ITEM 114-1007-R0302 ATTACHMENT **March 21-22, 2002**

BOARD OF REGENTS
STATE OF MONTANA

PROPOSAL

TO INITIATE A NEW, EXPANDED, COOPERATIVE, OR OFF-CAMPUS INSTRUCTIONAL PROGRAM

SUBMITTED BY:

THE UNIVERSITY OF MONTANA-MISSOULA

School of Pharmacy and Allied Health Sciences	Pharmaceutical Sciences
Name of College, School, or Division	Name of Department(s) or Area

A NEW, EXPANDED, COOPERATIVE, OR OFF-CAMPUS INSTRUCTIONAL PROGRAM LEADING TO:

M.S. in Toxicology, Ph.D. in Toxicology	Toxicology
Certificate, Associate, Bachelor's, Master's, or Doctoral Degree (give complete name of degree)	Academic Speciality or Area

September, 2002
Proposed Starting Date

THE DEVELOPMENT OF THIS PROPOSAL HAS BEEN APPROVED BY:

Department Chair/Division Head	Date	VP Administration and Finance	Date
Dean of College or School	Date	Provost/VP Academic Affairs	Date
Graduate Dean (for graduate proposals)	Date	President	Date

1. Briefly describe the proposed new program. Please indicate if it is an expansion of an existing program; a new program; a cooperative effort with another institution, business, or industry; or an on-campus or off-campus program. Attach any formal agreements established for cooperative efforts.

The new program proposed is a Masters (M.S.)/Doctoral (Ph.D.) degree program in Toxicology within the Department of Pharmaceutical Sciences of the School of Pharmacy and Allied Health Sciences at The University of Montana. Toxicology is the study of adverse health effects of xenobiotics (compounds foreign to humans). In the biomedical area, toxicologists study the mechanisms of action and exposure to chemical agents as a cause of acute and chronic illness. In addition, toxic agents are used to understand physiology and pharmacology in order to understand physiological phenomenon. Toxicologists are involved in the recognition, identification, and quantification of hazards resulting from occupational exposure to chemicals and the public health aspects of chemicals in air, water, other parts of the environment, food and drugs. Toxicologists are also intimately involved in the discovery and development of new drugs and pesticides. At the molecular level, toxicologists are studying mechanisms by which toxicants modulate cell growth and differentiation. Ultimately, many of these studies lead to new therapeutic approaches.

The new program is being proposed as a graduate degree educational arm of the newly-established Center for Environmental Health Sciences (CEHS). The CEHS was approved by The University of Montana and the Board of Regents during the 1999-2000 academic year and began formal operations July 2000. The new program effort is justified on the basis of the establishment of the CEHS, the focus of environmental health studies at The University of Montana, addition of several new faculty, the enhancement of research and research funding, and the national need for masters and doctoral trained individuals in toxicology.

The proposed program does not have formal cooperative effort agreements, but has strong ties through scientific collaboration with the McLaughlin Research Institute, the Rocky Mountain National Laboratories, The University of Washington, as well as with other departments and divisions inside and outside The University of Montana. In particular, the Department of Chemistry also has faculty members that are CEHS faculty. Therefore, this new program in toxicology brings together faculty across departmental lines.

2. Summarize a needs assessment conducted to justify the proposal. Please include how the assessment plan was developed or executed and the data derived from this effort.

There has not been a formal needs assessment conducted specifically for the proposed program. The Society of Toxicology, the main professional society for toxicologists, conducted a needs assessment in 1996. The survey and results are attached as Appendix 1. Although the survey is dated (no other surveys have been taken since 1996), it does indicate that growth was predicted in the needs of Ph.D. trained toxicologists. Steady slow growth was predicted in academia with more significant growth in the chemical industry, government, not-for profit, industry-other and "other" organization categories. In terms of types of toxicology jobs it was for research, regulatory and study director positions. The areas of risk assessment, biochemical toxicology and mechanistic toxicology were identified as the top three areas for specialized training.

Current and future research needs within the areas of mechanistic toxicology can be inferred from the plans being developed by the National Institute for Environmental Health Sciences (division of NIH primarily responsible for funding research and providing training grant support in mechanistic toxicology). These needs are available on the NIEHS Website (www.niehs.nih.gov/external/resinits/home.htm). Some of these areas include neurodegenerative diseases, autoimmune diseases, asthma, pesticides in food, and a number of other initiatives in children's health. These research areas match well with the expertise and research initiatives by investigators/mentors within the CEHS as described above and available at the CEHS Website (www.umt.edu/cehs).

