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A Baccalaureate Program in Toxicology

In June 1968 the Bureau of Health Manpower of the United States Public Health Service awarded a grant to the College of Pharmacy of St. John's University, Jamaica, N.Y., for the purpose of establishing a four-year undergraduate training program leading to the B.S. degree with a major in toxicology. The purpose of this article is to provide a summary of the rationale and curriculum for this program, as well as to discuss experiences with the program over that period.

A discussion of this program seems appropriate to and consistent with the aims of the American Academy of Forensic Sciences. Along those lines, in an analytical appraisal of the nature of forensic science, Dr. Paul Matte [*1*] has written:

> A first priority of the American Academy of Forensic Science might well be the accumulation of such data as is needed to develop a professional organization founded not simply on mutual interest and good fellowship, but on the unifying principle which has been described, with the development of certification procedures and educational and training standards for the various subdisciplines of forensic science. . . .

The initial impetus for the development of an undergraduate curriculum in toxicology came from a knowledge and recognition that, while there was a need for trained personnel in the area of toxicology, there was little formal training provided in institutions of higher education.

A review of government publications which collate information of the progress of higher education reveals that, during the period 1960–1961, there was no enrollment in specific formal programs in toxicology [*2*] and no degrees were cited as conferred in that specific field [*3*]. There is no question that toxicologists were educated during that period, but there was a question about how they were being trained. The latter question appeals to the educator because it generates further questions concerning the quality and uniformity of non-directed, non-structured training, and whether or not informal, on-the-job training was and is adequate to fill the needs which did exist and certainly still exist. The educator and the prospective student for this training would also be extremely interested in determining the depth of training as well as the suitability of the training for a specific position.

Certainly there are formal and structured programs in toxicology currently available on the graduate level [*4*, *5*]. However, the major proportion of individuals employed in this area have developed their expertise in the field through postgraduate employment, or by virtue of degrees received in related areas. For example, in 1965 there were 75 M.S.

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degrees and 88 Ph.D. degrees conferred nationwide in the area of pharmacology [6]. Again, there were no degrees in the specific area of toxicology, although presumably some of the emphasis and training in the area of pharmacology was toxicologic. The lack of formal training in toxicology becomes more evident when one learns that one governmentally sponsored survey proclaimed [6], "the 715,000 degrees conferred at the bachelor and higher levels during 1965–66 was the largest number in history . . . ." The incongruity of the situation is emphasized by an advertisement published in 1968 in which one well-known institution of higher learning offered to train toxicologists by correspondence course [7].

As previously stated, an initial stimulus for the development of a formal program in toxicology came from the realization that a need existed. Over ten years ago, in their *Textbook of Toxicology*, Dubois and Geiling [8] pointed out that "there is a great scarcity of adequately trained toxicologists. . . ." Further stimulus was provided by the prediction that several thousand toxicologists would be needed by 1975 [9].

The rationale for establishing an undergraduate program, rather than a graduate program, is two-fold. In the first place, it was assumed that a baccalaureate program would logically provide better trained candidates for established graduate programs and for jobs and, secondly, that the knowledge of the availability of an undergraduate program would publicize the area, its needs, and its potential. When the St. John's program was initiated it was understood that aspiring toxicologists received their training in toxicology on a graduate level in the few programs which were available throughout the country, or that such individuals recived on-the-job training in medical examiners' offices, hospitals, police or health laboratories, or industry. In any of these situations, the course of training can be difficult, time-consuming, and sometimes unsatisfactory. In many cases, difficulties encountered are due to deficiencies in the academic background of the trainee. Frequently, for example, the prospective trainee has a background only in chemistry and is not prepared to pursue graduate studies in biology or pharmacology without fulfilling other prerequisites. Conversely, the biologically trained individual is more than likely deficient in the area of chemistry. In both instances, the candidate may have no knowledge of pharmacology and toxicology, and must obtain basic information in these areas at the expense of something else. Consequently, it was concluded that a logical approach to the problem would be to make available to graduate schools, or to the prospective employer, a suitably trained candidate who already possessed a fundamental knowledge of the discipline of toxicology.

The availability of an undergraduate curriculum can fulfill the needs of those prospective candidates who have no immediate desire or need for graduate-level training. In addition, it was felt that this type of program would provide a pool of ready-trained, technical-level personnel.

The Program

In order to design a program which would fulfill the stated objectives and overcome obvious deficiencies in other areas, it was decided that the best approach would be to establish a panel of advisors familiar with the problem. The role of this advisory board would be (1) to develop a suitable curriculum, (2) to serve as critics and supervisors of the ongoing program, (3) to help evaluate and modify where necessary, and (4) to determine the ultimate fate of the program after a suitable trial period. To accomplish these goals outstanding individuals from outside of the University, prominent in the areas of forensic, industrial, applied environmental, and didactic toxicology, were approached and agreed

to serve on this committee. In addition, the advistory board membership contained university personnel familiar with academic and educational problems.

Meeting approximately once a month for the first year, the Advisory Board finally developed the curriculum which was submitted to and approved by the New York State Department of Education (Table 1). The syllabus for each of the proposed courses in toxicology was suggested by the board but finally developed by the faculty member recruited to give the course (Table 2).

