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Viewpoint

Early Champions of Research in Chemistry with Undergraduates: From William Albert Noyes to Percy Lavon Julian

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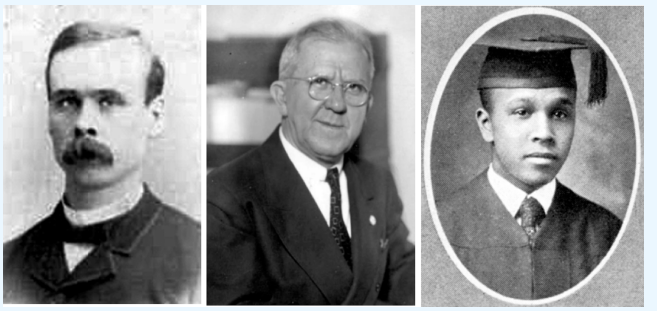
ABSTRACT: Research in chemistry with undergraduates is commonplace today, including in many liberal arts colleges. This educational opportunity for undergraduates goes back to the late 1800s, exemplified by William Albert Noyes at Rose Polytechnic, and was honed to an almost graduate-level experience by Percy Lavon Julian at DePauw University in the early 1930s. The connection between Noyes and Julian is discussed in this report. The article traces the origins of scholarly research performed by undergraduate students by Noyes at an institution that is now called the Rose-Hulman Institute of Technology. This model was then replicated and substantially expanded at DePauw University by Noyes's former colleague, William Martin Blanchard. Through sheer happenstance and a series of unfortunate incidents, Julian found himself entrusted with the task of running the undergraduate chemistry research program at DePauw in 1932. Julian's exceptional ability to mentor undergraduate students and to accomplish significant advances in synthetic organic chemical methodologies was highly successful despite the challenging circumstances of racial division, limited financial resources at DePauw during the Great Depression, and job uncertainty (as Julian was being paid by "soft money"). These experiences were undoubtedly formative in shaping Julian's career as a prominent scholar, inventor, and entrepreneur, and to his eventual legacy as one of the most inspirational chemical researchers in history. Julian's mentees at DePauw would also go on to have notable careers in the chemical sciences and allied scientific and academic disciplines.



INTRODUCTION

Today, Percy Julian (1899−1975) is most remembered as a role model, especially for young Black students who are considering a career in science, technology, engineering, mathematics, or medicine. Julian was the first African American chemist inducted into the National Academy of Sciences. He was a highly successful medicinal and natural products chemist and ultimately a pharmaceutical entrepreneur. His professional and financial successes provided Julian opportunities that he seized with vigor, ultimately becoming a philanthropist, a public speaker, a humanist, and an advocate for civil rights and the education of African American youth—all of which he performed with hope and optimism.[1−8]

Julian was the recipient of many awards, including a posthumous United States commemorative postage stamp issued in 1993 in his honor (Figure 1). Julian was profiled in a biographical PBS NOVA movie entitled *Forgotten Genius*.[3] The American Chemical Society honored Julian and his synthesis of physostigmine with a National Historic Chemical Landmark,[9,10] and his achievements have earned him membership in the National Inventors Hall of Fame.[11] He is featured in more than 100 websites, encyclopedias, and biographical collections of eminent role models. Several organizations hold annual "Julian" lectureships,[12,13] bestow "Julian" awards,[13−16] and provide "Julian" scholarships.[17,18]

What is unrecognized in the scientific, historical, and lay literature is Julian's role in the early 1930s in advancing research in chemistry with undergraduate students. In that activity, he was a pioneer who provided a legacy that continues today. Julian came into this endeavor by a rather indirect pathway, the last step of which was inglorious and ridden with racial discrimination.[1,2] The goals of this publication are (1) to describe Julian's nonlinear path to become a mentor to undergraduate students participating in research in chemistry and (2) to document his and his students' successes in this enterprise. During the research underpinning this publication, the roles of William A. Noyes and William Martin Blanchard were discovered. Therefore, another goal of this publication is (3) to document Noyes's and Blanchard's endeavors as well.

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Figure 1. United States Postal Service stamp honoring Percy Julian, 1993. Image courtesy Faith Julian. Copyright United States Postal Service.

JULIAN'S PATH BEGAN WITH WILLIAM ARTHUR NOYES

Quite remarkably, Julian's trajectory actually began with William Albert Noyes[19−24] (1857−1941), whose career flourished several years before Julian was even born.

Noyes was born on a farm near Independence, Iowa, in 1857. From 1875 to 1879, he attended Iowa College, which later became Grinnell College, where he received religious training and education in the classics and science. He taught for a year at Iowa College as head of the Department of Chemistry, received a M.S. degree from that school a year later, and then went to The Johns Hopkins University where he received his Ph.D. in 1882 under the supervision of the early American pioneering chemist Ira Remson.[19,20] Noyes then taught for a year at the University of Minnesota and three years at the University of Tennessee where apparently Noyes's Northern heritage was not so acceptable to Southerners at Tennessee. He then joined Rose Polytechnic Institute in Terra Haute, Indiana, where he taught chemistry from 1888 to 1903 (Figure 2). (That institution is now called Rose-Hulman Institute of Technology.) Noyes subsequently became the first Chief Chemist at the (National) Bureau of Standards from 1903 to 1907, and then became Chair of the Department of Chemistry at the University of Illinois until his retirement in 1927.

In addition to his own research, Noyes is noted for establishing the University of Illinois as one of the premier chemistry research institutions in the world. Noyes served as editor in chief of the *Journal of the American Chemical Society* (*JACS*) from 1902 to 1917 and president of the ACS in 1920. (His son W. A. Noyes, Jr. was editor in chief of *JACS* from 1950 to 1962 and president of the ACS in 1947.) Noyes founded *Chemical Abstracts* in 1907 and played major roles in establishing the *Journal of Industrial and Engineering Chemistry* (the precursor of *Chemical & Engineering News*) and *Chemical Reviews*. But it is Noyes's years at Rose Polytechnic that inform the subject of this report.

