

Training in Microbiology at Indiana University-Bloomington¹

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I. Introduction

The main campus of Indiana University, the oldest state university west of the Allegheny Mountains, is located in Bloomington, Indiana, the county seat of Monroe County (Clark, 1976a, 1976b, 1977; Myers, 1951; Wylie, 1890). Although the Medical School originated on this campus, the training was transferred to Indianapolis about 1908 (Myers, 1956) and there now are located the Schools of Dentistry, Medicine, and Nursing (Indiana University Medical Center on West Michigan Street), together, in late years, with a rapidly developing general undergraduate program in cooperation with Purdue University (IUPUI campus). The latter institution, a land grant university at West Lafayette, over the years has developed strong Schools (colleges) of Agriculture and Engineering. The Indiana University system now has, in addition to the programs in Bloomington and Indianapolis, several regional campuses scattered in various population centers throughout the state. Only introductory courses in bacteriology (microbiology) have been introduced at these centers.

It is surprising that a curriculum in microbiology was established in 1940 at Indiana University-Bloomington, since the campus lacked programs in agriculture, dairy and food sciences, medicine, and public health, which traditionally have given rise to strong programs in microbiology as at Wisconsin (Sarles, 1973) and in other states (Clark, 1961). Although there had been earlier sporadic offerings of a course in bacteriology on the Bloomington campus, as noted later, no attempt was made to initiate a full curriculum until 1940, with the appointment in May of the author to the faculty of the College of Arts and Sciences.

¹This article is dedicated to the memory of Dr. David Perlman, who requested that it be prepared.

The action was due in part to the request of the Home Economics faculty for the regular offering of a one-semester course primarily for dietetics majors. The appointment charge was made not only to offer such a course but also to develop a curriculum in the College to lead to the establishment of a department comparable to those of the sister sciences of Botany (chairman, Ralph E. Cleland) and Zoology (chairman, Fernandus Payne), which were, by then, strong departments (Campaigne, 1968; Torrey, 1940). Payne, then also Dean of the Graduate School, was an influential advisor to the new President, Herman B Wells, who was attempting to build a strong faculty on the Bloomington campus. The initiation of work in bacteriology was a bold move, since the majority of the strong departments in this subject area in other United States universities were located on campuses with agriculture or medical programs. The year chosen for the introduction of offerings in bacteriology was fortunate, because it was at the beginning of the remarkable era of development of the university under the energetic leadership of the new President. Even though the imminent World War II years occasioned a great reduction in the total student body, the enrollment in the various courses in bacteriology, initially much higher than predicted, continued to grow. With the expansion of the total campus curricular offerings through the efforts of the new President, bacteriology (as it was then called) grew and soon reached separate departmental status.

Rather than create a one-man department in 1940, by mutual consent the name of the Department of Botany was changed to Botany and Bacteriology and the initial and early faculty appointments were assigned to the combined department until July 1946, when the two units were separated and a Department of Bacteriology was created, with the author as Chairman. The budgets had been separate from the beginning, so that the departmental separation brought little change in administrative duties. The name of the department was retained until 1966, when it was changed to Department of Microbiology with the appointment of Howard Gest as Chairman to succeed McClung. In the previous year, the Departments of Bacteriology, Botany, and Zoology (and initially Anatomy and Physiology) had "federated" to form a Division of Biological Sciences, modeled after a similar pattern at the University of Illinois, with each department remaining an intact unit with its own chairman. The first Director of the new division was Frank Putnam, and McClung assumed (for a 3-year term) the duties of Assistant Director. The Divisional status was retained, with C.H.W. Hirs succeeding Putnam as Director after 3 years, until 1977, when the Division was replaced with a single Department of Biology and previous departmental curricula and degrees changed to programs. The Chairman of the new unified department from 1977 to 1979 was John Preer, a protozoologist. He was succeeded in 1979 by Gary Sojka, a microbiologist.

The following account will emphasize various aspects of the

bacteriology-microbiology program during the period 1940-1966, during which the author served as Chairman, with brief notes relative to the early period and to the post-1966 changes.

II. The Early Period

A previous review (McClung, 1941) reveals that the first course in bacteriology on the Bloomington campus was offered by Robert E. Lyons in the Department of Chemistry, about 1896. Beginning in 1892, Lyons had studied bacteriology at the University of Heidelberg, in Wiesbaden, in Jorgenson's laboratory in Copenhagen, and with Metchnikoff in Paris. The students in his course were primarily advanced undergraduate and graduate students in chemistry. A laboratory and media kitchen were available in Wylie Hall. The equipment was good for its time, having been purchased by Lyons in Europe for the most part. An independent study course was added in 1897-1898, and in 1902, a course in bacteriological chemistry. About 1900, additional instruction in bacteriology was added as a summer course at a lake station (initially, Turkey Lake and later, Winona Lake).

In the fall of 1903, a separate division as a medical department was established on the Bloomington campus, but soon this was transferred to Indianapolis (Myers, 1956). Wilfred H. Manwaring, later to be a member of the faculty at Stanford University and a well-known immunologist, was in charge of the bacteriology course in the medical program, aided in 1907 by Samuel W. Famulener. Students during this early era who achieved bacteriological fame include Leo F. Rettger, later of Yale University; James N. Currie, later of the Charles Pfizer Company, where he perfected a commercial process for production of citric acid; and I. M. Lewis, who became Professor in charge of bacteriology at the University of Texas.

III. The Modern Period

As noted above, the author was appointed in 1940 to the College faculty to establish a curriculum in bacteriology. As Assistant Professor, he offered two introductory courses during the first year; the first was a two-semester lecture-laboratory course for science majors, and the second, in the spring semester, was a brief course intended for home economics majors, although the majority of the enrollment consisted of majors from the other sciences. In both courses, the enrollment greatly exceeded the prediction of about 10-12 students; the major course enrolled 25 and the brief one, 59. Since the available laboratory room had only 24 stations, a third laboratory section was needed for the brief course, much to the amazement of the Dean (a professor of Latin). This third section occasioned the necessity (and the leverage) for additional faculty, and in the next year (1941-1942) John S. Sylvester, a

Ph.D. candidate at Wisconsin, was added and was assigned to the brief course.