The previous sections have addressed the national and regional need for individuals trained in biomedical research in order to better understand the mechanisms of diseases and environmental impacts on those diseases as well as to develop therapeutic intervention strategies. Many of these needs directly impact the health of Montana residents. These areas that directly impact Montana citizens include the asbestos-related diseases in Libby, Montana, and the significant metals contamination from mining activities. These training programs will also provide individuals with the training for open positions in academia, government and the pharmaceutical industry. In addition, many toxicologists are necessary for consulting purposes. Therefore, in addition to the health needs of Montana residents, these new programs offer a great opportunity for economic development in the state that is not dependent on extractable resources and can take advantage of the significant federal dollars funding these research activities.

Consequently, there are major economic benefits to Montana. Increased employment, acquisition of federal funding and the improved likelihood of attracting new economies to the state in the areas of biomedical research and development are direct positive outcomes from these research and training efforts. Doctoral students are a key ingredient in the research enterprise. They not only provide much of the energy and enthusiasm which sustains faculty through the research enterprise, they provide the linkage for collaborative ventures between departments, universities, hospitals and industry, and the association of a department with a strong doctoral program is critical in attracting the type of faculty who can further enhance undergraduate education, graduate education, and the research enterprise. Thus, doctoral students provide a key link between the research enterprise and undergraduate education.

3. Explain how the program relates to the Role and Scope of the institution as established by the Board of Regents.

The Mission Statement of The University of Montana (November 1999) states that:

"The University of Montana-Missoula dedicates itself and its resources to search for the truth and new knowledge, the responsibility to disseminate knowledge, and the obligation to provide service to the people of the state, nation and world. The University strives for excellence in all its endeavors, including creating and sharing new knowledge and serving the public, and seeks to assist the people of Montana to achieve their fullest cultural, professional, and personal potential."

The University of Montana is a doctoral level university, committed to program diversity through a balance between liberal learning and professional preparation. The University will continue to respond to the needs of the citizens of Montana, and this is "particularly strong in those areas in which The University has been assigned exclusive professional or graduate programmatic responsibility within the system" (Role and Scope Statements, March, 1990, pp 10-11). The proposed Masters and Doctoral Degree Program in Toxicology is consistent with this Role and Scope. The Program will facilitate new knowledge through research and creative activities, enhance opportunities for transmitting the knowledge through appropriate graduate instruction, and contribute to the economic development of Montana.

Employment and research training opportunities for undergraduates will result from external grants and contracts generated by the faculty. The program will lead to increased interaction of undergraduate students with faculty, graduate students, and postdoctoral fellows in the laboratory and allow them to participate in ongoing research. Furthermore, professional pharmacy students will have the opportunity to advance their training with doctoral education.

4. Please state what effect, if any, the proposed program will have on the administrative structure of the institution. Also indicate the potential involvement of other departments, divisions, colleges, or schools.

The proposed program will not affect the present administrative structure of The University. The graduate program will exist within the School of Pharmacy and Allied Health Sciences in the Department of Pharmaceutical Sciences. The Director of the CEHS or his appointee will be Director of the Graduate Program in Toxicology and serve as principal liaison with the Dean of the Graduate School and the Chair of Pharmaceutical Sciences on all matters relevant to graduate applications and graduate students' progress through the program and completion of graduation requirements. The offering of new graduate courses will allow graduate students from other departments such as Biological Sciences and Chemistry to expand their elective course portfolio and encourage interdisciplinary interaction, without affecting administrative structure. Members of other departments, schools or colleges (such as already exists for Chemistry) will be encouraged to actively participate in this program.

5. Describe the extent to which similar programs are offered in Montana, the Pacific Northwest, and states bordering Montana. How similar are these programs to the one herein proposed?

Montana

No Masters or Ph.D. training programs are available for students.

Colorado

University of Colorado (Department based)

Focus: biochemical toxicology

Colorado State University (interdisciplinary)

Focus: environmental toxicology

Oregon

Oregon State University (Department based)

Focus: ecotoxicology, exposure assessment, metabolism and biochemical toxicology

Utah

University of Utah (Department based)

Focus: metabolism and biochemical toxicology

Utah State University (Interdisciplinary program)

Focus: ecotoxicology with a more environmental focus than biomedial

Washington and Idaho

Washington State University with University of Idaho (Interdisciplinary program)

Focus: neurotoxicology, cancer research, and immunotoxicology

University of Washington (Department based)

Focus: ecotoxicology, genetic, and biochemical

North Dakota, South Dakota and Wyoming

No organized formal training programs

Most of the existing programs are "traditional" training programs that try to be all things to all students. Creating identical programs as those already existing would make it more difficult to recruit high caliber students and obtain training grant support. Therefore, the plan to focus the research training into the core areas of the CEHS training faculty also meets national and local needs. Students applying to our program will be well aware that there are very strong focal points. Therefore, these strengths will attract those students that want to move into these areas since this strategy does not exist elsewhere to any great extent.