Noyes had a deep interest in and commitment to the undergraduate laboratory and education in chemistry. He published textbooks entitled *Organic Chemistry for the Laboratory*[25] (1897) and *Laboratory Exercises in Chemistry*[26] (1917) in addition to several other chemistry textbooks.[27−30] Many of Noyes's books are available online (open access).[31] In a biographical memoir for the National Academy of Sciences on Noyes, Roger Adams—Noyes's successor at Illinois—wrote of Noyes's teaching at Rose Polytechnic,

> *"For many years, he taught all the courses of the chemistry curriculum. The seniors in the curriculum were required to present theses based on original research. Several of these were published in the American Chemical Journal [which merged with JACS in 1913], and Noyes' early scientific reputation was based on this work."* [20]

In an obituary of Noyes published in 1944 in *JACS*, B. Smith Hopkins wrote,

> *"The seniors in this curriculum [at Rose Polytechnic] were required to present a thesis based on original research. Several of these were published in the American Chemical Journal and later Professor Noyes said that three or four of these were among his most important researches in Chemistry."* [19]

In 1894, Noyes himself wrote in an article in *JACS*,

> *"The man who never uses a balance or handles a test tube will not for very long be a strong factor in the advancement of chemical science. But the method of laboratory instruction is essential, not because knowledge cannot be acquired in other ways, but because at the start the imagination of the student is deficient and it is only by means of personal experiments of his own that he can acquire the ability to understand and appreciate the experimental work of others. The memory is also deficient and the personal work on a subject may be of great value for that reason, as well. But the things which we should endeavor to secure in laboratory instruction are, first, such an acquaintance with experimental methods as shall enable the student to thoroughly grasp the solid experimental basis of the science and give him the mental habit of referring everything back to the rigid experimental test; and second, the ability to do accurate and independent experimental work himself."* [32]

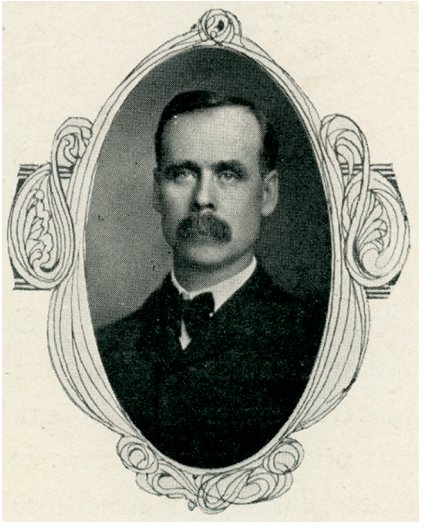

Figure 2. William Albert Noyes, Rose Polytechnic Institute, Terra Haute, IN, 1901. From the *1903 Modulus* Yearbook, 1901, page 5. Courtesy Bernadette Ewen, Logan Library, Rose-Hulman Institute of Technology.

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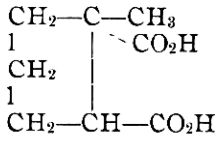
Let us see what Noyes himself wrote of research in chemistry with undergraduates. In a 1901 article in *The Rose Technic*, Noyes listed the names of

> *"six [undergraduate[33]] students graduated from the Chemical Course in June, 1901, and in connection with their thesis subjects a larger amount of productive work than usual was accomplished... Mr. Clay worked upon the determination of manganese in iron or steel... Mr. Crawford understood a study of the hydrolysis of maltose... Mr. Helmer continued and completed the study of the determination of sulfur in iron and steel which was commenced by Mr. Madison, of the class of 1900... Mr. Lyon studied the action of chlorine upon ammonia... Mr. Miller undertook the preparation of the acid [i]... Mr. Warfel made a careful determination of the boiling point of alcohol of various strengths and secured the data necessary for the complete boiling point curve of mixtures of alcohol and water... the work of Dr. Blanchard on Racemic campholytic acid and racemic dihydrohydroxycampholytic acid..."*[34] *(Image reproduced from Noyes;*[30] *1901.)*



i

Three items are of particular note from the above quote. First, Noyes published with numerous undergraduates, including the six so named.[35−51] Second, five of these six went on to careers in chemistry, though none attended graduate school, an unlikely educational step in those early days.[52] Third, Noyes cited a "Dr. Blanchard". As we shall shortly see, this refers to Dr. William Martin Blanchard, who played a key role in the life and career of Percy Julian.

In a 1902 article in *Science*, Noyes wrote,

> *"During the past twelve years twenty-three men have graduated from the chemical course of the Rose Polytechnic Institute. ... It is the custom, at all our best technical schools, to require a thesis for graduation. This thesis should always be based on careful experimental work continued for some months. It should, if possible, contain some real addition to the world's knowledge."*[53]

Noyes's commitment to and participation research in chemistry with undergraduate from the 1880s to early 1900s is thus unambiguous.

But perhaps it is not as simple as that. Perhaps it was Noyes's well-calculated master plan toward academic achievement. Just as Noyes was walking out the door of Rose Polytechnic, he was beginning his tenure as editor-in-chief of *JACS*. No matter how very skilled he was as an experimentalist—and he published many articles as the sole author at Rose—in order to fulfill his passions and to meet his intellectual fervor while at Rose, indeed wherever he was, he needed collaborators, experimental agents. In the 1880s and 1890s, he needed Rose undergraduates. After Rose, Noyes briefly left academia to become the first Chief Chemist for the National Bureau of Standards (1903−1907), though he spent the first year at Johns Hopkins University awaiting the completion of his laboratories. Noyes then taught at the University of Illinois (1907−1926) where he had many graduate students and thus did not engage in research in chemistry with undergraduates.[54]

WILLIAM MARTIN BLANCHARD, THE CONNECTION BETWEEN WILLIAM A. NOYES AND PERCY LAVON JULIAN

William Martin Blanchard[55−59] was the connection between William Albert Noyes and Percy Lavon Julian.

After receiving his Ph.D. at Hopkins with Remson in 1900, Blanchard taught chemistry at Rose Polytechnic Institute for one year (1900−1901) in Noyes's Department of Chemistry. No doubt that the Remson connection with Noyes brought Blanchard to Rose. And then, with Noyes's recommendation, Blanchard became the (first full) professor of chemistry at DePauw University in Greencastle, Indiana.[59] Blanchard learned a lot from Noyes in his short stay at Rose regarding research in chemistry with undergraduates.

Figure 3. William Martin Blanchard, Greencastle, IN, ca. 1915. Photograph courtesy DePauw University Archives.