Since the two-semester introductory course introduced some problems in the student's schedules, in 1941-1942, it was divided into separate courses, with the second semester titled "Applied Microbiology." The enrollment in this introductory course continued to climb in the early years until it reached 145 in 1948, and by then the course was being offered each semester and in the summer session; it later expanded to 345 per semester. The course number changed over the years and various members of the faculty took part in its development including: Bard, Brock, Gest, Poindexter, Ramaley, Rickenberg, and particularly Konetzka. In 1970, the traditional laboratory for the course was changed to an audiotutorial system designed by Konetzka.

In 1941-1942, a course in "Bacteriological Technique" was added, as was an independent "Advanced Problems" course with variable credit. The technique course was expanded and the title changed to "Diagnostic Microbiology" by Weinberg. Also initiated about this time was a "Seminar" (for advanced undergraduates and graduates) and a "Research" course (for graduate majors) for thesis research.

The next major addition to the curriculum (1946-1947) was a course in general "Virology," and this was offered by S. E. Luria, who had been appointed Instructor to succeed Sylvester upon his return to Wisconsin to complete his doctorate program. Luria was first assigned to the brief introductory course and the course in technique. Although at the time, courses in medical virology were rare at other institutions (and there were none in any undergraduate program), Luria's broad interest and training offered a unique opportunity to present basic information on bacterial viruses as well as those of interest in animal and plant pathology. With varying instructors (Weiss, Fraser, Taylor) through the years, and for a period of time with the title changed to include the rickettsia, the course has remained in the curriculum to the present.

The next major curriculum addition reflected the desire to include the van Nielian biology of bacteria type of training. With the appointment held open for a year to permit him to accept a Guggenheim Fellowship for study with Pringsheim at Cambridge, this type of training was offered by Roger Y. Stanier in 1946-1947, who also offered the first strictly graduate course, "Microbial Biochemistry." The undergraduate course was probably initially titled "Determinative Bacteriology," and, with varying titles, it has remained in the curriculum; other instructors include Bard, McClung, Stokes, Brock, and Hegeman. With the title "Biology of the Prokaryotes" at present, it is required for the undergraduate major.

During the period when Luria and Gunsalus were on the faculty, a new course was developed by them and titled, for want of a more descriptive name, "Advanced General Bacteriology." This course included advanced

material on bacterial morphology and cytology as well as aspects of the physiology of bacteria. Later, a portion of the material from this course was used to develop a new course, "Microbial Physiology and Biochemistry"; several of the faculty have been involved with the course, which has always been required. Introducing a required course in advanced chemistry, an innovation for a major in a program in undergraduate biology, was accomplished by making quantitative and organic chemistry prerequisites to the required physiology course. This was then the only mechanism for a requirement for a nondepartmental course.

With the appointment of Emilio Weiss to succeed Luria, it was possible to introduce a course in "Immunology." This was a course in fundamental immunology, with laboratory rather than applied serology. Weiss was succeeded by W. Dean Fraser, who taught both virology and immunology for a number of years. Later, the immunology course was dropped when Fraser assumed other duties. It has been reintroduced by J. R. Preer in 1980-1981.

"Medical (or Pathogenic) Bacteriology" was introduced by Weinberg in 1954. Originally, this was a combined lecture-laboratory course, but later, the laboratory credit was separated. Konetzka, has recently developed a special laboratory for the course. The lecture course has continued to grow and now rivals the introductory course in size. The newest course to be added to the curriculum is "Environmental Microbiology," which has been developed by Konetzka in recent years, though a course by the same title was taught by Koch for a few years.

A one-credit course, "Bacteriological Literature," was introduced by McClung as early as 1949. It has remained in the curriculum as one of the requirements for the B.S. degree and has recently been renamed "Biomedical Sciences Documentation." This course seeks to give the student training in the efficient use of current and old library resource materials. An additional one-credit course in "History of Microbiology" by Konetzka was offered for a few years from about 1958, but has been withdrawn from the curriculum.

"Mycology" has not been offered by the Department of Bacteriology (Microbiology) since an introductory (and some years advanced) course was offered by the Department of Botany (Plant Sciences). Early instructors included Marion Lohman, John R. Raper, Harold J. Brodie, Robert Johns, Stanley Dick, and, for the last several years, Michael Tansey. Similarly, a course in "Protozoology" was available in the Department of Zoology, with T. M. Sonneborn as instructor until lately, when Ruth Dippell has assumed responsibility for the course on the retirement of Sonneborn.

The first person to complete the A.B. degree requirements in bacteriology was Cornelius F. Sterling; this was in 1942. By 1966, the number increased to 174, and by 1979, to 392. The latter figure includes the recipients of both the A.B. and B.S. degrees. The first B.S. degree was conferred in 1974 and

since that time, the majority of the undergraduates have opted for this program, which includes a more strict list of course in the major and the cognate sciences. From the beginning, many of the undergraduate major continued their training to the M.A. and/or the Ph.D. in microbiology, with a number completing the M.D. or D.D.S. degrees. A good number of the early graduates are now faculty members at various institutions scattered throughout the country from Maine to California. Those who did not continue with graduate training have had success in careers in clinical or industrial microbiology.

As noted earlier, the first strictly graduate course "Microbial Biochemistry," was introduced by Stanier in 1946. On a visiting basis, Carl Robinow had presented a graduate course in bacterial cytology in 1946. The biochemistry course remained in the curriculum for a few years, with others participating in the instruction, but was withdrawn about the time some of the faculty of the department cooperated with members from Botany and Zoology to offer a new, broader-based course, "Molecular Aspects of Biology." In all versions, the laboratory was scheduled for the entire day on Saturday. The microbiology faculty has generally held that training in research rather than a proliferation of courses should dominate in graduate programs in the department. Hence, relatively few strictly graduate courses have been initiated. "Medical Microbiology" was introduced by Brock for medical and graduate microbiology majors in 1960-1961, when a special combined degree (medicine and speciality area research) program was added to the offerings on the Bloomington campus in addition to the standard M.D. curriculum on the medical school campus. With some success, a "rotating" course, "Recent Advances in Microbiology," has been used to present certain basic advanced material on a rotating schedule (by various instructors) and also for a single topic course, taught usually by a visiting faculty member. In late years, Gest has introduced "Prokaryotic Physiology," and White has offered "Microbiol Development."