The programs listed above in the region are aware of our proposed program and are fully supportive of its development and growth. Furthermore, the toxicology program along with the overall progress of the CEHS will be guided by the CEHS external Scientific Advisory Committee (SAC).

6. Please name any accrediting agency(ies) or learned society(ies) that would be concerned with the particular program herein proposed. How has this program been developed in accordance with the criteria developed by said accrediting body(ies) or learned society(ies)?

No existing accrediting agencies or learned societies can be identified that have or would have concerns with the program herein proposed. The Society of Toxicology (SOT) is the primary learned society dealing with training in toxicology. The proposed training program in Toxicology fits well with their perception of future needs (Appendix 1). Furthermore, many of the members of the CEHS are members of the SOT and will be able to keep abreast of any developments and guidance offered by the SOT.

7. Prepare an outline of the proposed curriculum showing course titles and credits. Please include any plans for expansion of the program during its first three years.

<u>Core Curriculum</u>

24 credits required for the PhD; 19 credits required for MS (MS courses designed with *)

BIOC 481, 482 Biochemistry (6 credits)*
PHAR 609 Biomedical Statistics (3 credits)* [PHAR 595 spring 2002]
PHAR 545 Research Laboratory Rotataions (3 credits for PhD; 2 credits for MS)*
PHAR 641 Toxicology I Principles of Toxicology (3 credits)* [formerly PHAR 619]
PHAR 642 Toxicology II Toxic Agents (3 credits)* [formerly PHAR 625]
PHAR 643 Cellular and Molecular Toxicology (3 credits) [new course]
PHAR 594 Seminar (2 credits for PhD; 1 credit for MS)*
PHAR 592 Current Research Literature (1 credit)* [currently PHAR 595]

<u>Elective Courses</u>

At least 9 credits are required from the following for the PhD
At least 3 credits are required from the following for the MS

PHAR 600 Immunotoxicology (2 credits) [formerly Immunopharmacology]
PHAR 610 Neuropharmacology (3 credits)

PHAR 630 Pharmacogenetics (3 credits) [PHAR 595 spring 2001, 2002]
PHAR 645 Respiratory Toxicology (2 credits) [new course]
PHAR 646 Neurotoxicology (2 credits) [new course]
PHAR 595 Special Topics (2-3 credits)
MICB 502 Advanced Immunology (3 credits)

Research, Thesis, Dissertation
PHAR 597/599 Research/Thesis up to 10 credits for the MS Degree
PHAR 697/699 Research/Dissertation up to 30 credits for the PhD Degree

Total Graduate Credit Requirements
At least 60 credits for the PhD, At least 30 credits for the MS

Required Graduate Courses – Core Curriculum (Masters degree students will be required to take courses designated with *)

There are plans for expansion of the available coursework. As soon as additional new faculty are brought into the Department of Pharmaceutical Sciences as well as other Departments with expertise to develop and teach core courses that are central to all training programs in the biomedical sciences, such as Cell Biology and Pathology, these will be added to the core courses in the Toxicology Program. Another course that needs to be developed is Ethics in Biomedical Research, normally 2 credits. This is required by the NIH and will be necessary before a training grant can be submitted. An option is to make this available through distance learning. New students entering the program would be required to take these courses while existing students would have the option of adding the new courses to their plan of study. It is also planned that additional new courses will be developed by existing and new faculty. These courses would be optional courses and may include Genetic Toxicology, Metals Toxicology, etc.

FACULTY AND STAFF REQUIREMENTS

1. **Please indicate, by name and rank, current faculty who will be involved with the program proposed herein.**

Howard Beall, Ph.D. Associate Professor
Richard J. Bridges, Ph.D. Professor
*Fernando Cardozo-Pelaez, Ph.D. Assistant Professor
Todd Cochran, Ph.D. Associate Professor
Douglas Coffin, Ph.D. Associate Professor
Charles Eyer, Ph.D. Professor
Andrij Holian, Ph.D. Professor
Craig Johnston, Ph.D. Associate Professor
*Tom Kuhn, Ph.D. Assistant Professor
Diana Lurie, Ph.D. Associate Professor
*Mark Pershouse, Ph.D. Research Assistant Professor
*Elizabeth Putnam, Ph.D. Research Assistant Professor
Kent Sugden, Ph.D. Assistant Professor
Charles Thompson, Ph.D. Professor

2. **Please project the need for new faculty over the first five-year program. Include special qualifications or training. If present faculty are to conduct the new program, please explain how they will be relieved from present duties.**

A number of new faculty were recently hired (indicated by * above) and two additional searches should be completed for an immunotoxicologist and a respiratory immunologist before the program is initiated. With the existing faculty and the new hires the responsibilities for the teaching will be accomodated.

