

# Scientific Working Group for Forensic Toxicology (SWGTOX) Standard for Breath Alcohol Personnel

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This standard has been adopted by the Scientific Working Group for Forensic Toxicology (SWGTOX) and is intended to reflect a minimum standard of practice. Laboratories choosing to meet this practice must decide on an implementation plan that is conducive to the operation, resources and means of the laboratory.

## 1. Introduction

### 1.1. Scope

- 1.1.1. This standard delineates the minimum requirements for educational qualifications, training, competency, experience, continuing education and professional development, and certification. This standard applies to personnel performing activities in the sub-discipline of human performance toxicology - Evidential Breath Alcohol Testing and Calibration. Standards for workplace breath alcohol testing are excluded.
- 1.1.2. Program personnel that perform administrative or non-technical duties are outside the scope of this document.
- 1.1.3. Existing regulations, codes, and rules may need to be modified to conform to this standard. SWGTOX develops and disseminates consensus standards for the practice of forensic toxicology, but has no legal authority to enforce these standards.
- 1.1.4. The minimum requirements for program personnel are categorized at the level of *Operator, Technician, Analyst, Toxicologist, and Technical Director*. Each category of employment builds on the requirements of the previous category.

## 2. Definitions

- 2.1. *Analyst (Breath Alcohol)* – An individual (however named) who conducts, directs or reviews Breath Alcohol Program activities, evaluates breath alcohol data<sup>1</sup> and reaches conclusions based upon those data. The analyst may testify to Breath Alcohol Program activities but does not provide interpretive opinions related to the results of toxicological tests.
- 2.2. *Breath Alcohol Program* – An organizational structure including policies, procedures, responsibilities and resources necessary for implementing core breath alcohol activities. The program includes, but may not be limited to, requirements or specifications for reference materials, training of operators, maintenance and calibration of instrumentation, the evidential breath alcohol test sequence, and record retention.
- 2.3. *Breath Alcohol Program Personnel* – Individuals who perform Breath Alcohol Program activities. This excludes administrative or non-technical support staff, and individuals not employed by the program (typically operators).
- 2.4. *Certification* – The recognition by an independent certifying body that an individual has acquired and demonstrated specialized knowledge, skills, and abilities.
- 2.5. *Competency* – The application of knowledge, skills, and abilities appropriate to the job function.
- 2.6. *Continuing Education* – Ongoing training whereby personnel remain current, or advance to a higher level of expertise, specialization, or responsibility.
- 2.7. *Course* – An officially recognized program of instruction that is taught through an accredited college or university program in which the student's successful completion is documented by an official record of the institution.
- 2.8. *Credential* – A formal recognition of a professional's knowledge, skills, and abilities (e.g., diploma, license).
- 2.9. *Education* – Formal coursework at an accredited college or university.
- 2.10. *Experience* - Direct observation of and participation in the practice of a discipline.
- 2.11. *Methodology* – The analytical processes and procedures used to support forensic toxicology (e.g., infrared spectroscopy, electrochemical oxidation).
- 2.12. *Operator (Breath Alcohol)* – An individual (however named) who performs a quantitative evidential breath alcohol test and completes associated records. The operator may testify as a factual witness.
- 2.13. *Professional Development* – The education and training that contributes to career advancement and succession planning (e.g., administration, leadership, management and fiscal responsibility).
- 2.14. *Qualifications* – The combined education, training, and experience of an individual.

<sup>1</sup>Evaluate data refers to the evaluation of scientific data to meet reporting criteria.

- 2.15. *Reference Material* – A material or substance, sufficiently homogenous, stable, and of known concentration with respect to one or more specified properties, which has been established to be fit for its intended use in a measurement process.
- 2.16. *Technical Director (Breath Alcohol)* - An individual (however named) who is responsible for the technical oversight of the Breath Alcohol Program.
- 2.17. *Technician (Breath Alcohol)* – An individual (however named) who performs Breath Alcohol Program functions following established policies and procedures. Functions may include maintenance, adjustment, calibration, verification, and other program activities.
- 2.18. *Toxicologist (Breath Alcohol)* – An individual (however named) who provides interpretive opinions related to the results of evidential breath alcohol tests.
- 2.19. *Training* – The formal, structured process of teaching and assessment, through which personnel reach a level of scientific knowledge and expertise required to perform specific tasks.