The first M.A. degrees in bacteriology were conferred in 1943 on Raymond N. Doetsch and Allen P. Saunders. By 1966, 73 individuals had completed the M.A. requirements, and by 1979, the total was 118. One of the graduates, Robert F. Acker, who finished the Ph.D. degree elsewhere, now serves as the Executive Director of the American Society for Microbiology. The numbers of M.A. students for whom the faculty served as advisors were: Bard—3, Blumenthal—2, Brock—4, Fraser—7, Gest—2, Gunsalus—3, Hegeman—3, Koch—5, Konetzka—11, Luria—5, McClung—27, Poindexter—1, Ramaley—2, Repaske—1, Rickenberg—1, Sojka—2, Stokes—1, Taylor—6, Weinberg—25, Weiss—2, White—3, and faculty in other departments—2.

The first to complete the Ph.D. requirements was Raymond C. Bard, in 1949. By 1966, 31 individuals had completed the requirements, and by 1979,

the number was 73. Many of the Ph.D. graduates have assumed teaching positions on the faculties of various universities or important positions in federal research laboratories. Only one will be mentioned by name—Willis A. Wood, now Chairman of the Department of Biochemistry at Michigan State University and the 1980 President of the American Society for Microbiology. Another illustrious graduate of Indiana University, James D. Watson of DNA structure fame, technically filled the Ph.D. requirements in the Department of Zoology, although Professor Luria in Bacteriology served as the major professor and supervised the thesis work in Luria's quarters in Kirkwood Hall. A list of those awarded the Ph.D. degree, together with the thesis title and the name of the advisor, is given in the Appendix.

From the beginning, aid to graduate students in the form of teaching assistantships (now called associate instructors) was available. Since the total departmental enrollment in laboratory courses was not huge, only two such assistantships existed initially; there are now about 12 per year. This aid was insufficient to support all who were admitted to the graduate program so it became necessary to seek additional funds for this purpose. Fortunately, just as the problem was becoming critical in our program, the National Institutes of Health announced a new program of training grants. The department immediately made application; when approved, it had one of the first such programs in microbiology. Beginning in 1959 for a 5-year period, with W. Dean Fraser designated as the Principal Investigator, the program, with successive renewals, continued until the mid-1970s, when the NIH predoctoral training grant program was phased out. From the grant, funds were available to support about 12 predoctoral and one or two postdoctoral students each year. These funds also permitted the department to bring in 12 or more distinguished seminar speakers per year. A limited amount of support, often for summer fellowships for those on teaching assistantships during the academic year, was available from the Bayard Floyd Fund, a designated bequest to the Indiana University Foundation from an early major in the biological sciences.

IV. Faculty and Research

Over the years, the faculty has changed and expanded in number. Rather than include a chronological list of the changes, the following list includes the major appointments, together with their teaching assignments, their educational backgrounds, and, when pertinent, their post-Indiana University (IU) appointments. The earlier faculty appointments, as well as those of the modern group, brought to the program a wealth of experience and personal achievement. At one time, all members of the faculty who were eligible to apply had held Guggenheim Fellowships. The individuals are listed here in alphabetical order.

BARD, RAYMOND C. (B.S., 1938, College of the City of New York; M.A., 1947, Ph.D., 1949, Indiana University) *At IU*: Instructor, 1949-1951; Assistant Professor, 1951-1953. *Teaching*: Introductory Bacteriology, Bacteriological Technique, Advanced General Bacteriology. *Research*: bacterial metabolism. *Post-IU*: Head, Microbiology Section, Research and Development Division; Associate Director of Research and Development; Vice President and Director of Research, National Drug Company, Philadelphia (1953-1962). Director of Research, College of Dentistry; Assistant Vice President for Research; Executive Director, University of Kentucky Research Foundation; Professor of Cell Biology (1962-1967). Professor of Cell and Molecular Biology and Dean, School of Allied Health Sciences, Medical College of Georgia, Augusta, Georgia (1967-present).

BLUMENTHAL, THOMAS (A.B., 1966, Antioch College; Ph.D., 1970, Johns Hopkins University) *At IU*: Assistant Professor, 1973-1977; Associate Professor, 1977-present. *Teaching*: Molecular Aspects of Biology, Microbial Genetics. *Research*: genetics of bacteria and bacterial viruses. Guggenheim Fellowship, 1980; Fogarty Fellowship, 1980.

BROCK, THOMAS D. (B.S., 1949; M.S., 1950, Ph.D. 1952, Ohio State University) *At IU*: Associate Professor, 1960-1964; Professor, 1964-1970. *Teaching*: Medical Microbiology, Biology of Bacteria. *Research*: mechanism of action of antibiotics, amino acid transport systems, bacteriocines and bacteriophages, yeast genetics, ecology of bacteria (particularly in high thermal environments). *Post-IU*: E. B. Fred Professor, Department of Bacteriology, University of Wisconsin. NIH Career Development Award, 1980.

FRASER, W. DEAN (B.S. Harvard University, 1938; M.S., 1939, Ph.D., 1941, University of Illinois) *At IU*: Associate Professor, 1955-1960; Professor, 1960-present; Chairman, Department of Microbiology, 1970-1976. *Teaching*: Virology, Immunology, and Introductory Biology, Strategy of Life (nonmajor course). *Research*: morphology, molecular biology and genetics of bacterial viruses, and biology of mycoplasma.

GEST, HOWARD (A.B., 1943, University of California-Los Angeles; Ph.D., 1949, Washington University) *At IU*: Professor and Chairman, Department of Microbiology, 1966-1970; Professor, 1970-1979; Distinguished Professor, 1979-present. Guggenheim Fellowships, 1970, 1979. *Teaching*: Introductory Microbiology, Biology of Bacteria Laboratory, Prokaryote Physiology, and a large group of postdoctorates. *Research*: comparative biochemistry of photosynthetic processes.

