

Literature Retrieval and Interpretation: A Nontraditional Medicinal Chemistry Laboratory

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ABSTRACT. The project objective was to introduce students to the methods of scientific literature retrieval. We have developed a medicinal chemistry class project to teach scientific literature retrieval methods. Students were presented with lectures and demonstrations of how to search for, analyze, and recover scientific literature from traditional library sources, electronic databases, and the World Wide Web (WWW). Students were presented with a drug name and required to search the literature for various pharmacological aspects of their drug. After the completion of a comprehensive written literature summary, students were divided into groups according to the pharmacological class of their assigned drug and required to present an overview of the pharmacological class. This project provided an innovative mechanism for introducing students to the methodologies of scientific literature retrieval, the use of computer technology, functioning in small problem-based, learning-type groups as well as public presentations, and an introduction to the chemistry and pharmacology of drug classes. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-342-9678. E-mail address: getinfo@haworthpressinc.com]*

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INTRODUCTION

Over the past few years, schools of pharmacy within the United States have become active in exploring new and effective teaching methodologies utilizing critical thinking skills and problem-based learning (1-5). As the use of these methodologies increases, so does the importance of the student's ability to search and interpret the scientific and medical literature (6-8). We have been aware for many years that students entering into the third year of the professional pharmacy program are severely limited in their literature retrieval and interpretation skills. With the University of Mississippi's recent decision to implement a problem-based learning curriculum, the need for intensive training in the techniques of modern literature retrieval and interpretation became even more important (9). We have designed a nontraditional laboratory project which provides instruction in the use of literature retrieval methodologies and mandates the use of these methodologies in researching, interpreting, and presenting scientific and medical information. This project has been implemented within the laboratory section of the course "Introduction to Medicinal Chemistry Principles" (MEDC 315), and requires four of the eleven traditional medicinal chemistry laboratory classes.

Traditional undergraduate medicinal chemistry laboratory courses, including the laboratory section of "Introduction to Medicinal Chemistry Principles," have focused on skills involving combinations of pharmaceutical analytical methodologies including (but not limited to) concepts of molarity, equivalents, molality, and chemical equilibria; pH and buffer systems; titration of drugs; potentiometric methods; effects of pH on solubility, partitioning, and biological properties of drugs; nonaqueous acid-base titrations; precipitation titrations; complexometric titrations; oxidation-reduction titrations; fundamentals of ultraviolet, visible, infrared, flame emission, fluorescence, and atomic absorption spectroscopy; concepts of chromatographic analysis, gas, liquid, and thin-layer chromatographies; analysis of drugs containing amine functional groups; analysis of drugs containing hydroxyl groups; and diagnostic test kits. With the role of the pharmacist directed more and more towards direct patient care, the need for pharmaceutical analysis skills has unfortunately been questioned, decreased and in some cases eliminated from core undergraduate pharmacy and Pharm.D. curricula (10). Our traditional undergraduate medicinal chemistry analytical methodologies course has been revised to include traditional experiments utilizing the concepts of chromatography, polarity, partitioning, stereochemistry, HPLC, chemical incompatibilities, diagnostic test kits, and molecular modeling. In addition, four of the laboratory sections have been utilized for training the students in the methodologies

of researching, interpreting, and reporting scientific and medical information from the literature.

Our overall goal was to introduce to the students the importance of three skills: a. how to search for, analyze and recover scientific literature from traditional library sources, electronic databases, and the World Wide Web (WWW), b. how to interpret and utilize scientific literature, and c. how to condense and effectively present a literature summary (11-14).

METHODS

The project is divided over four of the 13 laboratory sessions presented during the semester. The first three sessions are taught during the first three laboratory sessions of the semester; the fourth session is the last laboratory session of the semester. In addition, some project instructions are provided in the parent class, "Introduction to Medicinal Chemistry Principles" (MEDC 314).

Laboratory Session 1: An Introduction to the Library. Students are introduced to the library facilities, the basic organization of the library, and the most used reference resources for pharmacy. A formal lecture is provided to individual groups of approximately 25 students describing the facilities, what literature is available, and what references they are most likely to use. Each of the basic pharmacy-related reference materials is described briefly and the students are provided a handout which describes what information is likely to be found in these references. These references are divided into general references, specialty references, drug interaction references, pharmacology references, dictionary references, and journals. Two examples of the type of material that is provided to the students are shown in Figure 1. Students are given a pretest to measure their basic knowledge about the library. This test is given with the intention of providing the student with a self-measure of what minimal expectations are required at this point. A variation of the pretest is shown in Figure 2.