### 3. Educational Qualifications

#### 3.1. Overview

- 3.1.1. One indication of professional standing is educational qualifications. Diplomas and formal academic transcripts are required as proof of academic credentials.
- 3.1.2. Minimum standards for education, training, experience, and continuing education are summarized in Appendix A for each category of employment. Core scientific topics are listed in Appendix B.

#### 3.2. Operator (Breath Alcohol)

- 3.2.1. Individual (however named) who meets the educational requirements outlined by their employer. There are no additional educational requirements for this job function.

#### 3.3. Technician (Breath Alcohol)

- 3.3.1. Associate's degree in natural science (e.g., biology, chemistry, biochemistry) or applied science (e.g., forensic science, medical sciences) from an accredited institution.

#### 3.4. Analyst (Breath Alcohol)

- 3.4.1. Bachelor's degree in natural science (e.g., biology, chemistry, toxicology, biochemistry) or applied science (e.g., medical sciences, forensic science) from an accredited institution; successful completion of general and organic chemistry with associated laboratory classes (minimum 16 semester hours); a course in statistics; at least **two (2)** college-level courses from either Column A or Column B located in Appendix B.

#### 3.5. Toxicologist (Breath Alcohol)

- 3.5.1. Bachelor's degree in natural science (e.g., biology, chemistry, toxicology, biochemistry) or applied science (e.g., medical sciences, forensic science) from an accredited institution; successful completion of general and organic chemistry with associated laboratory classes (minimum 16 semester hours); a course in statistics; at least **one (1)** college-level course from Column A and **one (1)** from Column B located in Appendix B.

#### 3.6. Technical Director (Breath Alcohol)

- 3.6.1. Bachelor's degree in natural science (e.g., biology, chemistry, toxicology, biochemistry) or applied science (e.g., medical sciences, forensic science) from an accredited institution; successful completion of general and organic chemistry with associated laboratory classes (minimum 16 semester hours); a course in statistics; at least **one (1)** college-level course from Column A and **two (2)** from Column B located in Appendix B.

### 4. Training

#### 4.1. Purpose

- 4.1.1. Personnel require training to build competency. The length and content of the initial training provided to the individual will depend upon the scope of work to be performed, as well as the qualifications of the individual. The depth of training will be appropriate to the job function(s).
- 4.1.2. Regardless of qualifications, all technical personnel will be provided training to ensure competency in all assigned areas detailed in the training elements section.
- 4.1.3. Prior to assuming independent responsibility, personnel must have successfully demonstrated competency in their job function(s).

## 4.2. Source of Training

4.2.1. The source of training can be internal and/or external to the Breath Alcohol Program. Training partnerships are valuable because they provide broad perspectives and facilitate consistency of professional practice. Sources include government agencies, academic institutions, training academies or institutions, private sector organizations, manufacturers, professional societies, and mentors.

## 4.3. Training Program

4.3.1. The Breath Alcohol Program shall have a documented training program. It must address both theoretical and practical knowledge, skills and abilities necessary to perform job functions.

4.3.2. A training plan shall define training methodologies, performance standards and assessment methods (e.g., written and/or oral examinations, critical reviews, analysis of unknown samples or mock casework applicable to the sub-discipline).

4.3.3. Documentation of completion of the elements of the training program will be retained.

4.3.4. The relevance and content of the training program shall be evaluated by the organization annually.

## 4.4. Training Elements

4.4.1. Specific training elements shall include the following areas where applicable for the specific job duties as outlined in Appendix A.