- GUNSALUS, IRWIN C. (B.S., 1935; M.S., 1937, Ph.D. 1940, Cornell University) *At IU*: Professor, 1947-1959. *Teaching*: Advanced General Bacteriology, Microbial Biochemistry. *Research*: microbial biochemistry. *Post-IU*: Professor and Head of Department (1955-1966) of Biochemistry, University of Illinois. Guggenheim Fellowships, 1949, 1959, 1968. Member National Academy of Sciences.
- HEGEMAN, GEORGE D. (A.B., 1960, Harvard University; Ph.D., 1965, University of California-Berkeley) *At IU*: Associate Professor, 1972-1978; Professor, 1978-present. *Teaching*: Biology of Prokaryotes. *Research*: microbial biochemistry; microbial metabolism, regulation, and genetics.
- KOCH, ARTHUR L. (B.S., 1948, California Institute of Technology; Ph.D. 1951, University of Chicago). *At IU*: Professor, 1967-present. *Teaching*: Environmental Microbiology, Introductory Biology. *Research*: microbial physiology and metabolism, prokaryote evolution, biophysical aspects of microbiology.
- KONETZKA, WALTER A. (A.B., 1950, M.S., 1952, Ph.D., 1954, University of Maryland) *At IU*: Assistant Professor, 1955-1959; Associate Professor, 1959-1963; Professor, 1963-present. *Teaching*: General Microbiology of Bacteria, Applied Microbiology, History of Bacteriology, Environmental Microbiology, Medical Microbiology Laboratory. *Research*: microbiology of lignans, bacterial nutrition, antimicrobial agents, magnetotactic bacteria. Distinguished Teaching Award, IU, 1965; ASM Carski Award for Teaching, 1970. Senior Teaching Awards, 1970, 1974, 1978. *Post-IU*: University of Maryland-Baltimore County Campus, 1966-1968.
- LURIA, SALVADOR E. (M.D., 1935, University of Torino, Italy) *At IU*: Instructor, 1943-1945; Assistant Professor, 1945-1947; Associate Professor, 1947-1950. *Teaching*: Bacteriological Technique, Virology. *Research*: genetics of bacteria and bacterial viruses. *Post IU*: Professor of Bacteriology, University of Illinois, 1950-1959; Professor of Microbiology and Sedgwick Professor of Biology, Institute Professor, Massachusetts Institute of Technology, 1959-1978. From 1972, Director of Cancer Research. Nobel Prize, 1969; Lenghi Prize, Accademia dei Lincei, 1965. Honorary doctorates: Indiana University and Rutgers University, 1970; Providence College, 1972; Brown University, 1973; University of Palermo, 1973. Member National Academy of Sciences, American Philosophical Society; President, American Society for Microbiology, 1967-1968.

- McCLUNG, LELAND S. (A.B., 1931, M.A., 1932, University of Texas; Ph.D., 1934, University of Wisconsin) *At IU*: Assistant Professor, 1940-1944; Associate Professor, 1944-1948; Professor, 1948-present; Chairman, Department of Bacteriology, 1946-1966; Assistant Director, Division of Biological Sciences, 1965-1968. *Teaching*: General Bacteriology, Applied Bacteriology, Determinative Bacteriology, Biomedical Sciences Documentation, Man and Microorganisms (nonmajor course). *Research*: taxonomy of *Clostridium*, *Serratia*, *Aeromonas*; ecology of clostridia; bacteriophagy of *Clostridium perfringens*; food microbiology, particularly *C. perfringens* as agent of food poisoning; history of microbiology. Films on introductory biology and microbiology. Director of NSF Summer Institutes in Microbiology for High School Teachers, Delegate to Binational Conferences on Biological Education (Japan, 1966; India, 1971). Guggenheim Fellowship, 1940.
- POINDEXTER, JEANNE STOVE (A.B., 1958, Indiana University; M.A., 1961, Ph.D., 1963, University of California-Berkeley) *At IU*: Assistant Professor, 1964-1967. *Teaching*: Introductory Microbiology. *Research*: microbial ecology and taxonomy. *Post-IU*: City College of New York, Public Health Research Institute of New York.
- POLISKY, BARRY A. (BA., 1961, University of Chicago; Ph.D. 1973, University of Colorado) *At IU*: Assistant Professor, 1977-present. *Teaching*: Molecular Biology and Genetics. *Research*: expression of eukaryotic DNA in bacteria. NIH Career Development Award, 1980.
- RAMALEY, ROBERT F. (A.B., 1959, M.S., 1962, Ohio State University; Ph.D. 1962, University of Minnesota) *At IU*: Assistant Professor of Microbiology, 1966-1972. *Teaching*: Introductory Microbiology, Molecular Aspects of Biology Laboratory. *Research*: microbial biochemistry. *Post-IU*: Associate Professor, Department of Microbiology, Creighton University.
- REPASKE, ROY (B.S., 1948, Western Reserve University; M.S., 1950, University of Michigan; Ph.D. 1954, University of Wisconsin) *At IU*: Instructor, 1953-1955; Assistant Professor, 1955-1959. *Teaching*: General Bacteriology, Microbial Metabolism. *Research*: carbon dioxide metabolism, mechanism of oxidative metabolism. *Post-IU*: Laboratory of Microbiology, National Institute of Allergy and Infectious Diseases.
- RICKENBERG, HOWARD V. (B.S., 1950, Cornell University; Ph.D., 1954, Yale University) *At IU*: Associate Professor 1961-1963; Professor, 1963-1968. *Teaching*: Microbial Physiology; Molecular Aspects of Biology. *Research*: regulation of enzyme formation. *Post-IU*: Director, Division of Molecular and Cellular Biology, National Jewish Hospital

and Research Center; Professor, University of Colorado School of Medicine. Editor, *Microbiological Reviews*, 1979-present.

ROBINOW, CARL FRANZ (M.D., 1935, University of Hamburg) *At IU*: Visiting Professor, 1946-1947. *Teaching*: Cytology of Bacteria. *Research*: cytological studies on genus *Bacillus*. *Post-IU*: Faculty, University of Western Ontario.

SOJKA, GARY (A.B., 1962, Coe College; M.S., 1965, Ph.D., 1967, Purdue University) *At IU*: Research Associate, 1967-1969; Assistant Professor, 1969-1973; Associate Professor, 1973-1979; Professor, 1979-present; Chairman, Department of Biology, 1979-present. *Teaching*: Microbial Cell Biology, Physiology and Biochemistry of Microorganisms, Introductory Biology. *Research*: metabolic mechanisms and genetics of photoheterotrophic photosynthetic bacteria. IU Award for Distinguished Teaching, 1977.