DePauw, in Greencastle, IN, is only 40 miles from Rose in Terre Haute, IN, so Blanchard's move was quite simple. He would remain at DePauw for 40 years (Figure 3), and he would eventually serve also as Dean of the University (1927−1941) while continuing as professor of chemistry and head of the Department of Chemistry (1901−1940). As will be discussed shortly, he was also Julian's teacher while Julian was an undergraduate at DePauw (1916−1920) and later was Julian's departmental faculty colleague (1932−1936).

Blanchard was born August 25, 1874, in Perquimans County, North Carolina. He received his A.B. and A.M. degrees at Randolph-Macon College in Front Royal, Virginia, in 1894 and 1897, respectively, and his Ph.D. at The Johns Hopkins University in 1900 with America's foremost organic chemist of the era, Ira Remson.[60,61] Likely because of the Remson−Noyes connection, Blanchard was offered a position as an instructor at Rose Polytechnic for the 1900−1901 academic year. Blanchard must have impressed Noyes, not only with his instructional capabilities but also with his experimental zeal. In that short time, a joint Noyes−Blanchard publication appeared in the *American Chemical Journal* on camphoric acid,[62] a topic—camphor structure and chemistry—that Noyes studied for many years.

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At DePauw, Blanchard was an active academic. He initiated a Chemical Club in 1909 (or perhaps it was a Science Club) (Figure 4),[63] published books entitled *Laboratory Exercises in General Chemistry*,[64] a *Laboratory Manual for General Chemistry*,[65] and *An Introduction to General Chemistry*,[66] and wrote articles to improve the teaching of undergraduate chemistry.[67−69] But Blanchard's most exquisite vision was bringing chemical research and hands-on, laboratory experience to undergraduates in science.

Blanchard instituted a course simply entitled *Thesis* in 1920, a one-semester laboratory research project, requiring 15 hours a week in the laboratory and the final report of the work in a "thesis".[59] There is no record as to the success of this program called *Thesis*, and there were apparently no publications in scientific journals that resulted therefrom. Yet this is clear evidence that Blanchard had a commitment to provide experimental chemistry in the undergraduate curriculum at DePauw. In doing so, Blanchard was undoubtedly influenced by his observations of Noyes's massive program of research in chemistry with undergraduates. But the record—or rather, the lack of a publication record from *Thesis*—shows that whoever was responsible for *Thesis* was not overwhelmingly successful. A more research-passionate, chemistry-savvy entrepreneur was needed. Blanchard wrote in an article in 1934 in the *Proceedings of Indiana Academy of Sciences*,

> *"He who goes forth with an inquiring mind, bent on the search for truth, who carries on experiments with his own hands, records accurately observations made with his own eyes, discovers and establish facts hitherto unknown—he is a direct contributor to the progress of science. ... Some of us feel that there is much we can do. Promote the development of a potential scientist and we contribute to the development of science itself. What is it to be a teacher of science? Surely it is far more than being a purveyor of scientific knowledge. Undoubtedly there is a certain amount of satisfaction to be found in supplying this particular kind of pabulum to youthful minds. But does what we give them, really feed them, nourish them, add to their growth? Does it not too frequently give them mental indigestion? Do we not too often have the wrong idea about teaching? Is not real teaching a process of creating hunger rather than satisfying it, creating a thirst rather than quenching it? Or, using another figure, is it not the function of the true teacher to discover intellectual sparks and fan them into flame; or, again, to arrest for a moment purposeless youth and give it purposeful endeavor with the dynamic of a great inspiration?"* [70]

What Blanchard wanted was to "bridge the gap between college and university".[71] From a DePauw University planning document, we can see Blanchard's

> *"central idea was to take the senior who showed some special aptitude for Chemistry, place him under a man having some marked capacity for and skill in research, and have him work on a problem during such time as he could spare from his routine course required for graduation."* [72]

What Blanchard and DePauw needed was that special mentor. That was to be Percy Lavon Julian.

PERCY JULIAN AND RESEARCH IN CHEMISTRY WITH UNDERGRADUATES: THE PRELUDE

How did it transpire that Julian would do chemical research with undergraduates at DePauw in the early 1930s?

Julian's life story, at least in condensed form, has been told many times[1−5,73−79] and will be outlined again here. He was born in 1899 and raised in Montgomery, Alabama. There was no high school for Black children in Alabama at that time, but his parents, both graduates of the State Normal School for Colored Students in Montgomery[80,81] (which is today's Alabama State University[80]), succeeded in enrolling Julian, and he graduated in the class of '16.[82−84] Through family connections, he was admitted to DePauw in the fall of 1916 as a "sub-freshman" and, along with freshman classes, took remedial classes at the Indiana Asbury Preparatory Academy.[85] On a very limited budget, in his first year, he slept in the attic of a fraternity house where he worked as a waiter.[86] Julian graduated in 1920 with an A.B. degree, Phi Beta Kappa,[3,77,87] Sigma Xi honorary society, and class valedictorian,[3,77,88] reportedly with all A's save for one B.[89]

Figure 4. DePauw University Chemistry Club, 1918. Percy Julian (top row, first on the left) and William Martin Blanchard (first row, third from the left). Photograph courtesy DePauw University Archives.

William Blanchard was Julian's chemistry professor and advisor, as he was to all chemistry majors at DePauw in that era. Upon Julian's graduation in June 1920, Blanchard was unable to secure a position for him in graduate school, due at least in part to racial discrimination.[5] Julian taught at Fisk University, a historically Black college or university (HBCU) (1920−1922), then was awarded an Austin Fellowship from Harvard[9,90] and received his A.M. in 1923 from that institution.[87] Julian studied at Harvard for two more years though he was not admitted into their doctoral program, again due to racial discrimination. He then taught at West Virginia State College (1926−1927), an HBCU, and at Howard University (1927−1931), another HBCU, as Acting Chair of the Department of Chemistry. (Julian apparently replaced St. Elmo Brady who left Howard in 1927 to teach at Fisk; Brady is noted as the first Black American to obtain a Ph.D. in chemistry, that from the University of Illinois.) In 1929, Julian received a General Education Board fellowship funded by the Rockefeller family,[91] took a leave of absence from Howard University, and studied with the eminent alkaloid chemist Ernst Späth at the University of Vienna, Austria, and received his Ph.D. in 1931.[85,92−94] In the summer of 1931, together with a fellow Späth Ph.D. student Josef Pikl, Julian returned to Howard University where he was named Chair of the Department of Chemistry.[95] Pikl became Julian's assistant at Howard (and was to follow him to DePauw as well).