At the end of this first laboratory session, the students are given a short assignment designed to exercise their new knowledge of the library. A variation of this initial assignment is shown in Figure 3. The students are given one week to complete this assignment. Each assignment is graded and is the basis for approximately 5% of the total course grade.

Laboratory Session 2: An Introduction to the Electronic Library. Probably the most radical change in information science over the past ten years has been the computer technology which allows one to search the massive collections of scientific and medical data. We feel that it is imperative to

FIGURE 1. Examples of Reference Material Supplied to Students.

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1. *Merck Manual of Diagnosis and Therapy*, 16th ed., 1992 (Merck & Co., Inc., Rahway, NJ 07065, \$26.00) RC 55.M4 Ref.

This concise handbook is arranged alphabetically by disease category; each disease is discussed as to symptoms and signs, diagnosis, prognosis, and treatment. It includes how-to aspects of medical, nursing, and laboratory techniques. Well-indexed.

2. *Hansen's Drug Interactions*, 1996 (Lea & Febiger, Washington Square, Philadelphia, PA 19106, \$52.50) RM 302.H36 Ref. (looseleaf, with quarterly updates)

Contains drug-drug and drug-food interactions, drug effects on clinical laboratory results, and algorithms for some of the more important drug-drug interactions.

educate pharmacy students about the use of these technologies as early in their education process as possible. In the second laboratory session students are introduced to common Boolean logic terms and how they are used effectively. Methodologies are directed towards, but not limited to, the use of Medline and International Pharmaceutical Abstracts (IPA) on SilverPlatter CD-ROM. Examples of the basic features that are covered are shown in Figure 4. In addition, students as a group are introduced to the University's Online Public Access Catalog (OPAC), Innovative Interfaces, Inc. Example literature searches are illustrated and students are provided with detailed handouts of each example. The students are subsequently divided into small groups and given hands-on instruction at the computer workstations. Individualized instruction varies from student to student depending on their previous experience with the systems. Additional training is always available from library personnel, and many students return after the session for additional individualized training.

At the end of this second laboratory session, the students are given a short assignment designed to exercise their new knowledge of the electronic applications available in the library. A variation of this assignment is shown in Figure 5. The students are given one week to complete this assignment. Each assignment is graded and is the basis for approximately 5% of the total course grade.

Laboratory Session 3: An Introduction to the WWW and Project Assignments

An Introduction to the WWW. The Internet or worldwide web (WWW) has rapidly become a powerful information gathering and finding tool. It is

FIGURE 2. Sample of Pretest Administered to Students.

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1. The _____ is the guide to books and journals in the Pharmacy Library.
 2. The three basic types of journals in the Library are _____, _____, and _____. (Hint: *American Druggist*, *Journal of the American Pharmaceutical Association*, and *Journal of the American Medical Association* are examples of the three types.)
 3. The major indexes to pharmacy journal literature are _____ and _____.
 4. Articles listed in these two indexes may be found by looking under the _____ and _____.
 5. Journals are arranged on the shelf in _____ order by _____; books are arranged on the shelf by _____.
 6. A compilation of 28 international pharmacopoeias providing abstracts of articles about a drug is _____.
 7. The reserve book collection is located _____ in the Library.
 8. Reference books in the Pharmacy Library are indexed in the _____.
 9. Official standards for the manufacture of drug compounds are found in either the _____ or the _____.
 10. _____ is the encyclopedic volume covering all aspects of the practice of pharmacy.
 11. The two most-used sources for drug cost and availability information are _____ and _____.
 12. Several reference sources compile and republish manufacturers' package insert information. Name two: _____ and _____.
 13. An excellent unbiased source for drug information for both community and hospital pharmacists is _____, published by the American Hospital Formulary Service.
 14. The best all-around pharmacology text is _____.
 15. A standard manual of disease states, their treatment, and patient-related problems is _____.
 16. The most-used manual of drug-drug and drug-food interactions is _____.
 17. For information about OTC drugs, use _____.
 18. Name two medical dictionaries: _____ and _____.
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FIGURE 3. Sample of Initial Library Assignment Given to Students.

Instructions: Find the information asked for in the problems/questions and tell where you found it. (Include the book or index title, volume number, edition, page, etc.—any and all that apply to the particular reference used to answer each question).