3. **Please explain the need and cost for support personnel or other required personnel expenditures.**

There will be no additional support personnel required for the operation of this program.

CAPITAL OUTLAY, OPERATING EXPENDITURES, AND PHYSICAL FACILITIES

1. Please summarize operating expenditure needs.

		FY 03 FIRST YEAR FTE	HEADCOUNT	FY04 SECOND YEAR FTE	HEADCOUNT	FY05 THIRD YEAR FTE	HEADCOUNT
I.	**PLANNED STUDENT ENROLLMENT**						
A.	New Enrollment	2.25	3	6	8	7.5	10
B.	Shifting Enrollment	.75	1	3	4	7.5	10
	GRAND TOTAL PLANNED STUDENT ENROLLMENT	3	4	9	12	15	20

		FIRST YEAR FTE	COST	SECOND YEAR FTE	COST	THIRD YEAR FTE	COST
II.	**EXPENDITURES**						
A.	Personnel Cost						
	Graduate/Instruc Assistants	3	54,000	9	162,000	15	270,000
	Fringe Benefits	3	5,400	9	16,200	15	27,000
	Other (tuition/fees)	3	24,000	9	72,000	15	120,000
	Total Personnel FTE and Cost	3	83,400	9	250,200	15	417,000

		FIRST YEAR COST	SECOND YEAR COST	THIRD YEAR COST
B.	Operating Expenditures			
	Travel (seminar/recruitment)	4,000	7,000	10,000
	Total Operating Expenditures	4,000	7,000	10,000
GRAND TOTAL EXPENDITURES		**$87,400**	**$257,200**	**$427,000**
III.	**REVENUES**			
A.	Source of Funds			
	Appropriated Fund Reallocation	32,000	56,000	80,000
	Federal Funds	55,400	201,200	347,000
	Total Source of Funds	87,400	257,200	427,000
B.	Nature of Funds			
	Recurring	32,000	56,000	80,000
	Non-Recurring	55,400	201,200	347,000
GRAND TOTAL REVENUES		**$87,400**	**$257,200**	**$427,000**

2. Please evaluate library resources. Are they adequate for operation of the proposed program? If not, how will the library need to be strengthened during the next three years?

Library needs were addressed in the 1999-2000 review for approval of the CEHS. Toxicology is by definition an interdisciplinary science, sometimes called a borrowing science because it builds on and utilizes science from other disciplines. Many of those disciplines already exist and the library needs are, at least in part, being addressed. Since one of the Core areas is in neurotoxicology many of the journals supporting neurosciences are already in place. Furthermore, a number of key journals in toxicology are in place through the CEHS. CEHS staff will continue to identify any additional needs and work with the University library staff to advocate for and try to acquire funding for the expansion of electronic subscriptions that support research not only in toxicology, but within the biomedical sciences at the University.

3. Please indicate special clinical, laboratory, and/or computer equipment that will be needed. List those pieces of equipment or computer hardware presently available in the department.

The majority of computing needs are being addressed through the outstanding program at the University to replace outdated computers on a three-year cycle. Additional needs for the graduate students will be addressed through CEHS resources.

The CEHS/Department of Pharmaceutical Sciences has available both PC and Macintosh based computers. The instrumentation available is extensive and is comparable to any well equipped laboratory in the country. Furthermore, a number of state-of-the-art core facilities are available. These include a fluorescence imaging facility that contains fluorescent microscopes, fluorescent cell analyzer, a confocal microscope, and a laser scanning cytometer; a gene microarray facility including a robot slide spotter and a reader and a DNA sequencer; a proteomics facility including a two-dimensional gel with a spot cutter; and a modern histology core containing an automated tissue embedder, automated stainer, workstation, and cryotomes. Furthermore, additional resources are available through a HRSA equipment grant to substantially add to these equipment list as needs arise. All of this equipment is described in more detail on the CEHS website (www.umt.edu/cehs).

4. Please describe facilities and space required for the proposed program. Are current facilities adequate for the program? If not, how does the institution propose to provide new facilities?