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WASHINGTON
America's 6th Largest Colored City—Population 132,068
THE AFRO-AMERICAN
CAPITAL
WEEK OF JUNE 18, 1932
24 Pages
Hoover Cheered at Howard Commencement
JULIAN IS ASKED TO RESIGN
JULIAN - SHOHAN LETTERS COVER A WIDE RANGE
IVORY AND GOLD
Howard University Officials Ask Letter-Writing Dr. Julian to Resign
24,000 AT DRILL SEE DUNBAR WIN ALL HONORS
WHAT WILL HAPPEN NEXT?
HOOVER SPEAKS AT SHORTEST H.U. COMMENCEMENT
H.U. Chemistry Head Asked for Chemicals; Spent $1,500.
DAMN, HELL COME EASY TO PROF.
Dr. Johnson Said to Have Wept when He Read Photostatic Copies of the Julian-Shohan Correspondence, Released by the AFRO. Question is Now Whether Dr. Julian, Like Dr. Shohan, Will Get One Year's Salary in Advance while He Seeks Another Post. No Word Yet of a $1,000 Vacation Bonus.
Is Seventh Consecutive Victory in Annual Cadet Competition.
SILENT DRILL IS FEATURED
Exercises Completed in Just Forty-five Minutes.
PRESIDENT TALKS JUST 210 SECONDS

Figure 5. Front page of the Washington, DC section of the June 18, 1932, issue of *The Afro-American* newspaper. Note that of lesser importance to the Julian resignation was the smaller headline that President Herbert Hoover spoke at Howard University's commencement. Reprinted courtesy of *The Afro-American* newspaper image archives.

But within a year, serious problems arose for Julian. Julian fired two members of his staff, one apparently at the request of Howard's president and the second due to a situation much complicated by the claim that Julian was allegedly romantically involved with his wife [Anna Roselle née Johnson, whom Julian married in 1935]. In retribution, these two individuals apparently provided letters that Julian had written them while he was in Vienna, excerpts of which were published in *The Afro-American* newspaper. These letters contained quite unflattering comments about certain members of Howard's academic staff and administration. The letters also contained Julian's stories of his parties with Austrian and German White women. These were the kinds of letters that should never have been written in the 1930s, in case they become public, as they did. Excerpts from these letters were published week after week in 1932 in *The Afro-American* newspaper, causing great embarrassment to Julian, to Howard's president Reverend Mordecai Johnson, and to Howard University. Julian was forced to resign his position at Howard in the summer of 1932 (Figure 5).

Julian, a newly minted Ph.D. from one of the world's leading universities and one of the world's leading alkaloid chemists, was a superb experimentalist, and according to the University of Vienna's Professor Ernst Späth, a state-of-the-art chemical researcher. Yet Julian suddenly found himself unemployable. No White university or White chemical company would hire him. And as Julian himself recorded in a May 8, 1934, letter to the then editor of *The Afro-American*,

> *"In view of the fact that, after publication of my letters, etc. in your paper, every Negro school sent its regrets to me..."* [96]

Julian was ostracized by his own race.

As the academic year 1931−1932 ended, Julian was a chemist without a future in chemistry. Some might say, a chemist without any opportunity at all. So, Julian carried out a most reasonable maneuver. He contacted his old chemistry professor, now Dean at DePauw University, William Martin Blanchard.

PERCY JULIAN AND RESEARCH IN CHEMISTRY WITH UNDERGRADUATES: THE OPPORTUNITY

A confluence of life's circumstances met in harmonious resonance for Julian and DePauw University in the summer of 1932. William Blanchard was hoping to invigorate a program of research in chemistry with undergraduate students. He needed a chemical researcher with passion. And Percy Julian, a year past his Ph.D. and about ready to submit two manuscripts to *JACS* (which were published in November 1932[97] and May 1933[98]), was desperately in need of a position doing chemistry. Furthermore, as the evidence would show, Julian recognized that his route back into mainstream state-of-the-art chemistry was only achievable through publication of high-quality chemistry. And Blanchard's offer as a research fellow[99]—even though it was a non-tenure-track position—offered research possibilities. Indeed, the position *required* research performance. Julian would have the requisite resources. First, he would have the physical facilities and a fine institutional laboratory. Second, he would have a source of youthful, passionate collaborators who would share the joys and hard work of the laboratory. Third, he would have Josef Pikl, his fellow Späth Ph.D. student who would join Julian as his research assistant at DePauw. Blanchard agreed to funding Pikl as well. Fourth, Julian had himself: his ideas, his own laboratory "hands", and his passions. And fifth, he was returning home: to his undergraduate school in which he blossomed and to the family home of his parents and siblings who had moved to Greencastle shortly after Percy had matriculated as an undergraduate.

Julian was already quite disposed to carry out Blanchard's vision. As Julian wrote in 1929, "*Only the discoverer in science can really teach.*" [100] And Julian was primed to be a discoverer and a teacher.

PERCY JULIAN AND RESEARCH IN CHEMISTRY WITH UNDERGRADUATES: THE REALITY

DePauw University appointed Julian a Research Fellow in the Fall of 1932, with the duties of guiding the senior chemistry majors "to bridge the gap between college and the university" by offering a laboratory-based research program in chemistry for qualified seniors.[99] Julian directed research projects for senior chemistry majors, and possibly less advanced students as well, beginning in 1933 (Figure 6). He was also able to conduct research with his assistant Pikl.