TABLE 1—*Baccalaureate program in toxicology.*

First Year		
Phi. 45,58	Introduction to Philosophy, Philosophy of Man	6 cr.
Eng. 1 or 3, 6	English	6 cr.
His. 5–6	Survey of Western Civilization	6 cr.
Che. 21–22	General Chemistry	10 cr.
Mth. 69–70	Mathematics	8 cr.
Second Year		
Elec.	General Electives	6 cr.
The. 20	Theology	3 cr.
The. 30	Theology	3 cr.
Bio. 21–22	Fundamentals of Biology	8 cr.
Phy. 1–2	General Physics	8 cr.
PPA 18–19	Principles of Toxicology	8 cr.
Third Year		
Che. 23–24	Organic Chemistry	10 cr.
Che. 27–28	Physical Chemistry	6 cr.
PPA 8,9	Human Anatomy and Physiology, Biopharmaceutical Chemistry	8 cr.
PPA 20–21	Descriptive Methods of Toxicology	8 cr.
Fourth Year		
Che. 25	Quantitative Analysis	4 cr.
PPA 15–16	Pharmacology	10 cr.
The. 40	Theology	6 cr.
PPA 22–23	Toxicology Colloquium	8 cr.
Phi. 50	Philosophy	3 cr.

TABLE 2—*Description of toxicology courses.*

18–19 Principles of Toxicology

An introduction to toxicology with emphasis on materials involved as well as systems affected. A discussion of the classification of poisons and the preventive aspects.

Lecture, 4 h, 4 cr.

10–21 Descriptive Methods of Toxicology

Discussion of the various analytical procedures applied in separation and detection of toxicological materials. Synthesizes various practical experiences in application of these procedures to medico-legal and environmental situations with the advantages and disadvantages of each method.

Lecture, 4 h, 4 cr.

22–23 Toxicology Colloquium

Three segments of intensive exposure to the areas of industrial toxicology, drug testing, and environmental pollution through a series of guest lectures, field trips, and seminars. Practical application of previous training is emphasized.

Lecture, 4 h, 4 cr.

During the planning phase an active recruiting program was begun. This program used all means of communication but primarily relied on advertising and personal effort by all involved. One glaring defect, which came to light during early recruiting efforts, concerns the almost total ignorance of lay public guidance counselors and high school students with regard to the area of toxicology. That defect still exists and will only be corrected by some sort of concerted effort.

Despite initial difficulties, the original agreement with the Public Health Service was fulfilled successfully. It had been indicated by the applicant institution that no less than six students would be enrolled per year, and, from a number of applicants, six students were accepted into the first year. Over the three years the program has been in existence, recruitment goals have been met and current enrollment in all classes totals 30. Interestingly enough, nine of these are female students.

Because of the flexibility built into the curriculum, it is possible to accept students with advanced standing and, currently, one of the State University of New York colleges offers a two-year pre-toxicology program.[2] Therefore, one student graduated by June 1972. There will be seven graduates in June 1973.

The academic performance of all students has been most gratifying and we number some of the most outstanding students in the University in our ranks. The average academic index is 3.0 (or higher) out of a possible 4.0.

The Future

In assessing the results of the program to date one would conclude that it is a success as far as original goals are concerned. However, this program alone will never supply the needs projected in the various areas of toxicology. The prediction of the 60's of the need for several thousand trained personnel in these areas has now been expanded manyfold for the 80's. The most recent government document in this area [*10*], after analyzing the current fiscal and political situation, states:

> Taking full account of the hard realities of the current situation and recognizing the inherent uncertainty of the future, the soundest approach to estimating manpower needs for the future for biomedical research, education and related service activities is to, 1. appraise critically the long-term prospects for the growth of biomedical research, 2. examine the implications of such growth for manpower needs, 3. isolate the high priority functional requirements so that training programs can be targeted to urgent and specific manpower needs, and 4. identify the critical shortage categories. . . .

Despite an otherwise questionable outlook regarding future Federal funding, the report concludes that one of the "targeted areas" will be "the elimination of environmental poisons, not only the contaminants of water and air, but the cumulative effects of all kinds of chemicals and drugs, which are breathed, swallowed or touched. . . ."

Without considering the areas of pure forensic or industrial toxicology, the future needs in environmentally related areas will be considerable. As the previously mentioned report states, in the three pharmacology-toxicology research centers directed by the Department of Health, Education, and Welfare, which existed in 1967, 75 Ph.D. toxicologists were needed [*10*]. It is estimated that there will be twelve such centers by 1975 with a need for 500 researchers [*10*]. Similarly, in three environmental health research centers, the 1967 staff numbered 50. When the projected 25 centers are established in the late 1970's, the anticipated need will be 400 [*10*]. This same report states emphatically that:

> Among the more critical shortage categories are *environmental toxicology*, *stress physiology*,

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and *ecology*. The supply of scientists in each of these categories must be enlarged so that research may contribute to maintaining a better balance between urbanized man and hostile environmental changes which threaten health and the quality of life. . . .

Conclusion

At the beginning of this report, I indicated that this topic is appropriate for consideration by the forensic toxicologist. This is confirmed in an article which appeared in the *Journal of Forensic Sciences* in July 1971 where Wilber [*11*] stated: "It is submitted that the forensic scientists are clearly qualified for this involvement [with environmental pollution]. In fact, they may be uniquely qualified. It is an exciting challenge but a demanding one and it is hoped that the profession will respond positively. . . ."

I agree with Wilber but I go further and state categorically that future growth is predicated upon a change of attitude on the part of the toxicologist and a change of direction in toxicology training. As Dixon [*12*] stated recently, the problem of the toxicologist's inability to adjust may stem from his individual training experience, his exposure to a previous advisor, his current employment situation, or the tools at his disposal, but the basic problem is "a lack of coordination. . . ." The forensic toxicologist perhaps can see no role for himself in the area of environmental or economic toxicology, but as an educator, it must be pointed out that a role and mutual benefit exist.

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