STANIER, ROGER YATE (B.A., 1936, University of British Columbia; M.A., 1940, University of California-Los Angeles; Ph.D., 1942, Stanford University) *At IU*: Assistant Professor, 1946-1947. *Teaching*: Biology of Bacteria, Microbial Biochemistry. *Research*: biology of the myxobacteria, bacterial metabolism, metabolic pathways. *Post-IU*: University of California-Berkeley, 1947-1971; Institut Pasteur 1971-1980. *Honors*: Eli Lilly Award, 1950; American Academy of Arts and Sciences (Boston), 1955; Emil Christian Hansen Award, 1976; Chevalier de la Legion d'Honneur, 1977; Fellow of the Royal Society, 1978. Honorary Doctorates: Reims, 1973; Chicago, 1978. Member National Academy of Sciences, 1979; Honorary Member, American Society for Microbiology, 1979.

STOKES, JACOB LEO (B.S., 1934, Rutgers University; M.S., 1936, University of Kentucky; Ph.D., 1939, Rutgers University) *At IU*: Associate Professor, 1950-1953. *Teaching*: Determinative Bacteriology, Microbial Biochemistry. *Research*: microbial ecology and biochemistry. *Post-IU*: Bacteriologist, Western Utilization Research Laboratory, USDA, 1953-1957; Professor and Chairman, Department of Bacteriology and Public Health, Washington State University, Pullman, Washington, 1959-present.

SYLVESTER, JOHN C. (B.S., 1939, M.S., 1940, Ph.D. 1943, University of Wisconsin) *At IU*: Instructor, 1941-1942. *Teaching*: Introductory Bacteriology. *Research*: bacteriophagy of butyl alcohol organisms. *Post-IU*: Research bacteriologist, then Director of Experimental Biology Division, Abbott Laboratories, North Chicago, Illinois. Chairman, Inter-

science Conference on Antimicrobial Agents and Chemotherapy, 1962; American Academy of Microbiology, Board of Governors, 1963-1965.

TAYLOR, MILTON (B.S., 1961, Cornell University; Ph.D., 1966, Stanford University. *At IU*: Assistant Professor, 1967-1970; Associate Professor, 1970-1976; Professor, 1976-present. *Teaching*: Virology. *Research*: viral regression of tumors, viral RNA synthesis, molecular virology.

WEINBERG, EUGENE D. (B.S., 1942, University of Chicago; U.S. Army 1942-1947; M.S., 1948, Ph.D., 1950, University of Chicago) *At IU*: Instructor, 1950-1953; Assistant Professor, 1953-1957; Associate Professor, 1957-1960; Professor, 1961-present. Interim Chairman, 1976-1977; Associate Dean, Research and Graduate Development, 1978-1980. *Teaching*: Diagnostic Microbiology, Medical Microbiology. *Research*: trace metal effects on antimicrobial agents, synthesis and roles of secondary metabolites, effects of metals on infectious processes. IU Award for Distinguished Teaching, 1974.

WEISS, EMILIO (A.B., 1941, University of Kansas; M.S., 1942, Ph.D., 1948, University of Chicago) *At IU*: Assistant Professor, 1950-1953. *Teaching*: Virology and Immunology. *Research*: virology. *Post-IU*: Rickettsia Division, Chemical Corps Biological Laboratories, Camp Detrichu, 1953-1954; Assistant Head, Virology Division; Deputy Director, Department of Microbiology; Chairman, Department of Microbiology, Naval Medical Research Institute, 1954-present. Also Professor, Department of Preventive Medicine and Biometrics, Uniformed Services, University of the Health Sciences, 1977-present.

WELSHIMER, HERBERT J. (B.S., 1943, Ph.D. 1947, Ohio State University) *At IU*: Instructor, 1947-1949. *Teaching*: Bacteriological Techniques, Introductory Bacteriology. *Research*: cytology of bacteria. *Post-IU*: Faculty Department of Bacteriology, Medical College of Virginia.

WHITE, DAVID (A.B., 1958, Ph.D., 1965, Brandeis University) *At IU*: Assistant Professor, 1967-1973; Associate Professor, 1973-present. *Teaching*: Introductory Microbiology, Developmental Biology, Cell Biology, Bacterial Physiology. *Research*: developmental microbiology, bacterial physiology, biology of myxobacteria.

Almost all of the faculty have been successful in securing from various sources (e.g., NSF, NIH, USDA, AEC) grants of some magnitude to support their research programs. In addition to moneys for equipment, consumable

supplies, and full time assistants or associates, many of these grants have been sufficient to support one or more graduate students who serve as research assistant. Traditionally, the teaching load for a new faculty member is purposely kept light during at least the first two semesters in order to encourage and permit the initiation of a vigorous research program. A steady flow of publications is expected of those who are considered for raise in academic rank.

Space and time do not permit the listing of individual research projects. This is regretted because a number of fundamental discoveries that have opened new areas for investigation were made in the faculty research programs.

V. Physical Facilities

No separately designated facilities for bacteriology existed on the Bloomington campus in 1940, and no space was available in the Biology Building, which housed Botany and Zoology. To accommodate the initial phases of the new curriculum, three rooms on the west end of the third floor of the Chemistry Building were made available. By the start of the first semester, the rooms had been cleared of the former occupants but the promised changes for bacteriology had not been initiated; the first laboratory session actually took place in November. One of the rooms was sufficiently large to accommodate tables for 24 student stations, leaving in place a long chemical bench that could be used for demonstrations and for advanced students working during laboratory hours of the introductory course(s). Vertical to the remaining long wall were four smaller rooms. These were converted to 37°C and room temperature incubator rooms, a storeroom, and a media kitchen complete with autoclave, Arnold sterilizer, and a small mechanical dishwasher. The storeroom soon became inadequate and items were placed in corridor cabinets and atop an additional walk-in incubator with shaker for advanced problem and faculty research on X-ray mutants of *Penicillium* for penicillin production.