Currently space is available for all faculty, including the new hires and space is available for graduate studies. Plans are already being made for expansion of the research space in the School of Pharmacy utilizing federal dollars and private donations to increase the available research space by approximaately 10,000 sq. ft. This will more than accomdate program growth.

EVALUATION OF PROPOSED PROGRAM

1. Please name faculty committees or councils that have reviewed and approved the program herein proposed.

Graduate Standards Committee
- Faculty
- Faculty
- Graduate Faculty Council
- Faculty Senate

Department of Pharmaceutical Sciences
- Department of Pharmaceutical Sciences
- School of Pharmacy & Allied Health Sciences
- The University of Montana
- The University of Montana

2. If outside consultants have been employed, please list the names of these consultants, their current positions, and titles. Append copies of their written reports (this is required of new doctoral programs).

Roger A. Coulombe, Jr. Ph.D.
Professor of Toxicology and Molecular Biology
Director, Graduate Program in Toxicology
Department of Veterinary Sciences
Utah State University

B. Paige Lawrence, Ph.D.
Chair, Pharmacology/Toxicology Graduate Program
Assistant Professor
Department of Pharmaceutical Sciences
Washington State Universitiy

Curtis J. Omiecinski, Ph.D.
Director, Toxicology program
Professor

Kenneth R. Reuhl, Ph.D.
Director, Joint Graduate Program in Toxicology
Professor

APPENDIX 1

THE SOCIETY OF TOXICOLOGY
SURVEY MATERIAL
AND RESULTS

NEEDS ASSESSMENT FOR TRAINING OF FUTURE TOXICOLOGISTS

1996

SOT Placement Committee Report

JOB MARKET SURVEY: PAST, PRESENT, AND THE FUTURE

Summary

This 1996 survey of the toxicology job market suggests that the *overall* number of positions for toxicologists (Ph.D. or equivalent) will increase more during 1996-2000 than during the 1900-1995 time-frame. Response to the survey was >25% (225 respondents) and represented nearly 2500 North American toxicologists where >50% were Ph.D. level or equivalent. The survey identi-fied areas of growth and contraction within various types of organizations that employ toxicolo-gists. In addition, the types of training and experience needed for future toxicology positions were identified. Survey respondents also provided information on their recruitment techniques and an evaluation of whether past applicants had been adequately trained in toxicology and other related job skills.

Methods

The survey was developed with input from the Society of Toxicology (SOT) Placement Committee, SOT Officers and Council, and recipients of a pilot survey who were selected to represent various types of organizations that employ toxicologists. A completed survey was distributed in April 1996 to just over 900 individuals in North America. The distribution list was compiled mainly from the membership directories from the SOT and the Society of Environmental Toxicology and Analytical Chemistry (SETAC); the goal was to reach at least one individual from every North American organization which employed toxicologists. In organizations where more than one recipient of the survey was identified, the recipients were asked to coordinate their response within the organization to reduce the chance that redundant data would be collected.

Make-Up of Respondents

Response to the survey was slightly greater than 25%. Assuming that organizations receiving more than one survey consolidated their reply, the survey response rate was 27%. There were 225 respondents across various organizations that all together employed nearly 2500 toxicologists. This suggests that there are at least 9000 employed toxicologists in North America based on the survey response rate. The organizational breakdowns of survey respondents are shown in Table 1. Under Organization Type, the “Industry-Other” category represents a combined response for industries not falling into the categories of chemicals, consumer products, or pharmaceuticals. The category “Other” Organizations included government contractors, law firms, and some trade associations.

TABLE 1. Organizational Breakdown of Survey Respondents and Toxicologists Employed

Organization Type	Number of Respondents	Percent of Response	Number of Full-Time Toxicologists	Percent of Toxicology Work Force
Academia	51	23%	508	21%
Chemical Industry	23	10%	173	7%
Consulting	36	16%	290	12%
Consumer Products Industry	12	5%	80	3%

Government	27	12%	354	14%
Industry -- Other	28	12.4%	478	20%
Not-For-Prfit	9	4%	96	4%
Other	8	3.6%	45	2%
Pharmaceutical Industry	31	14%	422	17%
TOTAL	225	100%	2446	100%

Across all respondents, greater than 50% of the toxicologists employed were doctoral-level positions (47% full-time Ph.D. or equivalent, 4% post-doctoral, 2% part-time doctoral). The remaining 46% of the work force represented individuals with Bachelor of Science or Master of Science degrees and 1% had unspecified training. There were differences among organizations as to the breakdown of these positions as illustrated in Figure 1.