1. How much sodium is there in Correctol® laxative?
 2. Where and when were the first clinical trials of penicillin conducted?
 3. What brand name of furosemide 20 mg tablets is therapeutically equivalent to the generic?
 4. One of the reactions to Benadryl® overdosage is central nervous system depression. Should stimulants be used in case of overdosage of Benadryl® capsules?
 5. What is an enteric coating on a pharmaceutical dosage form?
 6. Draw the chemical structure of azomycin.
 7. What is the etiology of rheumatoid arthritis?
 8. What vegetables should a patient who is taking an oral anticoagulant avoid in excessive amounts?
 9. In what quantities does Goldline sell minoxidil?
 10. What are the three accepted indications for systemic tricyclic antidepressants (those that are included in U.S. product labeling)?
 11. Find and copy down references to two journal articles about the adverse effects of dietary sodium chloride. (You do not have to look up the actual articles in the journals).
 12. Find an abstract of a journal article about managed-care systems and home-health care. Copy down the complete reference to the article. Remember to tell which volume, issue, page, date, and abstract number you used to find the abstract.
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expected that the WWW will only continue its rapid growth in the future and we feel that it is imperative that today's pharmacy student, tomorrow's pharmacist, be able to utilize this tool with a high degree of skill and to differentiate between useful scientific data and conjecture and opinion.

The students receive a brief lecture dealing with various aspects of the WWW, including the great potential and pitfalls. The students are encouraged to double-check all information found on the web with known legitimate library resources. In this third laboratory session, the students are

FIGURE 4. Example of Search Methodologies Introduced to Students.

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1. Boolean Logic: the ability to cross concepts by combining terms.

OR = synonym or near synonym
 AND = in the same record (narrows/limits the search)
 WITH = in the same field
 NEAR = in the same sentence
 NOT = excludes whatever follows

you can link terms: hypertension OR stroke

you can link groups of terms: hypertension OR high blood pressure

2. Truncation: Use a symbol, such as a * or ? to make a root word in order to pick up all variations beginning with that root:

rat*-will pick up rat, rational, rationale, rationing, rates, etc.

Internal (embedded) truncation is allowed on SilverPlatter Medline and IPA:

tumo?r-will pick up the American spelling "tumor" and the British spelling "tumour"

3. Subject Headings/Descriptors: Also called "thesaurus terms" in Medline. Can be entered with hyphens which the computer recognizes as subjects. If you already know the subject and enter it with hyphens, it will save you time.

example: ciliary-body

Using truncation with the subject heading, you can retrieve all subheadings of the subject:

ciliary-body*-will pick up drug effects, metabolism, pathology, physiology, surgery and all other allowable subheadings of the subject ciliary body.

4. Author's Names: are usually entered in inverted order and hyphenated. To be safe, specify the author field:

Smith-MC in au (no periods after the initials)

5. Field Searching: terms can be limited to certain fields, for example:

tg = human (Medline)

hu = human (IPA)

You can limit a search to any field by specifying the field after your search term, for example:

JAMA in so

("so" is a short field label for source-the journal title)

FIGURE 4 (continued)

6. Subject Thesaurus/Descriptor Groups: You can retrieve all subjects that have a word in common by entering the word and limiting it to the subject field for that index:

Medline: heart in mesh
heart in mjme
race in mime

IPA: retail in de

7. Limiting by Publication Date or Language or Publication Type

py	=	1994
py	<	1994
py	=	1993-1995
la	=	english
cp	=	united-states (Medline)
cp	=	usa (IPA)
tg	=	human (Medline)
hu	=	human (IPA)

instructed in how to access the WWW at the University of Mississippi. The University of Mississippi provides free access to the WWW via directly wired libraries, computer laboratories, dormitory facilities, and remote modem access. The students are given a tour of some of the most useful pharmacy-related Internet sites shown in Figure 6.

At the end of this third laboratory session, the students are given a pair of assignments designed to exercise their new knowledge of the electronic applications available in the library. A variation of these assignments is shown in Figures 7 and 8. The students are given one week to complete this assignment. Each assignment is graded and is the basis for approximately 5% of the total course grade.

PROJECT ASSIGNMENTS

After the conclusion of the third laboratory session, the students are each given an individual generic drug name selected from the most recent top 200 list. The assignment of drug to student is totally random. The drugs are selected so that there are five to seven drugs in each of 14 pharmacological categories (see Figure 9). Each student is given approximately five weeks to prepare a detailed written thesis of their particular drug.

The literature research project was designed to enable the students to

FIGURE 5. Example of Electronic Library Applications Assignment.