One of the other smaller rooms had been partitioned; the front of this was used as the department (and faculty) office and the remaining portion as a faculty (McClung) laboratory, since it already had a chemical bench. Since only 6 V electricity was available in the room, some changes were necessary. The remaining room of similar size included a long chemical bench (again with 6 V electricity) and was hence designated for graduate students, and, in the second year, for a new faculty member. Very soon a portion of this room had to be used as a small enclosure for animal quarters—hardly pretentious for a future Nobel Prize winner (Luria) in his first permanent United States position.

During the war years, the enrollment in bacteriology increased although it declined in the other sciences; it therefore became imperative to move to

larger quarters since expansion within the Chemistry Building was not possible. In searching for space—any reasonably unoccupied area on the campus that could be converted to useful laboratory space—during a fourth of July (1946) sleuthing expedition (when most buildings would be unoccupied), a possible space was located, although it had several undesirable features. This was the attic fourth floor of the language building, Kirkwood Hall, in which there was no elevator, and, in the attic, no water, minimal electricy, and of course no steam line. It did have the redeeming feature of space, however—two large rooms plus two other fairly large rooms and two or three smaller ones. It was then occupied almost solely by a retired professor who used one of the rooms for office space and cluttered the remainder with plaster busts of Cicero, and sundry other discards, including the stage for the university theater. Since all other space located that day had even more objectional features, the Administration approved the choice (the department offered as first choice a large, three-story frame house, with full private knowledge that it would not be available, since it was already scheduled to be renovated for use as the first dormitory for Black women, who then were not eligible for assignment in the only Women's Residence Quadrangle). Soon after approval by the Administration, plans were developed for the conversion of the Kirkwood attic space.

One of the large rooms could accommodate the existing teaching laboratory tables (and another allowing expansion to 32 students per section) for the introductory course(s) and still leave space for a walk-in room temperature incubator (an old cold storage unit) and storage cabinets for precision glassware and chemicals. Space for 37°C incubation was created by opening up sections of under-the-eaves areas and even a small laboratory for the technician was possible, for quality testing of water and milk purchased by the university dormitory and union kitchens. In the Chemistry Building days, these tests had been done on a half-time basis by the half-time department secretary. Now the work load for the secretarial duties required a full-time person, so the bacteriological testing was assigned to another half-time appointee, who served as the stock culture curator.

A small room at the corner of the teaching laboratory served as the media kitchen (with the autoclaves in the student laboratory). Adjacent to this room, and connecting to a smaller glassware-washing and sterilization area, was a room without windows but already provided with floor-to-ceiling (20 foot!) shelving; this was used for storage of sterile glassware and bulk supplies.

The second of the larger rooms was divided by an 8-foot partition; one side was used as a laboratory for advanced courses, and the other as a research laboratory for graduate students. Office-study areas for these students were provided again by opening up under-the-eaves areas with portions being

reserved for a 37°C incubation and a "sterile" transfer area—sterile by virtue of a shielded ultraviolet light near the ceiling. When such areas were floored and desks placed against the slanted roof, it was still possible to stand in front of the desks—not ideal, but suitable.

The two larger of the additional rooms were outfitted with chemical bench, hoods, 30-in.-high tables, and an enclosed office cubicle, and were used by the faculty. One of the other rooms was used for several years as the animal quarters (until pressure of space moved the animals to a then-available quonset hut, about 1949), and another, quite a bit smaller, as an office-laboratory for an instructor.

It is recalled that the conversion of this attic area for laboratory space, despite funds being available to bring in the needed electricity, water, and steam, was not without some manpower problems. This was due to the fact that the university was moving to the campus 250 trailers to serve as postwar student housing and the same workmen were needed for both projects. On a give-and-take basis, both projects were completed by the fall of 1946, and bacteriology moved to its new spacious quarters early in the fall semester. It should be mentioned that for ventilation, large fans were installed in the ceilings (about 30 feet high) of the two large rooms used for teaching; these provided the only means of temperature control during the hot summer months. For teaching, as far as possible, agar plates were poured in the early morning hours, since by the time of the afternoon laboratory session, 2-3 hours would be required for agar in petri plates to harden sufficiently to be streaked. One exception to this was provided for the laboratory work of Professor Luria; his laboratory was air-conditioned, or at least air-cooled. This laboratory also had an open under-the-eaves area for students, including James D. Watson, working with Luria.

Space for the departmental secretary and an office for the chairman were provided by partitioning a section at the top of the stairs, and a small room behind this served as the chairman's laboratory. A walk-in commercial cold storage room was placed in the area.

Enrollment increases and space for additional faculty demanded expansion to the third floor by 1950. It was hence with great relief that plans were announced in 1951 for a new Biology Building that would include space for Bacteriology as well as Botany and Zoology.

The new building—Jordan Hall of Biology—was dedicated and occupied in 1955. McClung was a member of the planning committee, thus using his early training in engineering. Built of Indiana limestone at a cost of \$5,750,000, this five and one-half floor air-conditioned building contained 207,000 square feet, and Bacteriology was assigned sufficient modern space. This consisted mostly of the entire fourth floor (except for one wing that was used for animal quarters and shared with Zoology), the east wing of the third

floor, and two laboratories on the fifth floor, together with a small greenhouse. The particular space assignment was chosen to permit the bacteriological laboratories to be as far away as possible from front lobby dust contamination and to allow trucking of glassware on a horizontal basis rather than vertically.

Initially, three teaching laboratories were provided, one of which was soon converted to faculty use. Two of these were separated and commonly served by three walk-in constant-temperature rooms. One laboratory, used primarily for introductory courses, had 42 stations and the other, primarily for advanced courses, had 32 stations plus a double chemical bench and space for sterilizers and other equipment. The various faculty suites consisted of office, laboratory, and an adjacent—or across the hall—additional laboratory for graduate students. The service area (central media kitchen, glassware facility, and storeroom) was spacious and conveniently located. Additional storage area and specialty rooms were located in the basement. Separate smaller media kitchens and sterile glassware storage for graduate student use were provided on each floor, as were darkrooms, walk-in incubators, and cold storage.

From extremely modest initial holdings in 1940, the bacteriology library had been brought to top quality by funds provided by a new university librarian who had given carte blanche order authority on the basis of "order what you need for a good library in your field." Prior to 1955, the library for bacteriology had been combined with, although shelved separately from, the chemistry holdings in the Chemistry Building. With the move to Jordan Hall, it was natural to combine the bacteriology volumes with the holdings of Botany and Zoology to make a unified Biology Library.