Job Market Trends

Survey respondents identified changes in the number of positions for doctoral-degree (or equivalent) toxicologists within 18 categories for the time periods of 1990 to 1995 and 1996 to 2000 (Question 4). Overall, the growth that occurred in the 1990-1995 time frame (433 positions) was predicted to increase in the 1996-2000 time frame (531 positions) (Figure 2). Predictions differed among various organizations. For example, decreases in the number of toxicologists hired were forecast for organizations involved with consulting, consumer products, and pharmaceuticals. The numbers of positions within academia were predicted to remain nearly constant. Increases were predicted the chemical industry, government, not-for profit, industry-other and "other" organization categories.

Trends in the types of toxicology jobs were assessed by asking respondents to indicate increases or decreases in the number doctoral-level toxicology positions for 18 different jobs-types during 1990-1995 (Figure 3) versus 1996-2000 (Figure 4). The greatest increase was predicted for toxicologists hired for research, regulatory, and study director positions. More modest growth was predicted for toxicologists hired for academic, clinical, forensic, lab director, risk assessment, and sales positions. Decreases were forecast for consulting, environmental, product safety, and quality assurance positions. Numbers were steady for toxicologists in management, post-doctoral, product development, teaching, and trade association positions.

Characterization of Job Mix by Organization

Within each organization, respondents estimated the distribution of responsibilities for toxicologists among the categories of conducting toxicological research, conducting toxicological testing, providing consultation, teaching, or unspecified (Question 2). This type of information can be helpful in considering a career path. The response to this question by organization type is shown in Table 2. Except for academia, not-for-profit, and pharmaceutical organizations, consulting represents the largest proportion of the toxicologist's job. Overall, a greater proportion of time is spent on research in academia and not-for-profit organizations.

Table 2. Percent Distribution of Toxicology-Related Activities

	Percent Distribution				
ORGANIZATION TYPE	**RESEARCH**	**TESTING**	**CONSULTING**	**TEACHING**	**UNSPECIFIED**
ACADEMIA	47.3	2.6	5.1	31.4	13.6
CHEMICAL INDUSTRY	6.1	27.0	60.9	0.4	5.7
CONSULTING	0.8	0.3	89.4	2.5	6.9
CONSUMER PRODUCTS IND.	11.3	21.3	59.2	0.4	7.9
GOVERNMENT	24.1	7.8	50.0	3.2	15.0
INDUSTRY - OTHER	6.1	33.8	46.9	1.1	2.1
NOT-FOR-PROFIT	37.1	12.2	33.4	3.9	13.3
OTHER	22.8	19.8	36.3	0.0	21.3
PHARMACEUTICAL IND.	13.4	58.4	20.0	1.3	6.9
TOTAL	**19.9**	**18.9**	**41.6**	**8.4**	**11.2**

Nature of Future Toxicology Positions

Of the 227 respondents, 148 indicated that they had positions to fill in 1996-2000 and completed some or all of the remaining survey regarding training, qualifications, and skills needed for future positions (Questions 5-10). They

estimated the percentage of individuals that they expected to recruit in the future in the categories of general toxicologists, toxicologists with specialized training, or scientists trained in specialized areas with a general awareness of toxicology (Figure 5).

Requirements for Post-Doctoral Training and Professional Certification

Respondents were asked to rate the importance of completing a post-doctoral fellowship and of obtaining certification from the American Board of Toxicology (DABT), the Academy of Toxicological Sciences (ATS), and the American Board of Applied Toxicology (ABAT). The re-sponse, summarized in Figure 6, indicates that 29% of respondents with future positions indicated that a post-doctoral fellowship was an "absolute requirement" (absolute), was "desirable, but not required" (desired) by 38 % of the respondents, and was "not a significant consideration" (not sig-nificant) for 32% of the respondents.. DABT certification was required by 5%, was desired by 54%, and was not significant by 39% of the respondents. ATS and ABAT certification were each desired by 15% of respondents; most indicated that ATS and ABAT were not significant (81 and 82 %, respectively). Only a small number of respondents (<2) indicated that post-doctoral fellowships or certification would be "regarded as a negative factor" (negative) for any of the categories.

Organizations that had absolute or desired requirements for are summarized in Table 3. Post-doctoral fellowships were most often required in academia and desired in industry. DABT certification was most often required and industry and desired in industry and consulting organizations.