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1. Using the Thesaurus on the 1997 Medline disk, search for one of the following conditions/diseases and find a reference to an article on drug therapy for it. Using at least one Boolean operator, limit your search to articles about humans and in English only. Print out one record, including the abstract and your search strategy, and attach it to this sheet and turn it in.
 - a. gastroesophageal reflux
 - b. schizophrenia
 - c. Creutzfeldt-Jakob syndrome
 - d. Parkinson's disease
 - e. Syndrome X
 - f. hematoma
 - g. liver, cirrhosis
 - h. meningitis, fungal

 2. Using freetext searching on the IPA disk, perform one of the following searches. Using at least one Boolean operator, limit your search to human only and in English only. Print out one record, including the abstract and your search strategy, and attach it to this sheet and turn it in.
 - a. nitric oxide and inhal*
 - b. bismuth and helicobacter pylori
 - c. osteoporosis and estrogen*
 - d. asthma and steroid*
 - e. Persian gulf and chemical war*
 - f. mari?uana and cognit*
 - g. garlic and lipid*
 - h. managed care and benefit manage*

 3. Use the Innovative Interfaces OPAC computer to:
 - a. Find a book on nonprescription drugs. The book must be located in the Pharmacy Library. Print out a copy of the screen that shows the location, call number, and status (whether checked out already) of the title you choose. Attach the printout to this sheet.

 - b. Find out if a journal title in one of the references you found on Medline or IPA is available on campus. If one of the titles is available, print out the screen showing its location and latest issue received. If neither of the titles is available on campus, look up the journal *JAMA* and print out the screen showing its location and latest issue received. Attach the printout to this sheet.
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FIGURE 6. Pharmacy-Related Internet Sites.

Food and Drug Administration	http://www.fda.gov/bbs_topics.html
Doctor's Guide to the Internet	http://www.ps1group.com/Mednews.htm#Medical
From Doctor's Guide	http://www.ps1group.com/NEWDRUGS.HTM
Pharmaceutical Info Homepage	http://www.pharminfo.com/
Medical Sciences Bulletin	http://www.pharminfo.com/pubs/msb/
Drug Data Base	http://www.pharminfo.com/drugdb/db_mnua.html
Drug Receptors	http://www.infoseek.com/Titles?qt=receptors
The Virtual Pharmacy Center	http://www-sci.lib.uci.edu/~martindale/Pharmacy.html
Virtual Library: Pharmacy Page	http://www.cpb.uokhsc.edu/pharmacy/pharmint.html
Pharmacy Info	http://www.rxlist.com/
Therapeutics	http://www.mic.ki.se/Diseases/e2.html
Drug Metabolism	http://ull.chemistry.uakron.edu/genobc/Chapter_23/
Drug Infonet	http://www.druginfonet.com
Compounding	http://www.emanate.com/panorama
RxList (Top 200 Drugs)	http://www.rxlist.com
American Association of Pharmaceutical Scientists	http://www.cpb.uokhsc.edu/aaps/aaps.html
American Society of Health- System Pharmacists	http://www.ashp.com
American College of Clinical Pharmacists	http://www.pitt.edu/~gib/accp.html
Centers for Disease Control and Prevention	http://www.cdc.gov
American Pharmaceutical Association	http://www.aphanet.org
American Association of Colleges of Pharmacy	http://www.aacp.org
Facts and Comparisons	http://www.fandc.com
National Institutes of Health	http://www.nih.gov
The Formulary	http://www.theformulary.com
Poison Information	http://www.pitt.edu/~martint/pages/poisres.htm
PharmWeb	http://www.pharmweb.net

FIGURE 7. Electronic Library Applications, Assignment 1.

The uses of the Internet obviously extend far beyond computer games and e-mail. There are many useful sites for those interested in pharmacy and the pharmaceutical sciences. One such site is a drug metabolism site which contains many useful and timely drug summaries. You can access this site on Netscape at the following location:

http://odin.chemistry.uakron.edu/genobc/Chapter_23/

Your take-home assignment involves your accessing this site, viewing each page, and then answering the questions below.