In his three years at DePauw, Julian conducted research with at least 12 undergraduates (Table 1), with whom he published eight articles in *JACS*[71,101−107] and one article in *Organic Syntheses*.[108,109] An anonymous reviewer asked if Julian was the first African American to publish in *JACS*. At latest count, he was the third to do so. St. Elmo Brady, the first African American Ph.D. chemist (University of Illinois, 1916), published eight times, the first three times in *Science*, once in 1915[110] and twice in 1916,[111,112] and once in *JACS* in 1939.[113,114] Edward M. A. Chandler, the second African American Ph.D. (University of Illinois, 1917), according to SciFinder never published in a chemistry journal. As Sibrina

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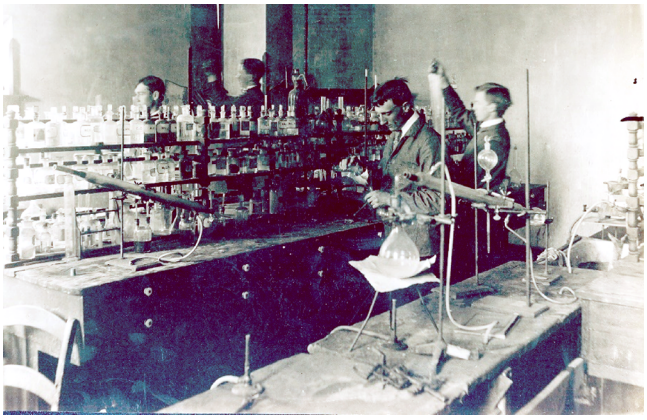

Figure 6. Chemistry laboratory, Minshall Laboratory, DePauw University, ca. 1925−1935. Photograph courtesy DePauw University Archives.

Collins recently discovered, the third African American Ph.D. was Langston Fairchild Bate, who received his Ph.D. in 1926 from the University of Chicago. Together with his advisor Ben H. Nicolet, Bate published "Some Pseudo-thiohydantoins and Alpha-Mercapto Acids from Higher Fatty Acids" in *JACS* in 1927.[161] Julian was the fourth African American Ph.D., but as noted above, he received his Ph.D. degree from a non-American university, the University of Vienna. Of course, Julian had several hundred publications and patents of the highest scholastic and proprietary standards. Julian's first publicatiion in *JACS* was in 1932.[162] But the very first African American to publish in *JACS* was Alice Augusta Ball, a female, in 1914[163] and 1917,[164] with her undergraduate research advisor William M. Dehn at the University of Washington.[165]

Julian was at DePauw from 1932 to 1936, where his research interests fell into two categories: a series of papers entitled "Additions to Conjugated Systems in the Anthracene Series" and another entitled "Studies in the Indole Series". A full discussion of Julian's research with undergraduate students is outside the scope of this publication. But several highlights will be briefly mentioned, to provide a sense of their scientific flavor and to place this chemistry within the context of state-of-the-art in the early 1930s. I must note: in addition to providing ideas and mentoring, Julian participated in the hand-on experiments (Figure 7), including running the "old fashioned, macroscale carbon−hydrogen combustion apparatus".[115]

The former series of publications had its origin in Julian's research at Harvard with E. P. Kohler. While he never published with Kohler, Julian included some of his Harvard results in his Ph.D. thesis[92] and in a 1932 publication with Walter Passler,[97] another former student from the University

Table 1. Undergraduates Who Did Research in Chemistry with Percy Julian at DePauw University and Pertinent Bibliographic Information

Name and year of DePauw degree(s)	Graduate education in chemistry (Ph.D. advisor)	Career	Number of SciFinder citations: With Julian + not with Julian
Doyle Boggess A.B. '33, M.A. '34	Studying for a Ph.D., University of Wisconsin but apparently not completed and possibly not registered[a]	Chemist, Beveridge Paper Mills, Indianapolis, IN	1 + 0
John Wayne Cole A.B. '35	M.S. and Ph.D. '38, University of Illinois (R. C. Fuson); Postdoctorate, University of Wisconsin (W. Bachmann)	Glidden Company, Julian Laboratories, Abbott	16 + 33
Ray Fields Dawson '35	Ph.D. (botany), Yale	Professor of Botany, Columbia, Princeton, Rutgers	1 + 55
Gerhard H. Diemer	–	Glidden Company, Julian Laboratories, Abbott	3 + 0
William J. Gist '35	–	–	1 + 0
Wesley J. Lyda '35 (a Black student)	*b*	Ph.D. educator, Indiana University	0 + 0
Arthur Magnani '33 or '34	Ph.D. '37, University of Wisconsin[116] (S. M. McElvain)	Glidden Company, Julian Laboratories, Smith Kline & French Laboratories	28 + 8
Edwin W. Meyer, Sr. '36	Ph.D. '43, Northwestern University (Byron Riegel)[117,118]	Glidden Company, Julian Laboratories, Central Soya Company	44 + 18
John J. Oliver '35 (a Black student)	–	Publisher, *The Afro-American* newspaper[119]	2 + 0
J. G. Schafer	–	Glidden Company[c]	1 + 0
Bernard Miller Sturgis	Ph.D. '36, MIT (J. Flack Norris)	DuPont	1 + 42
Frank E. Wantz '35	–	–	1 + 0
Thomas F. Wood '35	M.S. '40,[120,121] Washington University (J. H. Gardner)[d]	United States Rubber Company, Givaudan Corporation	1+ 41
Richard Haskins '36[122]	–	–	0 + 1 (plus ???)
Robert Ragan '36[122]	–	–	0 + ???
Carl Smith '36[122]	–	–	0 + ???

[a]From a 1936 newspaper notice of his wedding: "...has been working on his Ph.D. for the past two years in Wisconsin."[123] There is no record of Boggess in the University of Wisconsin's commencement registers, admission papers, alumni directories, UW Digitized Collections, nor library catalogue according to the University's Archives,[124] nor is there any record of attendance at UW according to the University's Office of the Registar.[125] [b]Lyda was professor of secondary education and the first director of the Afro-American Studies Center at Indiana State University, where he taught from 1968 to 1980.[126] [c]Schafer's sole publication[127] with Julian (in 1949) on *Conjugated Systems* has the Glidden byline but Schafer's contributions may have come from his undergraduate research with Julian at DePauw. This was publication VI[106] in Julian's series on *Conjugated Systems* that began when Julian was at Harvard (with E. P. Kohler, ca. 1924) and continued at Howard (1931−1932), then at DePauw (ca. 1935), and finally at Glidden (ca. 1949). [d]May have been a graduate student with John H. Gardner at Washington University,[128] then later at U.S. Rubber and Givaudan. The name "Thomas F. Wood" is insufficiently unique to allow unambiguous biographical information to be made. "–" and "???" = unknown.