TABLE 3. Requirements for Post-doctoral Training and Certification

	Percentage			
Organization	**Post-Doctoral**	**DABT**	**ATS**	**ABAT**
Academia				
Absolute	18	0	0	0
Desired	5	5	3	3
Consulting				
Absolute	1	1	0	0
Desired	6	12	3	3
Government				
Absolute	1	1	0	0
Desired	5	3	2	2
Industry				
Absolute	8	3	0	0
Desired	19	29	1	6
Not-for-Profit				
Absolute	1	0	0	0
Desired	1	5	1	1
Other				
Absolute	0	0	0	0
Desired	1	1	0	0

Perceptions of Training Needs for Future Toxicology Positions

The 148 respondents with positions to fill in 1996-2000 helped to identify the types of toxicology training that would be required or desired as cross-training, the types of specialized training, and the types of other scientific support skills that would be needed by candidates for these future positions. It is hoped that this type of information will be useful in evaluating the scope of current toxicology training programs and, thus, this information is not sorted by organiza-tion in this report. A response rank list for toxicology training and cross-training is provided in Table 4. Disciplines that are high on both lists (training & cross-training) and selected by >20% of re-spondents in both categories were pharmacology, biochemistry, molecular biology, and rodent toxicology.

Table 4. Rank List of Toxicology Training Required and Desired as Cross-Training for Future Toxicology Positions

Required Training		Desired Cross-Training	
No. of Responses	**Discipline**	**No. of Responses**	**Discipline**
50	Whole Animal Studies	68	Pathology
49	Rodent Toxicology	66	Pharmacology
38	Biochemistry	52	Molecular Biology
36	Pharmacology	50	Physiology
31	Molecular Biology	49	In Vitro Toxicology
22	Physiology	47	Biochemistry
22	In Vitro Toxicology	33	Aquatic Toxicology
16	Pathology	32	Wildlife Toxicology
16	Large Animal Toxicology	31	Rodent Toxicology
13	Primate Toxicology	26	Whole Animal Toxicology
12	Aquatic Toxicology	25	Primate Toxicology
8	Wildlife Toxicology	19	Large Animal Toxicology
3	Insect Toxicology	3	Insect Toxicology
3	Regulatory Toxicology	1	Regulatory Toxicology
2	Analytical Toxicology	1	Nutrition
2	Microbiology	1	Biotechnology
1	Nutrition		
1	Plant Toxicology		

Table 5 provides a rank list of specialized scientific training needed for new positions. The areas of risk assessment, biochemical toxicology, and mechanistic toxicology were identified as the top three areas for specialized training.

Table 5. Rank List of Specialized Scientific Training Needed for Future Toxicology Positions

Number of Responses - Area		
80 - Risk Assessment	48 - Metabolism	28 - Hepatotoxicity
73 - Biochemical Toxicity	43 - Dose-Response Modeling	27 - Behavioral Toxicity
72 - Mechanisms	38 - Neurotoxicity	24 - Nephrotoxicity
67 - Toxicokinetics / Disposition	37 - Genotoxicity	23 - Anatomy
65 - Chronic Toxicity / Carcinogenicity	36 - Occupational Health / Industrial Hygiene	23 - Epidemiology
55 - Environmental Toxicity	32 - Dermatotoxicity	23 - Hematotoxicity
53 - Developmental Toxicity	32 - Inhalation / Pulmonary Toxicity	19 - Cardiovascular Toxicity
53 - Reproductive Toxicity	32 - Product / Food Safety	19 - Ocular Toxicity
53 - Statistics	29 - Process Safety / Industrial Toxicity	14 - Gastrointestinal Toxicity
49 - Immunotoxicity	29 - Public Health	10 - Other *

* Other areas specified included: 2 - endocrinology, 2 - regulatory toxicology, and 1 each for veterinary medicine, scientific methodology, structure activity response modeling, natural toxins, chemistry, and general toxicity.

Finally, Table 6 summarizes a rank list other scientific support skills needed for new positions as identified by the 148 respondents. The top ranked skills indicate a clear need for candidates who have strong written and oral communication skills and who have good knowledge of computers. In addition, candidates for future jobs will need to be knowledgeable of good laboratory practices, project management skills, and statistics.

Table 6. Rank List of Scientific Support Skills Needed for Future Toxicology Positions.

Number of Responses - Area		
98 - Computers	45 - Study Director	23 - Laboratory Animal Science
90 - Report Writing	45 - Cell Culture	20 - Laboratory Management
84 - Presentations	41 - Quality Assurance	16 - Good Clinical Practice
81 - Technical Writing	38 - Grant Writing	12 - Foreign Language(s)
81 - Good Laboratory Practices	37 - Staff Management	8 - Forensic
79 - Project Management	33 - Teaching	7 - Electron Microscopy
72 - Statistics	33 - Histopathology/Pathology	7 - Other *
58 - Analytical Chemistry	28 - Contract Negotiation	
53 - Regulatory Submissions	27 - Radioisotopes	

* Other areas specified included basic chemistry, clinical skills, good analytical laboratory practices, literature searching, math, solvent toxicology, and relating in vitro observations to the in vivo situation.