1. Is the major metabolite of pentobarbital as shown more or less polar than pentobarbital itself? Draw the structure of this metabolite:
 2. Is the major metabolite of procaine active or inactive? Draw the structure of this metabolite:
 3. Most metabolic enzymes in the liver are located in the _____ of the endoplasmic reticulum.
 4. Phase I reactions are referred to as _____ reactions while Phase II reactions are referred to as _____ reactions.
 5. The process of introducing initially high oral doses of a drug which saturate liver enzymes is referred to as _____.
 6. How many metabolites of verapamil have been identified? _____. What is the name of the major metabolite of verapamil? _____.
 7. Does the metabolism of codeine result in more active or less active metabolite than codeine itself? _____. Draw the structure of this metabolite:
 8. How many milligrams of ethanol per kg of body weight can the body metabolize each hour? _____. The enzyme responsible for metabolizing ethanol is _____. The initial product of oxidation of ethanol is _____.
 9. The increase in the NADH/NAD⁺ ratio resulting from the oxidation of ethanol would cause a _____ (increase or decrease?) in gluconeogenesis and a _____.
 10. The structure of the hepatotoxic metabolite of acetaminophen is incorrectly drawn. Draw the correct structure:
-

FIGURE 8. Electronic Library Applications, Assignment 2.

This assignment requires you to: a) access three different sites on the Internet, b) read the information indicated at each site, and c) answer the following questions relating to those sites.

1. The Food and Drug Administration has a New Drug Approvals List site which is very valuable for keeping up with new drug introductions. This site is:

<http://www.fda.gov/cder/da/da.htm>

When a new drug is approved the FDA assigns a code for chemical type and therapeutic potential. A chemical code of "1" indicates that the drug is a new chemical entity. A therapeutic potential code of "P" indicates that the drug received a "priority" review while a code of "S" indicates that the drug received a "standard" review. In December of 1996 the FDA approved 13 new drugs with either a 1P or 1S rating. Locate these new drugs and list them as follows:

Generic Name	Trade Name	FDA Rating
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2. The *Doctor's Guide to the Internet* is an excellent source for keeping up with news regarding medical and pharmaceutical developments within the past seven days or within the past month (30 days). This site can be found at:

<http://www.pslgroup.com/Mednews.htm#Medical>

Locate the following two articles and then answer the questions provided for each article.

A. "FDA Urged to Expand Uses for Aspirin"

- a) This year marks the _____ anniversary of aspirin's discovery by _____ laboratories in _____.
- b) Approximately _____ Americans suffer stroke each year; as many as _____ women in the U.S. suffer stroke annually _____. (More or Less) women than men die from stroke each year.
- c) The FDA will broaden aspirin's currently approved indications and will encourage physicians to administer aspirin for 1) _____ and 2) _____.
- d) Heart attack is the nation's leading killer striking _____ Americans annually, killing nearly _____.

B. "Resistance Does Not Develop to HIV Protease Inhibitor in Clinical Study"

- a) The code name for the HIV protease inhibitor in this report is _____.
- b) _____ was the first antiviral medicine developed for use in adults and children with HIV. This drug was introduced in _____ by _____ laboratories.

3. *Medical Sciences Bulletin* is a useful site for drug reviews. This site is located at:

<http://pharminfo.com/pubs/msb/>

Locate the following two articles and then answer the questions provided for each article.

A. "Two Thrombolytics Approved"

1. Two recombinant tissue plasminogen activators (tPAs) were recently approved by the FDA. Provide the generic and trade names of these two agents:
2. One of these two has been on the market for several years but for a different indication than the one recently approved. Which of these drugs is the "older" drug and what was its originally approved indication?

Drug _____ Indication _____

3. What are the advantages of the "newer" tissue plasminogen activator over the older one in terms of half-life?
4. Streptokinase (Streptase®) is a standard regimen. What advantage does the "newer" tPA have over streptokinase?
5. Indicate whether the following statements are TRUE or FALSE:

The "newer" tPA is a non-glycosylated deletion mutein of tPA.
The "newer" tPA binds fibrin more tightly than does tPA.
The "newer" tPA competes with plasminogen for fibrin-binding sites.

B. "Anesthetic Ropivacaine Approved"

1. Ropivacaine is the first local anesthetic to receive FDA approval in _____ years.
2. Ropivacaine is a _____ compound closely related chemically to bupivacaine.
3. The trade name for ropivacaine is _____.
4. Compared to bupivacaine, ropivacaine causes significantly _____ depression of cardiac conductivity.
5. Local anesthetics block the conduction of nerve impulses by _____ the permeability of the nerve cell membrane to _____ ions.
6. Ropivacaine is metabolized by cytochrome _____.
7. Ropivacaine is marketed as the pure _____ enantiomer while bupivacaine is marketed as a _____.