### 4.4.2. Administrative and program policies

4.4.2.1. Accreditation

4.4.2.2. Document and record control

4.4.2.3. Method validation

4.4.2.4. Quality management

4.4.2.5. Safety and security

4.4.2.5.1. Biological, chemical, and physical hazards (e.g., storage, handling, disposal)

4.4.2.5.2. Security (e.g., facility, instrumentation and equipment, reference materials)

4.4.2.6. Standard operating procedures

### 4.4.3. Alcohol toxicology

4.4.3.1. Interpretation

4.4.3.1.1. Mathematical calculations (e.g., retrograde extrapolation, Widmark's equation)

4.4.3.2. Pharmacodynamics

4.4.3.3. Pharmacokinetics

4.4.3.4. Physiology

4.4.3.4.1. Blood to breath ratio

### 4.4.4. Calibrating device

4.4.4.1. Dry gas cylinder

4.4.4.1.1. Barometric pressure

4.4.4.1.2. Theory

4.4.4.1.3. Uses/limitations

4.4.4.1.4. Wet/dry offset

4.4.4.2. Wet bath simulator

4.4.4.2.1. Partition ratio

4.4.4.2.2. Temperature

4.4.4.2.3. Theory

4.4.4.2.4. Uses/limitations

- 4.4.5. Communication
  - 4.4.5.1. Report writing
  - 4.4.5.2. Verbal and nonverbal skills
    - 4.4.5.2.1. Non-technical
    - 4.4.5.2.2. Technical
- 4.4.6. Instructional development (applicable if individual will instruct Operator courses)
  - 4.4.6.1. Adult learning principles
  - 4.4.6.2. Knowledge and/or development of curriculum
  - 4.4.6.3. Use of assigned multi-media equipment
- 4.4.7. Instrumentation
  - 4.4.7.1. History
  - 4.4.7.2. Maintenance and troubleshooting
  - 4.4.7.3. Operation
  - 4.4.7.4. Technical functions (adjustment/calibration)
  - 4.4.7.5. Testing functions
  - 4.4.7.6. Theory
  - 4.4.7.7. Uses/Limitations
- 4.4.8. Legal aspects
  - 4.4.8.1. Applicable laws and rules (regulations) including Federal Guidelines for instrument performance (e.g., NIST, NHTSA)
  - 4.4.8.2. Case law
  - 4.4.8.3. Terminology
  - 4.4.8.4. Testimony
    - 4.4.8.4.1. Courtroom procedure
    - 4.4.8.4.2. Deposition and courtroom
- 4.4.9. Quality control
  - 4.4.9.1. Reference material preparation
  - 4.4.9.2. Traceability
  - 4.4.9.3. Uses /Limitations
  - 4.4.9.4. Theory
- 4.4.10. Standards of conduct
  - 4.4.10.1. Ethics
  - 4.4.10.2. Professionalism
- 4.4.11. Statistical analysis
  - 4.4.11.1. Calculations
  - 4.4.11.2. Control charts and/or trending
  - 4.4.11.3. Measurement assurance
  - 4.4.11.4. Measurement uncertainty
  - 4.4.11.5. Terminology

4.5. Operator (Breath Alcohol) initial training. Specific training shall include elements listed in Section 4.4, commensurate with operator duties.

## 5. Competency

### 5.1. Initial competency of Breath Alcohol Program personnel

- 5.1.1. Regardless of academic qualifications or past work experience, all individuals shall satisfactorily complete a competency assessment prior to assuming independent Breath Alcohol Program responsibilities.
- 5.1.2. The format for initial competency assessment(s) will be specified by the program in the training plan. The program may use different formats such as oral, written, and video as a means of ensuring and documenting competency.
- 5.1.3. All areas of technical expertise will include a practical component for their competency assessment (e.g., conducting a subject test, performing a calibration, issuing a report, providing interpretation).
- 5.1.4. The trainee shall demonstrate integration of theoretical and practical knowledge, skills and abilities to perform their functions through the completion of competency tests.
- 5.1.5. Verification document(s) demonstrating that personnel have achieved the required competence must be maintained by the program.

### 5.2. Ongoing competency of Breath Alcohol Program personnel

- 5.2.1. The program shall monitor competency of personnel on a continuous basis, documented annually.
- 5.2.2. Competency shall be assessed at the appropriate level commensurate with job duties.
- 5.2.3. Evaluation of competency may be determined through the following:
  - 5.2.3.1. Audits of paperwork (e.g., instrument files, Certified Reference Material preparation files)
  - 5.2.3.2. Compliance with standard operating procedures
  - 5.2.3.3. Direct observation of employee duties
  - 5.2.3.4. Evaluation of testimony
  - 5.2.3.5. Proficiency testing
  - 5.2.3.6. Technical review
  - 5.2.3.7. Written and/or oral examination
- 5.2.4. The program shall establish a predetermined acceptable level of performance.
- 5.2.5. The program shall establish remediation and corrective action plans when expected outcome(s) are not achieved.

### 5.3. Competency of Operator (Breath Alcohol)

- 5.3.1. Initial competency for Operator (Breath Alcohol) is demonstrated by successfully completing and/or obtaining a certificate, license, or permit (however named) within their jurisdiction to administer an evidential breath alcohol test.
- 5.3.2. Operators (Breath Alcohol) are required to re-certify (however named) on a predetermined time frame.
  - 5.3.2.1. The time frame may be specified in existing law, rules or regulations.
  - 5.3.2.2. If not specified in a legal requirement, the period shall not exceed 2 years (24 months).