Assessment of Candidate Skills and Knowledge

Respondents who had recent (within 5 years) experiences in interviewing and hiring candi-dates for toxicology positions were asked to characterize their overall knowledge and skills in three categories: General Skills, Basic Knowledge Areas, and Specialized Knowledge Areas (question 13). Approximately 150 of the survey respondents provided their evaluations to these areas by rating the candidates overall as "excellent", "satisfactory", "poor", "don't know", or "not applicable".

Table 7 summarizes the assessment of general skills. Communication skills (verbal, written, and oral) are applicable to most all candidates and are considered satisfactory or better in the major-ity of candidates. Other applicable skills that are satisfactory or better in most candidates are inter-personal skills, the ability to critique studies and reports, and information retrieval. At the other end of the spectrum, foreign language skills were evaluated as poor by 32% of the respondents, however, 41% of the respondents indicated that foreign language skills were not applicable.

Table 7. Assessment of General Skills in Recent Toxicology Candidates

General Skill	Percentage Response		
	Satisfactory - Excellent	Poor	Not Applicable
Verbal Communication	87%	8%	2%
Computer Competency	83%	7%	4%
Interpersonal Skills	83%	11%	2%
Written Communication Skills	80%	15%	2%
Presentation Skills	78%	12%	3%
Ability to critique studies / reports	77%	13%	3%
Information Retrieval	73%	10%	5%
Project Management Skills	55%	23%	8%
People Management	50%	25%	12%
Grant Writing	28%	17%	40%
Foreign Languages	8%	32%	41%

Table 8 summarizes the assessment of basic knowledge areas relevant to toxicology. A large percentage of respondents viewed most candidates as satisfactory or better in general and agent-specific toxicology, and biochemistry.

Table 8. Assessment of Basic Knowledge Areas in Recent Toxicology Candidates

Basic Knowledge Areas	Percentage Response		
	Satisfactory - Excellent	Poor	Not Applicable
General Principles of Toxicology	89%	5%	2%
Biochemistry	85%	5%	2%
Agent Specific Toxicity	78%	10%	4%
Physiology	73%	12%	6%
Current Tox. Issues & Controversies	72%	16%	6%
Experimental Design	71%	12%	4%
Statistical Analysis	69%	17%	4%
Anatomy / Pathology	65%	17%	5%
Molecular Biology	61%	18%	9%
Eco/Environmental Toxicology	53%	23%	14%
Analytical Chemistry	51%	24%	11%
Regulatory Toxicology	50%	38%	6%

Table 9 summarizes the assessment of specialize knowledge areas applicable to toxicology. Risk assessment, which was ranked as the top area of specialty scientific training (Table 5) for future toxicology positions, was considered to be satisfactory or better in only 50% of recent toxicol-ogy candidates. Similarly, good laboratory

practices, ranked highly as an important scientific support skill in future candidates (Table 6), was considered to be satisfactory or better in only 49% of recent toxicology candidates.

Table 9. Assessment of Specialized Knowledge Areas in Recent Toxicology Candidates

Specialized Knowledge Areas	Percentage Response			
	Satisfactory - Excellent		Poor	Not Applicable
Xenobiotic Metabolism	74%	12%	9%	
New Research Techniques	70%	11%	9%	
Toxicokinetics	68%	19%	8%	
Standard Testing Protocols	51%	25%	10%	
Risk Assessment	50%		33%	9%
Good Laboratory Practices	49%		29%	11%
Cell / Tissue Culture	48%	15%	23%	
Good Clinical Practices	18%	22%	42%	

Recruitment Preferences

Respondents were asked to rank the top three recruitment tools they found for filling toxi-cology positions. The most effective recruitment tool was networking / word-of-mouth, selected as one of the top three tools by 71% of the respondents. Advertisement was ranked as the next most effective recruitment tool (57%). Advertisement media included Science and other journals, local and/or national newspapers, society newsletters, and internal government or agency recruitment processes. Recruiting professionals were ranked in the top three tools by 40% of respondents and the SOT Placement Center ranked by 37% of respondents as one of the top three recruitment tools. Finally, other professional society postings / placement services ranked in the top three for 16% of respondents.

Appendix 2

Letters from Regional Area Toxicology Graduate program Directors are on file in the Office of the Commissioner of Higher Education.