4. Using the *USP Dictionary of USAN and International Drug Names* which can be found in the Reference Section in our Pharmacy Library (RS 55 .U54 1997), draw the chemical structure of ropivacaine.

FIGURE 9. Drug List Used for Student Drug Thesis.

Antihypertensives–Calcium Channel Blockers	Diuretics (continued)
verapamil	hydrochlorothiazide
nifedipine	indapamide
diltiazem	omeprazole*
amlodipine	Antidepressants
isradipine	venlafaxine
Antihypertensives–Adrenergic Blockers	sertraline
terazosin	paroxetine
doxazosin	amitriptyline
metoprolol	nortriptyline
atenolol	fluoxetine HCl
Antihypertensives–ACE Inhibitors	Hypocholesterolemic
benazepril	lovastatin
fosinopril sodium	simvastatin
enalapril	pravastatin
lisinopril	fluvastatin
captopril	gemfibrozil
Antihistaminics–H ₁ Antagonists	Nonsteroidal Antiinflammatory Agents and Analgesics
loratidine	oxaprozin
terfenadine	naproxen
astemizole	ketorolac
promethazine HCl	ketoprofen
Antihistaminics–H ₂ Antagonists	etodolac
nizatidine	ibuprofen
cimetidine	tramadol HCl
ranitidine	Anxiolytics and Hypnotics
famotidine	diazepam
Antibiotics–Penicillins and Macrolides	alprazolam
azithromycin	buspirone
clarithromycin	lorazepam
penicillin V	zolpidem tartrate
erythromycin	Bronchodilators
amoxicillin	theophylline
Antibiotics–Cephalosporins	salmeterol
cephalexin	cromolyn sodium
cefaclor	albuterol
cefuroxime	ipratropium bromide
cefprozil	Corticosteroids
cefadroxil	beclomethasone dipropionate
Diuretics	betamethasone dipropionate
triamterene	triamcinolone acetonide
furosemide	fluticasone propionate
	mometasone furoate

*An antiulcer agent added to this category for the sake of convenience.

gain an understanding of the various aspects of the pharmacological literature. Therefore, a wide array of components are required in the literature assignment based on:

- a. requiring the student to gain a knowledge of the various names associated with drugs;
- b. requiring the students to differentiate between the chemical class and pharmacological class of drugs;
- c. requiring the student to use basic organic chemistry knowledge to identify basic functional groups, ionization possibilities, and hence chemical stability;
- d. introducing the student to chemistry associated with understanding pharmacological mechanisms of action;
- e. introducing the student to the chemistry associated with the metabolism of drugs; introducing the student to the chemistry associated with the drug half-life and disposition;
- f. introducing the student to the chemistry associated with the synthesis or isolation of a drug; and
- g. introducing the student to the style of literature associated with indications, interactions and adverse effects.

The students are encouraged to use chemical structures and illustrations to describe as many of the various components as possible. It is required that each thesis be typed, fully referenced in the *Journal of Medicinal Chemistry* style, all structures be computer-generated (not hand-drawn), and not exceeding ten single-spaced pages. Students are encouraged to use a variety of literature sources to compile their drug thesis. Each student is required to address the certain components in their report (see Figure 10). Once the written projects are completed, the students are asked to retain a photocopy of the thesis and submit the original for grading. The written

FIGURE 10. Components of Student Drug Thesis.

1. Chemical Structure	9. Pharmacophore-Drug Receptor
2. IUPAC Name	Interactions
3. Trade Name	10. Indications and Contraindications
4. Pharmacological and Chemical Class	11. Drug Interactions and Adverse Effects
5. Physical Chemistry	12. Pharmacokinetics
6. Functional Groups	13. Metabolism
7. Acid-Base Chemistry	14. Source and Basic Method of Production
8. Pharmacological Mechanism of Action	

portion of this assignment accounts for approximately 25% of the total laboratory course grade.

Laboratory Session 4: Group Presentations. Once the written literature thesis is submitted, the students are grouped together based on the 14 pharmacological classes. Groups vary in size from five to seven students, depending on the relative chemical diversity of the drug category (*i.e.*, there are seven members of the NSAID and Analgesics group and only four in the H₂ Antagonists Group). Since the students work independently on their literature projects, until this point they are unaware of who their group members will be. The student is thus required to adapt quickly to working in small groups. The student groups are given approximately two weeks to prepare a 15- minute oral presentation/overview of their pharmacological class of drugs. They are encouraged to be innovative, use as many group members in the presentation as possible, and to use creative presentation techniques.