## 6. Experience

### 6.1. General

- 6.1.1. Experience is a component of building competency prior to performing the job function. Experience includes both practical and theoretical aspects of breath alcohol.

### 6.2. Operator

- 6.2.1. No experience beyond initial training is required.

### 6.3. Technician

- 6.3.1. No experience beyond initial training is required.

#### 6.4. Analyst

6.4.1. No experience beyond initial training is required.

#### 6.5. Toxicologist (Breath Alcohol)

6.5.1. Prior to assuming independent responsibilities and providing comprehensive and interpretive testimony, one year of relevant forensic alcohol experience is required.

6.5.2. Relevant forensic alcohol experience from previous work experience can be included in the one year minimum experience requirement.

6.5.3. An initial training phase culminating in a competency assessment shall occur as part of this program experience.

#### 6.6. Technical Director (Breath Alcohol)

6.6.1. Prior to assuming independent responsibilities as Technical Director of a Breath Alcohol Program, a minimum of two years of experience as a Toxicologist (Breath Alcohol) performing independently is required.

6.6.2. Relevant forensic alcohol experience from previous work experience can be included in the minimum experience requirement.

6.6.3. An initial training phase culminating in a competency assessment shall occur as part of this program experience.

### 7. Continuing Education and Professional Development

7.1. All Breath Alcohol Program personnel have an ongoing obligation to remain current within the discipline through continuing education and professional development activities appropriate for the scope of job functions.

7.2. Individuals should also strive to advance the profession. This may be accomplished through professional involvement such as research, mentoring, teaching, participating in professional organizations, scientific publications and other professional activities.

7.3. Recognition of any continuing education or professional development requires proper documentation. The Breath Alcohol Program is responsible for maintaining permanent, official training records. Assignment of CE credit for various activities is the purview of the respective Certification Bodies.

7.3.1. The program shall maintain documentation of attendance through a mechanism such as certificates of completion, duration of training, program agenda/syllabi, travel documentation (if applicable).

7.3.2. The activities must be independently verifiable and may include seminars, conferences, coursework, professional meetings or documented training sessions/classes in relevant subject areas.

7.3.3. Continuing education activities also include an individual's contribution to the field of forensic toxicology. Examples include presentations, publications in peer-reviewed literature, or authorship of books or chapters.

7.3.4. Continuing education and professional development will be a combination of internal and external activities. The sources of external continuing education and professional development are diverse (e.g., government agencies, academic institutions, training academies or institutions, private sector organizations, professional societies, vendors).

7.3.5. Continuing education and professional development can be delivered in-person or online.

7.3.6. Continuing education and professional development from organizations that provide recognized continuing education credits are preferred.

7.4. Minimum continuing education and/or professional development requirements for Breath Alcohol Program personnel are as follows:

7.4.1. A minimum of 25% of the required continuing education and/or professional development must be obtained from external sources.

7.4.2. Technicians (Breath Alcohol): four (4) hours annually, which must be relevant to forensic toxicology.

7.4.3. Analysts (Breath Alcohol): eight (8) hours annually, which must be relevant to forensic toxicology.

7.4.4. Toxicologist (Breath Alcohol): sixteen (16) hours annually, which must be relevant to forensic toxicology.

7.4.5. Technical Director (Breath Alcohol): twenty (20) hours annually, which must be relevant to forensic toxicology and/or laboratory management.

7.5. It is the responsibility of the program to ensure that the following resources are available and accessible to program personnel:

7.5.1. Reference texts in key subject areas (e.g., analytical chemistry, toxicology, pharmacology).

7.5.2. Reference literature containing physical, chemical, pharmaceutical and/or analytical data (e.g., Merck Index, Clarke's Analysis of Drugs and Poisons).

7.5.3. Relevant periodicals and peer-reviewed journals.

7.6. Program management has an ongoing responsibility to provide support and opportunities for continuing education and professional development.

## 8. Certification

### 8.1. General

8.1.1. Certification provides the public and the judicial system a means of identifying those practitioners who have successfully demonstrated competency. It provides an additional means of verifying ethical standards and is an external review of ongoing competency.

### 8.2. Individuals Requiring Certification

8.2.1. All individuals (however named) performing functions commensurate with those of an Analyst (Breath Alcohol), Toxicologist (Breath Alcohol), or Technical Director (Breath Alcohol) shall be certified within 3 years of reaching eligibility requirements as established by the certification bodies.

8.2.2. Operators (Breath Alcohol) may be authorized (or individually certified) by local or state statutes, and are exempt from certification by certification bodies.