Although she cannot be termed a "facility," it seems an appropriate place—since she was so intimately concerned with the planning of bacteriology quarters in Kirkwood and Jordan and provided extraordinary service to all courses and research programs—to acknowledge the invaluable assistance of Helen Ruggles Arthur, who was first appointed on June 12, 1945, to the position of "Media Technician." She was a graduate of a local rural high school, without any training in science much less a degree in bacteriology. The position had just been made full time, and carried the added duties of animal caretaker in the summer when NYA students were not available. She has grown with the position during the years, and now has the title of "Administrative Assistant to the Chairman." She quickly learned how to correctly prepare, dispense, and sterilize various media, varying in quality from simple to complex and in volume from small amounts to 100-liter batches. She learned how to order supplies and equipment for the best price advantage, to service equipment, to read blueprints, and a variety of other skills, including being "mother confessor" to the majority of the graduate majors and the faculty!

APPENDIX

LIST OF PH.D. RECIPIENTS, 1949-1979

Number	Year	Name	Thesis title	Advisor
1	1949	Bard, Raymond Camillo	A function of iron in the metabolism of <i>Clostridium perfringens</i>	I. C. Gunsalus
2	1950	Roessler, William George	<i>Clostridium sporogenes</i> and related proteolytic anaerobic bacteria	L. S. McClung
3	1950	Wood, Willis Avery	The mechanism of D-amino acid formation: An alanine racemase from <i>Streptococcus faecalis</i>	I. C. Gunsalus
4	1951	De-Moss, Ralph Dean	The intermediary carbohydrate metabolism of <i>Leuconostoc mesenteroides</i>	R. C. Bard
5	1951	Dolin, Morton Irwin	Studies on the pyruvate and alanine metabolism of <i>Streptococcus faecalis</i>	I. C. Gunsalus
6	1951	Feldman, Louis Israel	Transaminases: Bacterial enzymes for aliphatic, aromatic, and polyfunctional amino acids	I. C. Gunsalus
7	1951	Rhutland, Lionel Edward	The mechanism of tryptophane synthesis by <i>Lactobacillus arabinosus</i> ; The role of anthranilic acid	R. C. Bard
8	1951	Gary, Norman Dwight	The effect of nutrition on the carbohydrate metabolism of <i>Bacillus subtilis</i> (Marburg)	R. C. Bard
9	1953	Pine, Martin Joseph	The formation of formic dehydrogenase and other adaptive enzymes by micro-organisms	J. L. Stokes
10	1954	Shankar, Kirpa	The effect of magnesium on the growth and metabolism of <i>Clostridium perfringens</i> BP6K	R. C. Bard
11	1956	Sames, Richard William	Studies on the bacteriophages of <i>Clostridium perfringens</i>	L. S. McClung
12	1957	Josten, John J.	Oxidation and electron transport in <i>Azotobacter</i> extracts	R. Repaske
13	1958	Cook, Elizabeth Anne	Studies on the influence of the metallic ion environment of the growth of yeast and on the antimicrobial activity of juglone and kojic acid	E. D. Weinberg
14	1959	Bain, William Murray	An investigation of cross-resistance in <i>Escherichia coli</i>	W. A. Konetzka
15	1959	Stone, Robert Louis	An examination for phage-mediated genetic transfer mechanisms in <i>Staphylococcus aureus</i>	W. D. Fraser
16	1959	Wittenberger, Charles Louis	Hydrogen oxidation and electron transport in species of <i>Hydrogenomonas</i>	R. Repaske

(Continued)

APPENDIX (Continued)

Number	Year	Name	Thesis title	Advisor
17	1960	Crane, Anatole	Changes in surface properties associated with cross-resistance in <i>Escherichia coli</i>	W. A. Konetzka
18	1960	Pfau, Charles Julius	Properties of <i>E. coli</i> susceptible to the protoplast-infective agent P1	W. D. Fraser
19	1960	Woodings, Eric Torrance	The microbial dissimilation of aromatic methyl ethers	W. A. Konetzka
20	1961	Kaufman, Bernard	The physiology of carbohydrate formation by <i>Azotobacter vinelandii</i>	R. Repaske
21	1962	Smith, James Lee	Biochemical mechanisms of action of bacitracin	E. D. Weinberg
22	1963	Berrah, Ghoulam	The dissociation of macromolecular biosynthesis by phenethyl alcohol	W. A. Konetzka
23	1963	Escobar, Mario Rene	Serological studies of the genus <i>Serratia</i>	L. S. McClung
24	1963	Lukemeyer, Jack W.	Studies on the antimicrobial properties of perphenazine	E. D. Weinberg
25	1965	Kessler, Donald P.	Methylglucoside transport and catabolic repression in <i>E. coli</i>	H. V. Rickenberg
26	1965	Roeser, Joanne	Chromosome transfer and the DNA replication cycle in <i>Escherichia coli</i>	W. A. Konetzka
27	1965	Treich, Ronald W.	Control of deoxyribonucleic acid synthesis in <i>Escherichia coli</i> by B-phenethyl alcohol	W. A. Konetzka
28	1965	Vidaver, Anne M. Kopecky	Characteristics of a <i>Streptococcus faecium</i> bacteriophage	T. D. Brock
29	1966	Boyle, James Vincent	Studies on an antifungal antibiotic produced by <i>Streptomyces</i> sp. JM57h	E. D. Weinberg
30	1966	Davie, Joseph Myrten	The molecular basis of resistance to the bacteriocins of <i>Streptococcus pyogenes</i>	T. D. Brock
31	1966	Malacinski, George Michael	Physiological and biochemical aspects of the bacterial oxidation of orthophosphite	W. A. Konetzka
32	1967	Fuscaldo, Anthony Alfred	The radiological and physical properties of coliphage C-1	W. D. Fraser
33	1967	Mohlolt, Bruce Andrew	Host-controlled modification and restriction of T-even bacteriophages	W. D. Fraser
34	1968	Crandall, Marjorie Ann	Biochemical and genetic studies of sexual agglutination in the yeast <i>Hansenula uingei</i>	T. D. Brock
35	1968	Steenbergen, James F.	The role of zinc and cadmium in the nutrition and physiology of <i>Torulopsis fermentans</i> and certain other yeasts	E. D. Weinberg
36	1969	Hsie, Abraham Wuhsiang	Aspects of glyconeogenesis and catabolic repression in <i>Escherichia coli</i>	H. V. Rickenberg
37	1969	Kelly, Michael Thomas	Physiological ecology and biochemical geography of <i>Leucothrix mucor</i>	T. D. Brock