The presentations were given to the entire MEDC 315 class in a special evening session. The presentations were graded by both the course faculty and the entire class. Grading was based on the following criteria: a. originality, b. clarity, c. preparation, d. group involvement, e. teaching quality, and f. overall quality (see Table 1). The group presentations accounts for approximately 10% of the total laboratory course grade.

EVALUATION

As a mechanism to determine the effectiveness of the literature project, a formal evaluation form was given to each student participant (see Figure 11).

RESULTS

Students enrolled in the laboratory section of the Introduction to Medicinal Chemistry Principles class (MEDC 315) at the University of Mississippi were presented with lectures and demonstrations of how to search for, analyze and recover scientific literature from traditional library sources, electronic databases, and the WWW.

The initial literature retrieval training sessions, laboratory sessions 1-3, provided students with the background necessary to initiate and complete a modern drug literature assignment. Individual grades for the assignments resulting from these three sessions ranged from 90 to 100%.

TABLE 1. Evaluation Sheet for MEDC 315 Presentations.

Drug Class	Originality	Clarity	Preparation	Group Involvement	Teaching Quality	Overall	Total Score
1. Antihypertensives-Calcium Channel Blockers							
2. Antihypertensives-Adrenergic Blockers							
3. Antihypertensives-ACE Inhibitors							
4. Antihistamines-H ₁ Antagonists							
5. Antihistamines-H ₂ Antagonists							
6. Antibiotics-Pencillins and Macrolides							
7. Antibiotics-Cephalosporins							
8. Diuretics							
9. Antidepressants							
10. Hypocholesterolemic							
11. NSAID-Analgesics							
12. Anxiolytics-Hypnotics							
13. Bronchodilators							
14. Corticosteroids							

Draw Xs through your own group—do not score your own group. Under each column rate the groups from 1 to 5 (5 highest).

The project assignments allowed the students to utilize their literature retrieval training individually in finding scientific information on a drug found in the top 200 drug listing. In addition, the students were indirectly introduced to an array of information and techniques including: drug classification and naming, computer-generated chemical structures, metabolism, mechanisms of action, scientific writing, referencing, etc. Individual grades for the written assignment ranged from 90 to 100%.

The group presentations required the students to put together cohesively scientific information that was gathered independently, and present it in a self-teaching mode. In addition, these presentations allowed students an opportunity to work in small problem-based learning groups. Each of the students was required to have speaking roles in the presentation, introduc-

FIGURE 11. Student Evaluation Form.

STUDENT EVALUATION					
<i>Literature Project</i>					
	Agree	*	Disagree		
1. This was an enjoyable way to be introduced to literature searching	1	2	3	4	5
2. The introduction to the library (hardcopy) was helpful and informative	1	2	3	4	5
3. The introduction to the library (computers) was helpful and informative	1	2	3	4	5
4. The introduction to the Internet was helpful and informative	1	2	3	4	5
5. The written project was helpful and informative	1	2	3	4	5
6. The class presentation was useful and informative	1	2	3	4	5
7. This project has increased my confidence in literature searching methodologies	1	2	3	4	5
8. Because of this project, I feel more comfortable in being able to find literature	1	2	3	4	5
9. Having a personal computer would have made this project less time-consuming	1	2	3	4	5
10. This project required an appropriate amount of time for the nature of the course	1	2	3	4	5
11. This project has helped me to work efficiently in small groups	1	2	3	4	5
12. This project has helped me better my communications skills	1	2	3	4	5
13. This project helped to increase my "Internet surfing" skills	1	2	3	4	5
14. This project has provided me with useful skills	1	2	3	4	5
15. This project is an important component of MEDC 315, and I would recommend continuing it as a course component as is, or with slight modification	1	2	3	4	5
16. Based on laboratory/class projects that I have participated in this year and how much I have learned, I would rate this project as effective	1	2	3	4	5
*No opinion					
NAME _____					
GROUP _____					

ing interprofessional interaction. Students were encouraged to be creative. The presentations included a variety of skits such as:

- a. The calcium channel blocker group presented a beauty competition with students playing the roles of each of the drugs. Contestants were asked questions based on their structures, pharmacological effects, etc.
- b. The adrenergic blockers group performed a skit of the aristocrats (alpha blockers) versus the country bumpkins (beta blockers). They used swimming noodles of varying diameter to illustrate drug effect on blood vessels and a punching balloon to illustrate effects on heart rate.
- c. One antibiotics group performed a skit which was a takeoff on Sesame Street. It included a sick child being confronted with all of the drugs (characters) and what they were going to do for her and why.
- d. The second antibiotics group performed a skit involving a patient/doctor/pharmacist scenario to illustrate their drug classes.
- e. The diuretics group performed a skit with a physician and a cranky old woman.
- f. The antidepressants group utilized a model of receptor binding illustrating drug mechanism.
- g. The hypocholesterolemics group used a multimedia computer presentation.
- h. The NSAID group performed a skit dealing with a TV news special report, multimedia, and a takeoff on the ad "I've fallen and I can't get up."
- i. The anxiolytic group used video to create a takeoff on the NSF's "Bill Nye the Science Guy."
- j. The bronchodilators group did a skit on the home shopping network where there was a special on the bronchodilators.
- k. The corticosteroid group used a traditional overhead lecture approach.

Results from the peer-evaluation were typically high, with students tending to rate each other highly. Based on instructor-evaluation and peer-evaluation, each group received a grade of 100% for the presentation portion of the project. Results from the student evaluation are presented in Table 2.

DISCUSSION

The objective of this project was to introduce third-year pharmacy students to the ever-changing methods of scientific literature retrieval.

TABLE 2. Results of Student Evaluation.*

	Agree		Disagree	
1. This was an enjoyable way to be introduced to literature searching.	51	29	16	3
2. The introduction to the library (hardcopy) was helpful and informative.	49	36	13	1
3. The introduction to the library (computers) was helpful and informative.	41	36	18	4
4. The introduction to the Internet was helpful and informative.	46	30	16	4
5. The written project was helpful and informative.	49	46	5	0
6. The class presentation was useful and informative.	44	31	15	7
7. This project has increased my confidence in literature-searching methodologies.	43	35	21	1
8. Because of this project, I feel more comfortable in being able to find literature.	43	39	14	3
9. Having a personal computer would have made this project less time-consuming.	60	20	10	6
10. This project required an appropriate amount of time for the nature of the course.	35	35	18	9
11. This project has helped me to work efficiently in small groups.	45	38	10	6
12. This project has helped me better my communications skills.	46	31	17	6
13. This project helped to increase my "Internet surfing" skills.	32	28	22	4
14. This project has provided me with useful skills.	40	45	14	1
15. This project is an important component of MEDC 315, and I would recommend continuing it as a course component as is, or with slight modification.	58	33	9	0
16. Based on laboratory/class projects that I have participated in this year and how much I have learned, I would rate this project as effective.	52	42	6	0

*Figures in % based on a response rate of 68-73 participants responding to each question.

Students were presented with lectures and demonstrations of how to search for, analyze, and recover scientific literature from traditional library sources, electronic databases, and the WWW.

After the training sessions, the students did exceptionally well on their written project assignments. Very few were unable to find the requested information and when information could not be found the students provided extensive bibliographies of the references and databases that were investigated. The ability of the students to retrieve the appropriate information was overwhelmingly successful, resulting in individual grades that ranged from 90 to 100%.

The group presentations required the students to meld scientific information that was gathered independently and present it in a self-teaching mode. One intent of the group presentation was to require the students to work in small groups very similar to the problem-based learning modules that are employed by our clinical pharmacy program. There were very few

problems associated with the groups with only an occasional complaint by leaders from one or two groups about a particular student not exhibiting a suitably high level of enthusiasm.

Results from the student evaluation indicate that the majority of students felt the exercise to be educationally beneficial. The evaluation indicates that the students had varying levels of literature retrieval skills at the beginning of the project. For example, this particular class was well acquainted with the use of Internet browsers. To compensate for this result, we intend to scale back certain lessons as the basic computer skills of our incoming students increase. The students also indicated that the project possibly consumed too much of their time; however, the group presentations and evaluation were given at the end of the semester just before final exams, a high stress time for the students. There was a clear indication that the students felt that the project would have been less time-consuming if they had a personal computer. This result added support to the School of Pharmacy's recent decision to require all pharmacy students to purchase a laptop personal computer beginning in the fall semester of 1997.

Based on the quality of the written projects, the presentations and the overall evaluation response of the students, it appears that this project provided an innovative mechanism for introducing pharmacy students to the methodologies of scientific literature retrieval, the use of computer technology, functioning in small problem based learning-type groups as well as public presentations, and an introduction to the chemistry and pharmacology of drug classes.

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