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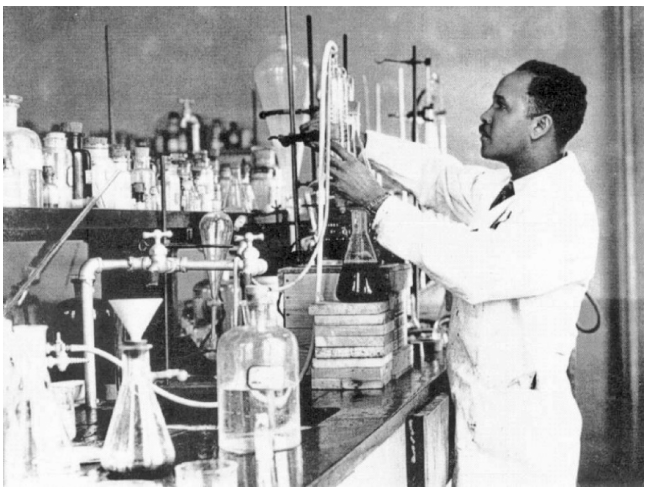
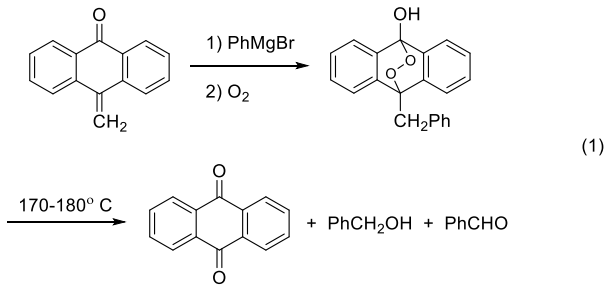


Figure 7. Percy Julian in the Minshall Laboratory, DePauw University, ca. 1933. Photograph courtesy DePauw University Archives and Faith Julian.

of Vienna.[129] Julian's second publication with a DePauw undergraduate examined the addition of phenylmagnesium bromide to methyleneanthrone (eq 1).



(1)

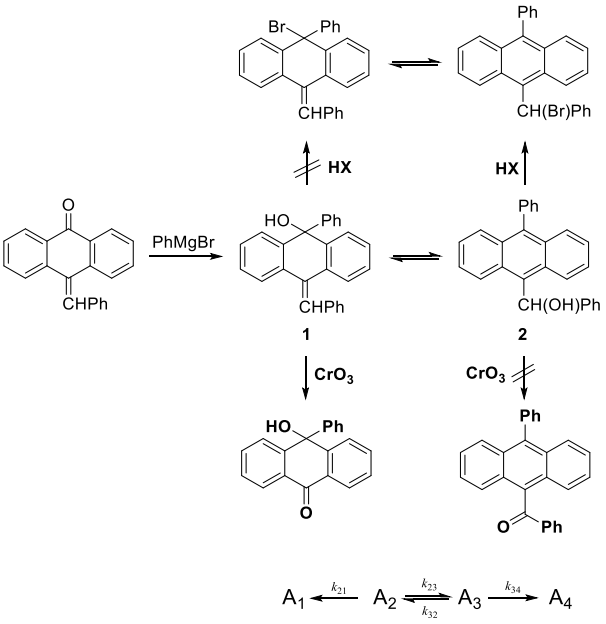
The very last sentence in this publication is quite interesting and rather clever. The casual reader might very well miss the significance that the acknowledgment is to "the authors" who were students of Dean Blanchard. The plurality refers to both Percy Julian from the Class of 1920 and his student Arthur Magnani from the Class of 1933 or 1934, both of whom had been students of Blanchard, though 15 or so years apart.

> *"The authors are indeed grateful to their first teacher of chemistry, Dean W. M. Blanchard, without whose generous support, constant encouragement, helpful advice and criticisms, this work would have been impossible."* [101]

Scheme 1 presents one example of the interesting chemistry studied by Julian and his undergraduate students, this from 1935. They uncovered evidence for the equilibrium **1** ⇋ **2** in a series of reactions, in which products stemming from either **1** or **2** are obtained depending on the reaction conditions. This chemistry is reminiscent of the Curtin–Hammett/Winstein–Holness kinetic system[130] (eq 2) that was not understood until the late 1940s and early 1950. Julian had a sleeping beauty in chemistry.[131,132]

The "conjugated systems" chemistry Julian reported in 1934[101] was far more complex than he understood at the time. He and his students and eventually some of the members of his research group at Glidden (on the side, so to speak) continued this chemistry for another 15 years. The last two publications of this series appeared in 1949.[127,133] Julian's co-authors were his former undergraduate students who went to Glidden with

Scheme 1. Chemistry Reported by Julian and Cole[a]



(2)

[a]In 1935,[103] they proposed what was then the novel idea of a set of interconverting compounds, each of which gives different products depending on reaction conditions. This sequence was later generalized by the Curtin–Hammett principle, the Winstein–Holness equation, and the Eliel–Ro equation.[132]

him: Cole, Diemer, and Schafer (who may or may not have joined the others at Glidden). In 1965, Israeli chemist E. D. Bergmann, an expert in the field,[134] referred to these as "now classical papers".[135]

The second of Julian's series at DePauw, *Studies in the Indole Series*, had its beginning with Julian in his dissertation research with Späth. In the second section of his 1931 Ph.D. dissertation entitled "Versuche zur Synthese Alkaloide. Cusparein", Julian wrote,

> *"For some years, cusparein had been analyzed in the laboratories of the University of Vienna. At that time, three possible formulae were considered [I, II, and III, see Figure 8]... . It was decided that certain syntheses should serve as guidelines..."* [92]

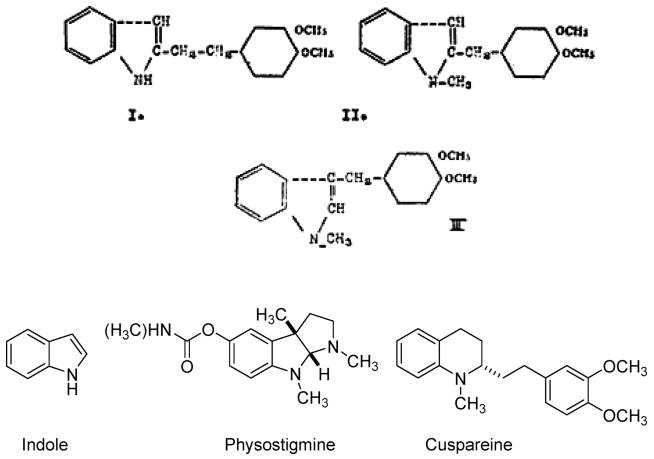


Figure 8. (Top and middle) Excerpts from page 16 of Percy Julian's 1931 Ph.D. dissertation.[92]

