
 - ⁴⁰ RF, RG 3, Series 922, Box 1, Folder 1.
 - ⁴¹ RF, RG 3.2, Series 924, Box 1, Folder 1.
 - ⁴² RF, RG 1.2, Series 200, Box 98, Folder 850.
 - ⁴³ RF, RG 1.2, Series 200, Box 103, Folder 903.
 - ⁴⁴ RF, RG 3.2, Series 926, Box 1, Folder 1.
 - ⁴⁵ RU, RG 439, Series C661, Box 19, Folder 2.
 - ⁴⁶ RU, RG 439, Series C661, Box 19, Folder 2.
 - ⁴⁷ RF, RG 3, Series 915, Box 1, Folder 1.

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- ⁴⁸ RF, RG 3, Series 915, Box 4, Folder 38.
⁴⁹ RF, RG 1.1, Series 713, Box 5, Folder 51.
⁵⁰ RF, RG 3, Series 915, Box 2, Folder 9.
⁵¹ RF, RG 3.1, Series 915, Box 3, Folder 17.
⁵² RF, RG 3, Series 915, Box 1, Folder 1.
⁵³ RF, RG GEB, Series 12, Box 26, Folder 90.
⁵⁴ RF, RG IEB, Series 1, Sub-series 2, Box 31, Folder 437.
⁵⁵ RF, RG 3, Series 915, Box 2, Folder 12.