38	1969	Witner, Heman John	Photodynamic action of proflavine on coliphage T3	W. D. Fraser
39	1970	Bernstein, Kenneth	Physiological and evolutionary studies on the "RC" locus of <i>Escherichia coli</i>	A. L. Koch
40	1970	Choe, Byung-Kil	Transfer RNA synthesis in mammalian cells	M. W. Taylor
41	1970	Dancis, Barry Martin	The effect of amino acids on the total rate of RNA synthesis in <i>Escherichia coli</i>	A. L. Koch
42	1970	Doemel, William Naylor	The physiological ecology of <i>Cyanidium caldarium</i>	T. D. Brock
43	1970	Fernald, Nancy Jane	Purification and properties of ω -amidase from <i>Bacillus subtilis</i> 168 and <i>Thermus aquaticus</i> YT-1	R. Ramaley
44	1970	Lee, Kuo-Yung	Effect of magnesium, manganese, iron, calcium and zinc on the growth and sporulation of <i>Bacillus megaterium</i>	E. D. Weinberg
45	1970	Nath, Kamalendu	Protein degradation in <i>Escherichia coli</i>	A. L. Koch
46	1970	Norris, Thomas Elfred	Controls affecting RNA synthesis in a chemostat system of <i>Escherichia coli</i> involving different growth rates	A. L. Koch
47	1970	Ray, Paul Herman	The effect of temperature on the spheroplasts of two mesophilic bacteria and on the lipid composition of <i>Thermus aquaticus</i>	T. D. Brock
48	1970	Sedmak, Gerald Victor	I. Biochemical and physical studies of coliphage C-1 II. The binding of cations to T2 DNA	W. D. Fraser
49	1970	Sedmak, Joseph James	Purification and properties of <i>B. subtilis</i> 168 nucleoside diphosphokinase and its phosphorylated form	R. Ramaley
50	1970	Wall, Thomas Randolph	The host-dependent restriction of mengovirus replication	M. W. Taylor
51	1970	Zeikus, Joseph Gregory	Studies of the protein synthesizing apparatus of an extreme thermophile, <i>Thermus aquaticus</i>	T. D. Brock
52	1970	Zilinsky, Joseph William	Studies on the physiology and biochemistry of the photosynthetic bacterium, <i>Rhodospseudomonas capsulata</i>	H. Gest
53	1972	Bland, Judith Ann	<i>Leucothrix mucor</i> as an algal epiphyte in the marine environment	T. D. Brock
54	1972	Fliermans, Carl Bernard	The ecological significance of chemotrophic bacteria in hot acid soils	T. D. Brock
55	1972	Johnson, Roosevelt Young	The cell wall of <i>Mycrococcus xanthus</i> : Chemical changes related to morphogenesis	D. White

(Continued)

APPENDIX (Continued)

Number	Year	Name	Thesis title	Advisor
56	1972	Ouellette, Andrew Joseph	Comparison of phenylalanyl-tRNA synthetase and transfer RNAs of liver and Morris hepatoma 5123D	M. W. Taylor
57	1972	Weiss, Richard Lawrence	Survival of bacteria in extreme environments	T. D. Brock
58	1973	Cordell-Stewart, Barbara	Mechanism of bovine enterovirus-1-induced oncolysis and cytopathology	M. W. Taylor
59	1973	Lueking, Donald Robert	Studies on the glycerol metabolism of the non-sulfur purple photosynthetic bacterium, <i>Rhodospseudomonas capsulata</i>	C. Sojka
60	1974	Orlowski, Michael Edward	Regulation and properties of isocitrate lyase from developing myxospores of <i>Mycrococcus xanthus</i>	D. White
61	1974	Poos, Jocelyn Carol	Aspects of growth and cell division in the bacterium <i>Flexibacter</i>	D. White
62	1974	Prather, Suzanne Virginia	I. Restricted mengovirus replication in MDBK cells. II. Effects of cordycepin on mengovirus replication in HeLa cells	M. W. Taylor
63	1974	Yen, Hwei-Che	Regulation of biosynthesis of aspartate family amino acids in the photosynthetic bacterium <i>Rhodospseudomonas palustris</i>	H. Gest
64	1975	Kottell, Randall Henry	Isolation and characterization of the myxospore of <i>Mycrococcus xanthus</i>	D. White
65	1975	Su, Tzyh Chuan Robert	Bovine enterovirus-1: Characterization, replication, and maturation	M. W. Taylor
66	1976	Failla, Mark Lawrence	Zinc transport and metabolism in <i>Candida utilis</i>	E. D. Weinberg
67	1976	Nielson, Allen Madsen	Studies on the photosynthetic metabolism of acetate by <i>Rhodospseudomonas capsulata</i> strain "St. Louis"	C. Sojka
68	1977	Dubos, Michael Scott	The function and distribution among procaryotes of host factor for coliphage Q β RNA replication	T. Blumenthal
69	1978	Bowman, Llewellyn Harper, III	Studies on the distribution of glycerophosphate dehydrogenase in the membranes of the non-sulfur photosynthetic bacteria <i>Rhodospseudomonas capsulata</i> and <i>Rhodospseudomonas sphaeroides</i>	C. Sojka
70	1978	Kirkconnell, Scott Wolfe	Bacterial oxidation of carbon monoxide	G. Hegeman
71	1978	Moench, Thomas Taylor	Distribution, isolation and characterization of a magnetotactic bacterium	W. A. Kometzka
72	1979	Beremand, Phillip	Events associated with energy perturbations and amino acid starvation in <i>Rhodospseudomonas capsulata</i>	C. Sojka
73	1979	Blumberg, Gerald R.	The nucleoid of <i>Escherichia coli</i> B/r and related physiological studies	A. L. Koch

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