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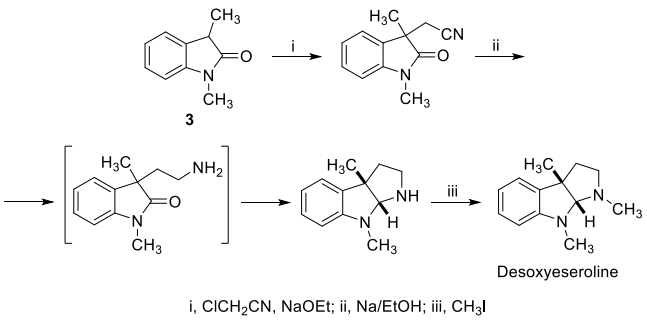
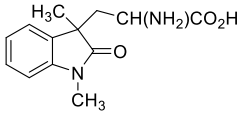
It was his research on the synthesis of cuspareine for his Ph.D. dissertation that led Julian to a major synthetic target: the total synthesis of physostigmine completed with Pikl[136] at DePauw. This would be a high point of Julian's career that brought him much international fame.[9,10,137] It is good fortune for Julian that the portion of his Ph.D. research on cuspareine was based on the assumption that that natural product incorporated an indole ring system, just like physostigmine. Ironically, cuspareine is actually a tetrahydroquinoline, a fact not fully confirmed until 1950.[138−141]

Julian's route to physostigmine was modeled after his route to desoxyeseroline, involving a key and novel step for that era, the alkylation of oxindoles (e.g., Scheme 2). At that time,

Scheme 2. Julian's Route to the Core Skeleton of Physostigmine, Published with Doyle Boggess B.A. '33, M.A. '34 and Josef Pikl[136]



alkylation of oxindoles (e.g., **3**) was novel and superior to other pathways to physostigmine that were being undertaken by Julian's major competitor, Oxford University's Robert Robinson, whose route was ultimately surpassed in time and in success by Julian. Subsequent research with another undergraduate led to the synthesis of **4**, as a model "for introduction of the grouping $-CH_2-CH(NH_2)COOH$ into the 3-position of oxindoles".[106]



4

Julian and a further series of undergraduates at DePauw would have continued research and publications in *JACS*, perhaps for many years to come, but Blanchard's sources of soft money disappeared in late 1935. Recall, America was then in the midst of the Great Depression. Furthermore, Julian's promotion to a tenured or tenure-track professorship was blocked by the DePauw Board of Trustees despite the strong support of Dean Blanchard and DePauw's faculty and president, G. Bromley Oxnam. This was another instance of racial discrimination.

By 1936, Julian and Pikl were dismissed from DePauw. Pikl went to DuPont where he enjoyed a decade-long career. Julian moved to Glidden in Chicago, Illinois, where his career as a medicinal chemist and entrepreneur was to begin. Both of their careers would blossom, but in different directions. And for Julian, in particular, he would make his way into the history books as an important role model for both Blacks and Whites.

In 2021, the Board of DePauw acknowledged its racial discriminatory behavior toward Julian and posthumously promoted him

> *"to the DePauw University Chemistry faculty for the years 1933−1934 through 1936−1937, which are the years Dr. Julian is listed as a Research Fellow in DePauw course catalogs."* [88]

As of this writing, Harvard University has not made an apology for their refusal to admit Julian to their Ph.D. program. That being said, in 2022, Harvard issued a major report entitled *Harvard & the Legacy of Slavery* in which the University "reckon[ed] with slavery and its legacies".[142] Harvard has also committed major funding "to remedy the persistent educational and social harms that human bondage caused".[142] My attempts to have Harvard award a posthumous Ph.D. to Julian failed, being informed by Joan Rouse, Senior Associate Secretary of Harvard's Board of Overseers, "that Harvard's practice is to confer honorary doctoral degrees only on living persons".[143]

REMINISCENCES OF JULIAN BY ONE OF HIS STUDENTS

Ray Fields Dawson was the Julian student who had the most illustrious, prolific academic career (Table 1). Dawson remembered Julian:

> *"My most vivid memory consists of Julian in his white laboratory coat [Figure 7] standing at the head of the library table introducing his students in the Advanced Organic Class to the chemical literature. Around the table sat [his students], all to produce senior theses of sufficient quality to qualify for publication in JACS..."* [144]

and

> *"When I first became his laboratory assistant... when daily classes and study were over, I would join him at the laboratory around 11:00 pm and work until 2:00 in the morning. In the quiet hours of the night, the physostigmine project advanced smoothly. While he worked, Julian poured out his frustrations at being a highly educated Black in a community of biased Whites. I think that the mere presence of a listener did much to ease his tensions. Around 2:00 am, we would drive in his dilapidated car to the railroad yards, where there was a place willing to serve him a cup of coffee before we retired to our respective abodes for a few winks of sleep."* [145]

and

> *"If one thinks about the brief span of Julian's stay at DePauw and about the number of students whom he stimulated to follow careers in one branch or another of chemistry, it seems to me that there is a valuable lesson to be learned. That is, in the perpetual argument over what higher education is or should be, and how it should be presented to impressionable minds. ... Percy knew the importance of developing a sense of the structure, or anatomy, of knowledge. That is, where, in the overall purview of things, knowledge had been accumulated, how that knowledge might be retrieved, how it may be used and how to add to the store."* [145]

On reflecting upon his time with Julian, Dawson reflected:

> *"For once I touched the soft winds of genius."* [99]

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REVIEWS OF JULIAN'S PROGRAM OR CHEMICAL RESEARCH WITH UNDERGRADUATES

On July 12, 1935, Dean Blanchard wrote a brief summary report to President G. Bromley Oxnam and a note of thanks for his financial support of the chemical research program at DePauw. Blanchard described the students' dedication to their research with Julian:

> *"Six of our boys voluntarily remained in Greencastle to help us complete some research for publication this summer and to give us a chance to start new problems in the fall. This showed a wonderfully fine spirit—the same kind of spirit, I take it, that prompted the President to give up his summer vacation and remain in Greencastle during the hot summer to work for DePauw. You very graciously volunteered to help these boys out in the cost of room and board..."* [122]