### 8.3. Standards for Forensic Toxicology Certification Bodies include:

8.3.1. A formal application process.

8.3.2. Verification of minimum educational qualifications. (see Section 3).

8.3.2.1. Review of official transcript(s) from an accredited college or university sent directly to the certification body.

8.3.2.2. Transcripts from foreign institutions must be evaluated for equivalence by a transcript evaluation service that is recognized or accepted by an accredited college or university within the United States.

8.3.3. Review of professional references.

8.3.3.1. A minimum of two references from practitioners with knowledge of the applicant's experience in a Breath Alcohol Program, submitted directly to the certification body.

8.3.4. Evaluation of credentials.

8.3.4.1. Documentation of successful completion of relevant training (internal and/or external).

8.3.4.2. Competency (practical) evaluation including but not limited to proficiency testing or review of same.

8.3.4.3. Verification of required training and experience.

8.3.5. Statement of adherence to a professional code of conduct.

8.3.6. A written, proctored examination appropriate to the level of certification.

8.3.6.1. Examination questions shall be periodically evaluated for relevancy and bias.

8.3.6.2. Examinations shall include specific questions to determine the applicant's ability to evaluate and interpret test results where appropriate.

8.3.6.3. Certification bodies shall have predefined criteria for successful completion.

8.3.7. A requalification process that occurs at least every 5 years and includes the following:

8.3.7.1. Mandatory minimum annual continuing education requirements appropriate for the level of certification.

8.3.7.2. Evaluation of competency through one or more of the following: proficiency testing, case audits, evaluation of court testimony, and/or other appropriate mechanisms based on the discipline and level of certification.

8.3.8. A process to reapply for certification in the event an individual does not qualify.

8.3.9. Certification bodies shall be accredited based on a relevant ISO standard (e.g., ISO/IEC 17024 Conformity assessment: General requirements for bodies operating certification of persons).



## 9. References

- [http://www.iactonline.org/Resources/Documents/IACTtraining\\_recommendations2011.pdf](http://www.iactonline.org/Resources/Documents/IACTtraining_recommendations2011.pdf). International Association for Chemical Testing: Recommendations for Evidential Breath Alcohol Personnel [Internet] cited August 22, 2014.
- National Institute of Justice, Education and Training in Forensic Science: A Guide for Forensic Science Laboratories, Educational Institutions, and Students. Washington, DC, (2004).
- National Research Council. Strengthening Forensic Science in the United States: A Path Forward. *Washington, DC: The National Academies Press, 2009.*

## Appendix A: Summary of Minimum Standards for Breath Alcohol Personnel

	Operator (breath alcohol)	Technician (breath alcohol)	Analyst (breath alcohol)	Toxicologist (breath alcohol)	Technical director (breath alcohol)
<b>Scope</b>	Performs evidential breath alcohol test and completes associated records. Testifies as factual witness.	Performs Breath Alcohol Program functions following established policies and procedures. Functions may include maintenance, verification, adjustment, calibration and other activities. Testifies to Breath Alcohol Program Activities.	Conducts, directs and/or reviews the Breath Alcohol Program activities, evaluates data <sup>1</sup> and reaches conclusions. The analyst may testify to Breath Alcohol Program activities but does not provide interpretive opinions related to the results of toxicological tests.	In addition to other duties, provides interpretive and/or expert opinions related to the results of evidential breath alcohol tests.	In addition to other duties, is responsible for the technical oversight of the Breath Alcohol Program.
<b>Education</b>	Meet the requirements of employer.	Associate's degree <sup>2</sup>	Bachelor's degree <sup>2</sup>	Bachelor's degree <sup>2</sup>	Bachelor's degree <sup>2</sup>
<b>Required Courses</b>	NA	NA	<ul style="list-style-type: none"> <li>General &amp; organic chemistry (16 semester hr)</li> <li>Statistics</li> <li>2 analytical and/or interpretive courses (Appendix B)</li> </ul>	<ul style="list-style-type: none"> <li>General &amp; organic chemistry (16 semester hr)</li> <li>Statistics</li> <li>1 analytical and 1 interpretive course (Appendix B)</li> </ul>	<ul style="list-style-type: none"> <li>General &amp; organic chemistry (16 semester hr)</li> <li>Statistics</li> <li>1 analytical and 2 interpretive courses (Appendix B)</li> </ul>
<b>Training and Work Experience</b>	<ul style="list-style-type: none"> <li>Completion of formal, structured training program for Operators.</li> </ul>	<ul style="list-style-type: none"> <li>Completion of formal, structured training program appropriate to job function.</li> </ul>	<ul style="list-style-type: none"> <li>Completion of formal, structured training program appropriate to job function.</li> </ul>	<ul style="list-style-type: none"> <li>Completion of formal, structured training program appropriate to job function.</li> <li>1 yr relevant forensic alcohol experience is required prior to assuming independent <i>Toxicologist</i> duties.</li> </ul>	<ul style="list-style-type: none"> <li>Completion of formal, structured training program appropriate to job function.</li> <li>2 yr experience as a <i>Toxicologist</i> (Breath Alcohol) prior to assuming role of a <i>Technical Director</i>.</li> </ul>
<b>Independent Certification</b>	<ul style="list-style-type: none"> <li>Not required</li> </ul>	<ul style="list-style-type: none"> <li>Not required</li> </ul>	<ul style="list-style-type: none"> <li>Required</li> </ul>	<ul style="list-style-type: none"> <li>Required</li> </ul>	<ul style="list-style-type: none"> <li>Required</li> </ul>
<b>Annual Continuing Education &amp; Professional Development</b>	Recertification at pre-determined interval, not to exceed 24 months unless mandated.	<ul style="list-style-type: none"> <li>4 hr relevant to forensic toxicology</li> <li>1 hr from external source.</li> </ul>	<ul style="list-style-type: none"> <li>8 hr relevant to forensic toxicology</li> <li>2 hr from external source.</li> </ul>	<ul style="list-style-type: none"> <li>16 hr relevant to forensic toxicology</li> <li>4 hr from external source.</li> </ul>	<ul style="list-style-type: none"> <li>20 hr relevant to forensic toxicology and/or lab mgmt</li> <li>5 hr from external source.</li> </ul>