And of Julian's approach to mentoring research with undergraduates, in the October 1935 issue of the *Journal of Chemical Education*, Blanchard wrote about "creative scholarship",

> *"The students take up the work and carry it on with great enthusiasm, giving a great deal more time to it than they would to any routine course. In order to broaden their knowledge of chemistry in general while centering their attention largely on some very definite problem, they meet together from time to time, each to give account of himself, his progress, his methods, the difficulties encountered, new problems arising, and so forth. ... Should we not let every man work out his own destiny to his own satisfaction, and without interference or hindrance from others, so long as he injures no one and does not stand in the way of the progress of others motivated by as noble aims and ideas as himself?"* [146]

CONCLUSIONS

William A. Noyes was one of the leaders of American chemistry in the first quarter of the 20th Century and is most associated with the University of Illinois. He was editor-in-chief of *JACS*, the founder of *Chemical Abstracts* (the antecedent of *SciFinder*), and one of the founders of *Chemical Reviews*. Under his leadership at Illinois (1907−1926), his department would become one of the powerhouses in chemistry worldwide. But during his earlier years at Rose Polytechnic Institute (1886−1903), Noyes was heavily engaged in conducting chemical research with many undergraduates. From those teaching and mentoring opportunities, numerous publications appeared in *JACS* and in the *American Chemical Journal* (which was absorbed by *JACS* in January 1914).

Percy Lavon Julian was one of the leaders in pharmaceutical chemistry in the mid-20th Century (ca. 1936−1975). He was also the first Black to achieve prominent distinction for his research in chemistry and to be among the chemical elite during his lifetime and have continued stardom thereafter. During his several years at DePauw (1932−1936), a liberal arts institution, Julian was heavily engaged in conducting chemical research with many undergraduates. Numerous publications resulted in *JACS*. Julian was an early pioneer in mentoring young students in state-of-the-art chemical research and in publishing with them in top journals. And this was accomplished in a PUI (primarily undergraduate institution)! Furthermore, many of these students attended graduate school and obtained their Ph.D. degrees.

Noyes and Julian were linked by William Martin Blanchard. Blanchard, like Noyes, was an Ira Remson Ph.D. student from Johns Hopkins. Blanchard had taught at Rose for one year (1900−1901) before joining the faculty at DePauw, where he served as Chair of the Department of Chemistry and Dean of the University for decades. Julian studied under Blanchard for his A.B. degree (1916−1920), and then was hired by Blanchard as a Research Fellow in the 1930s. Blanchard's exposure to Noyes's program of chemical research with undergraduates surely formed Blanchard's commitment to that academic endeavor and brought Julian to DePauw to initiate such a program.

In their publications, both Noyes and Julian clearly acknowledged that their co-workers were undergraduate students. Such citations made it clear that research in chemisry with undergraduates can be enormously successful. Blanchard publicized DePauw's program of research in chemistry with undergraduates in several publications. In the competitive environment of student enrollment, other liberal arts colleges and universities surely took notice. Today, the Web sites of the departments of chemistry of most liberal arts colleges and universities boast of their research experiences for their undergraduates and highlight their publications with undergraduates. Perhaps not unexpectedly, the majority of Noyes's and Julian's research students chose careers in chemistry, and many of Julian's obtained Ph.D. degrees as well. (Ph.D. degrees were much rarer in the late 1800s as were research opportunities in industry.) Ray Dawson, Julian's student, received his Ph.D. degree in botany, though most of his own later academic research was on the biosynthesis of nicotine and other tobacco alkaloids,[147−151] performing research not unlike that by organic chemist Edward Leete.[152−157]

What was the key to Noyes's and Julian's research success with undergraduates? Their close, intimate mentoring was the key. Research, even for the highly experienced, is complicated—from intellectual and practical perspectives. Running experiments and purifying and isolating pure products, that is tough. For undergraduates, close mentoring is essential. Noyes and Julian provided that, made especially possible by being both being at a PUI.

And now I focus on Julian and what he achieved. After he graduated as valedictorian at DePauw in 1920, no graduate school would admit him into their Ph.D. program, and all he could hope for was to teach at an HBCU.[5] Even after he obtained an A.M. degree at Harvard, that institution would not admit him to their Ph.D. program in chemistry because "they feared that Southern White students mightn't accept him as a teacher".[11,78] How ironic it is, that in a few short years, Julian would become a successful teacher and mentor with many White undergraduates. In his own lifetime, Julian proved that the prejudice he experienced was so very wrong, and at the same time, demonstrated the real opportunities of doing chemical research with undergraduates.

Julian's successes were due to several factors. The primary factors were his passion for research, his need to resurrect himself from a serious ostracism by the Black community, and his drive to be a professional chemist in the milieu of perversive racial discrimination within the White academic and industrial chemistry institutions. Julian also loved chemistry.

Both Noyes's and Julian's[158] undergraduate mentoring stopped when they left Rose Polytechnic and DePauw, respectively. As Noyes's and Julian's careers progressed and blossomed, they both supervised large research groups of

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graduate and postdoctoral students (for Noyes) and Ph.D. and other professional chemists (for Julian, who also had no opportunity to carry on research with undergraduates). Noyes and Julian clearly demonstrated and documented the reality of chemical research with undergraduates. Today's commitment to research in chemistry with undergraduates no doubt stems from the earlier pioneering role models of William Arthur Noyes and Percy Lavon Julian.

CODA

At the death of William Martin Blanchard, Percy Julian wrote a six-stanza poem honoring Blanchard that appeared in the January 1941 issue of the DePauw *Alumnus* and was reprinted in the Indianapolis *Recorder* on April 14, 1941, following its release by the Associated Negro Press. Here is its first stanza:[159]

From him I learned that Truth and Grace
Do not belong to but one race,
For in his love of God's great Truth
That North or South, courageous youth
Could join their hands as brothers true.
And build a strife-torn land anew,
His Sire did touch his Freeman's hand;
With Godly grace he bade him stand
Straight by his side with shoulders square.
Sad eyes aglow with Freedom's flare;
That Master's sons might look and see
That Truth and Grace make all men free!

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Notes

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DEDICATION

Dedicated to the memory of Ray Fields Dawson (1911−2012), a good friend of the author for nearly 40 years. While an undergraduate at DePauw University, Dawson conducted research with Percy Julian.

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adding substantial numbers of such outstanding young men to the American cult of science."
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