<sup>1</sup>Evaluate data refers to the evaluation of scientific data to meet reporting criteria.

<sup>2</sup>Represents a degree in a natural science or applied science from an accredited institution.

## Appendix B: College-Level Course Overview

The courses below serve as *examples* of acceptable courses in accredited colleges or universities. **This list is not meant to exclude similar courses with similar content bearing different titles.** These courses do not replace the required 16 semester hours of chemistry.

**Table 1.**

Examples of Acceptable College-level Courses.

Column A Chemistry courses (analytical)	Column B Specialized science courses (interpretive)
Analytical chemistry	Biochemistry
Chemical informatics	Drug metabolism
Instrumental analysis	Forensic toxicology
Mass spectrometry	Medicinal chemistry
Quantitative analysis	Pharmacology
Separation science	Physiology
Spectroscopic analysis	Toxicology

### **Chemistry Course Descriptions – Examples (Column A)**

*Analytical Chemistry* – A study of the separation, identification, and quantification of chemical components.

*Chemical Informatics* – Computer methods for experimental design and data analysis of spectroscopic, electrochemical and chromatographic data. Topics include sampling theory, detection limits, curve resolution, Fourier transform-based instruments and factor analysis.

*Instrumental Analysis* – Theory and practice of spectrophotometric, electroanalytical and chromatographic methods.

*Mass Spectrometry* – Topics include mass spectrometry ionization methods, mass analyzers, theory and applications for ion structure determination.

*Quantitative Analysis* – Theory and practice of gravimetric, volumetric and instrumental analysis techniques and treatment of multiple equilibria in aqueous solutions.

*Separation Science* – Principles of separation science as applied to chemical problems with emphasis on current techniques, instrumentation and applications.

*Spectroscopic Analysis* – Theory and application of spectroscopic techniques to determine molecular structure.

### **Specialized Science Courses – Examples (from Column B)**

*Biochemistry* – A presentation of structural biochemistry, enzymology, biophysical techniques, bioenergetics and an introduction to intermediary metabolism.

*Drug Metabolism* – Biotransformation and emphasis on the molecular aspects of Phase I and Phase II drug metabolism.

*Forensic Toxicology* – Basic principles of analytical and/or interpretive toxicology as they apply to legal issues.

*Medicinal Chemistry* – A combination of fundamentals and applications of drug design including molecular aspects of drug action.

*Pharmacology* – The mechanisms of action of major drug classes and basic principles of pharmacology, including pharmacokinetics and pharmacodynamics.

*Physiology* – A human physiology course based on an analysis of organ systems.

*Toxicology* – Dynamic interactions of xenobiotics with living systems. Correlations of toxicological responses with biochemical, functional and morphological changes.